2017

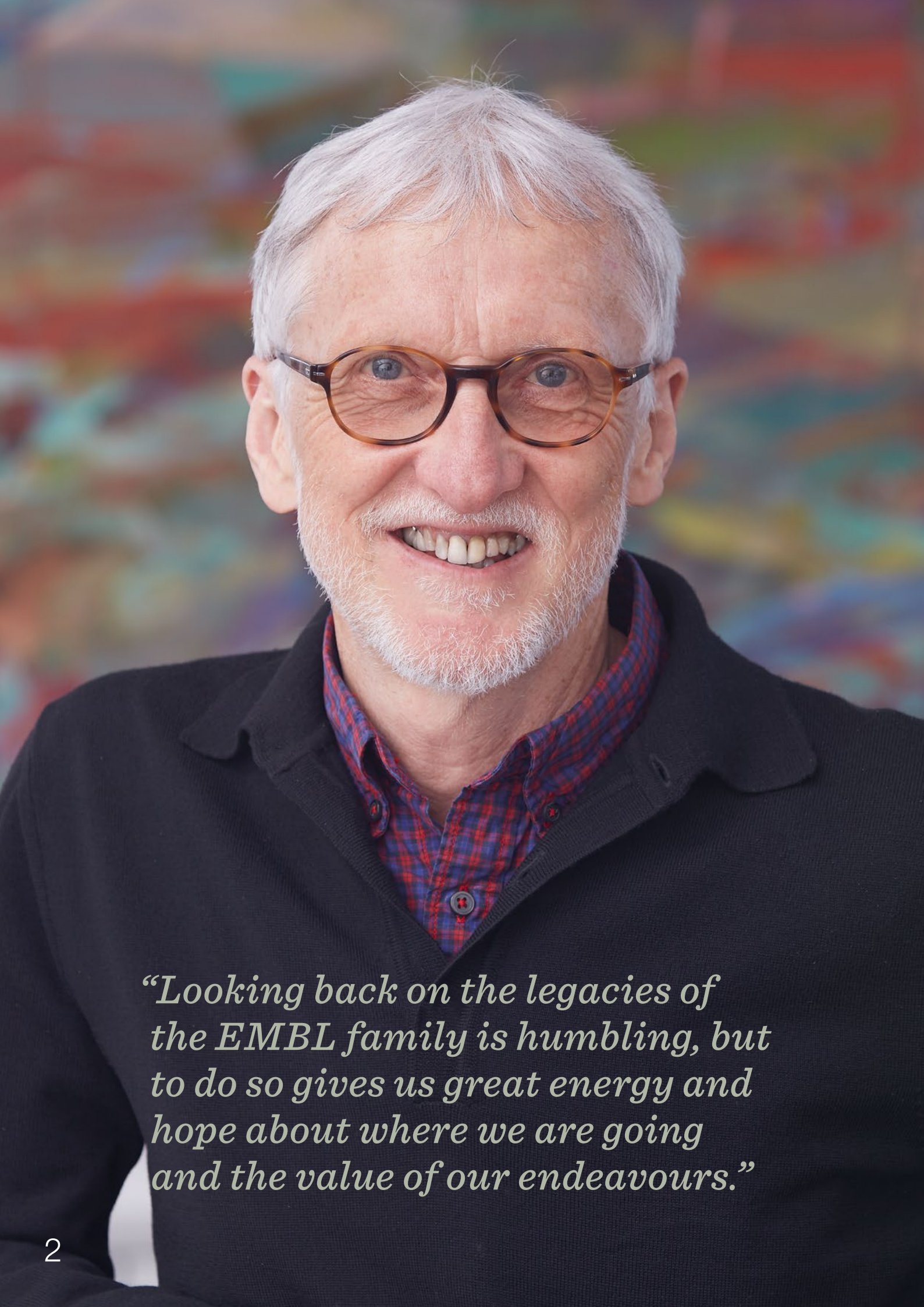
Annual Report

EMBL

Cover image

Confocal image of astrocytes in a rat primary retinal culture. Glial Fibrillary Acid Protein (GFAP) in cyan and nuclei in magenta. IMAGE: Sandra Correia/EMBL

Contents



“Looking back on the legacies of the EMBL family is humbling, but to do so gives us great energy and hope about where we are going and the value of our endeavours.”

Foreword

This past year was one of renewal for EMBL, a time to prepare the ground for the organisation's future. In June, Council selected Edith Heard to be my successor as EMBL's next Director General, starting in 2019. Edith is an excellent choice to lead EMBL, and I have every confidence in her ability to steer the organisation towards future success.

As I prepare to hand over stewardship of EMBL to Edith, I look back on two projects that have moved forward in significant ways this year. First, EMBL's latest site, in Barcelona, was opened in April. EMBL's sixth site is situated in the vibrant Barcelona Biomedical Research Park and explores tissue biology and disease modelling, fields that complement EMBL's research programme and bring our science closer to the clinic. Second, with the prospect of funding from German state and federal governments, as well as industry partners and private donors, we are moving closer to the realisation of a new EMBL Imaging Centre in Heidelberg, which will offer our technology, services and expertise in imaging to scientists from around the globe.

October saw EMBL alumnus Jacques Dubochet named as co-recipient of the 2017 Nobel Prize in Chemistry for work he carried out at EMBL on cryo-electron microscopy sample preparation. Jacques' award is a reminder of our legacy of excellence in developing scientific methods that push the entire field forward.

The year also brought its losses. We were deeply saddened by the death of Fotis Kafatos. Fotis was EMBL's third Director General, and he went on to become the founding president of the European Research Council. Fotis's contributions to the life sciences and the scientific community over five decades had a significant impact not just at EMBL, but also on European science in general.

Looking back on the legacies of the EMBL family is humbling, but to do so gives us great energy and hope about where we are going and the value of our endeavours. This is especially true of 2017.

Iain Mattaj

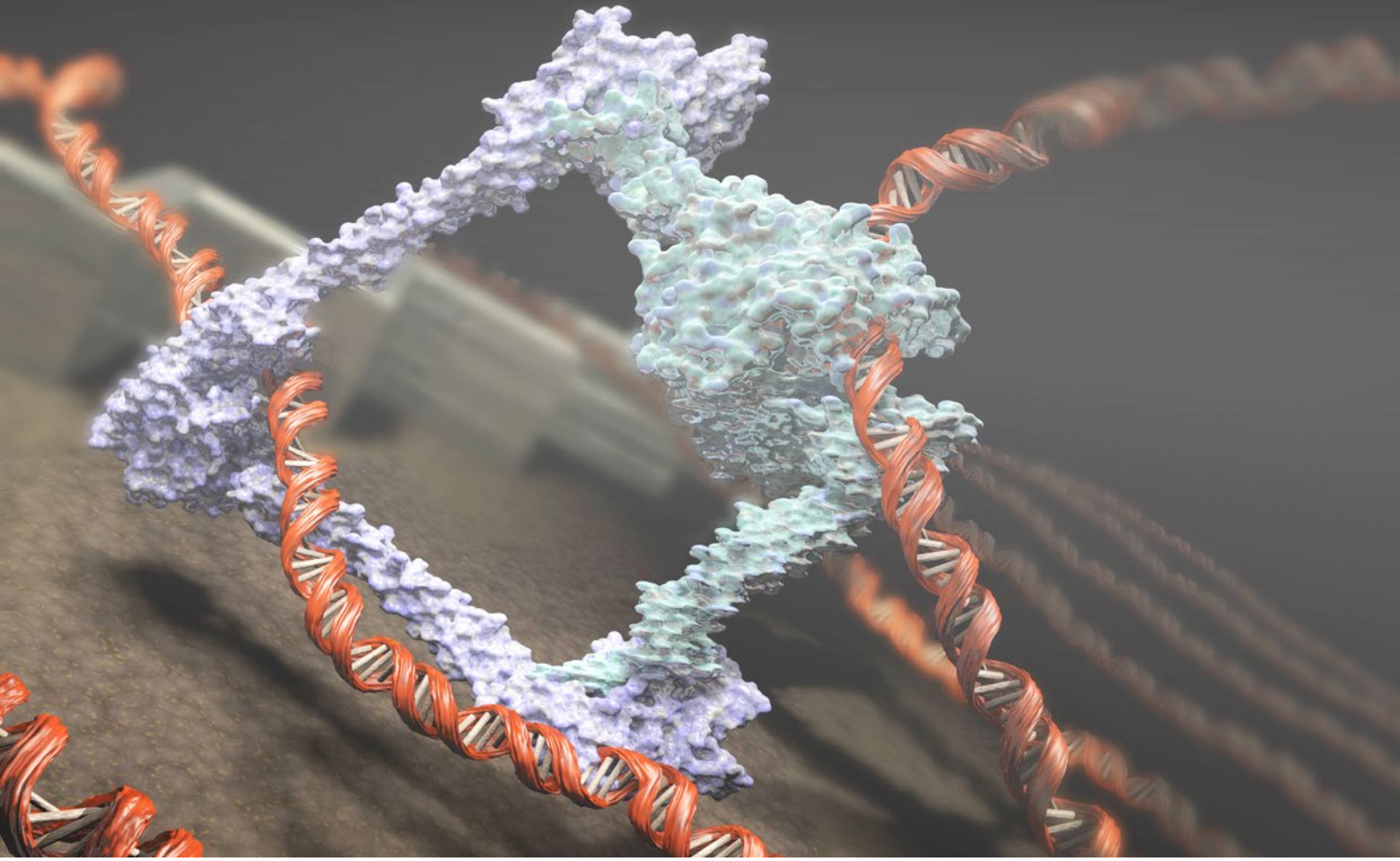
Research highlights

Uncovering the secrets of life

In a busy year at EMBL, 2017 saw the launch of the new site in Barcelona, the election of Edith Heard as EMBL's next Director General, and EMBL alumnus Jacques Dubochet scooping the Nobel Prize in Chemistry. These are just a few of EMBL's success stories from the past year. The following research highlights illustrate some of the most prominent findings and projects in which EMBL scientists engaged in 2017.

Cell Biology and Biophysics

Thanks to improvements in healthcare, more and more breast cancer patients survive the initial tumour. However, residual breast cancer cells that persist after chemotherapy often reinitiate growth after some years, causing a relapse that is often fatal. Breast cancer relapse has remained largely unexplored. The residual cells are difficult to identify and analyse



Condensin, a ring-shaped protein complex, packs DNA into chromosomes. The Häring group discovered that it holds part of a DNA strand, acting like a molecular motor to move another part of the strand through the condensin ring

because – until relapse – they look and act like normal cells. Researchers in the Jechlinger group found that, in mice, the tumour cells that survive therapy and eventually cause a relapse have specific traits that distinguish them from healthy cells. The scientists revealed that two of these traits could be promising targets for treatments to reduce tumour recurrence in breast cancer patients.

Havas KM et al. (2017) Metabolic shifts in residual breast cancer drive tumor recurrence. J Clin Invest 127(6):2091–2105. doi: 10.1172/JCI89914

The way DNA is compacted into chromosomes is a mysterious process in which condensin, a ring-shaped protein complex, plays a key role. In collaboration with scientists at Columbia University and TU Delft, the Häring group revealed a possible mechanism by which condensin packs DNA into chromosomes. One of their studies has shown that condensin acts like a molecular motor, moving with much larger steps than any other known motor protein. In another study, they revealed how the condensin complex interacts with DNA. Part of the complex encircles the DNA molecule, acting like a safety belt to hold it in place. This novel way of binding DNA provides key insights into the molecular mechanism of condensin-mediated chromosome organisation.

Kschonsak M et al. (2017) Structural basis for a safety-belt mechanism that anchors condensin to chromosomes. Cell 171(3):588–600. doi: 10.1016/j.cell.2017.09.008

Terakawa T, Bisht S, Eeftens JM et al. (2017) The condensin complex is a mechanochemical motor that translocates along DNA. Science 358(6363): 672–676. doi: 10.1126/science.aan6516

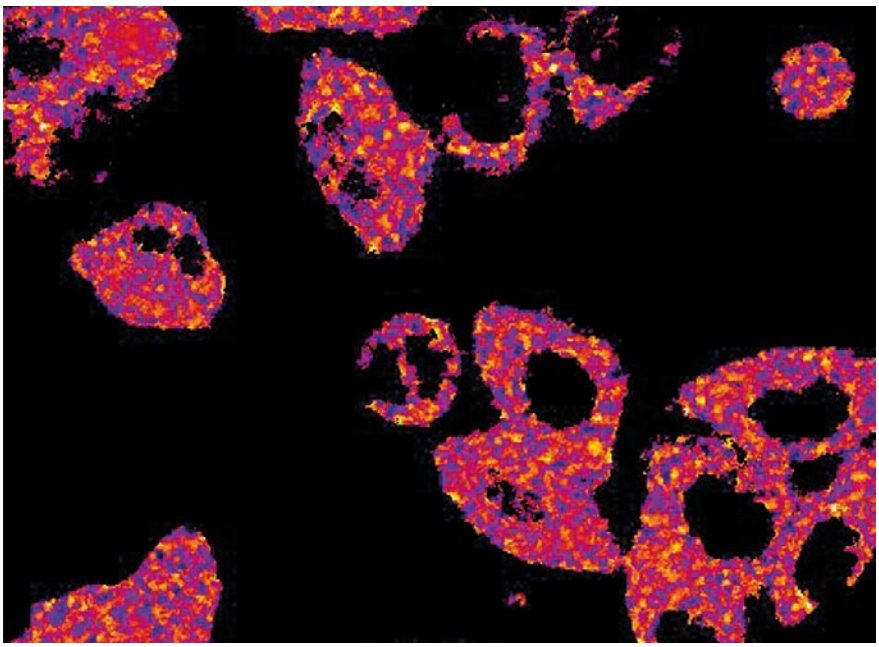
The nucleus of a cell is an exclusive place. The pores found in the nuclear membrane – a protective cover for the cell's nucleus – grant access to certain molecules, while others are kept out. Researchers from the Ellenberg, Beck and Schwab groups revealed the mechanism by which nuclear pores form. The findings could provide useful insights for treating health conditions such as cancer and immune and nervous system disorders.

Otsuka S et al. (2018) Postmitotic nuclear pore assembly proceeds by radial dilation of small membrane openings. Nat Struct Mol Biol 25(1):21–28. doi: 10.1038/s41594-017-0001-9

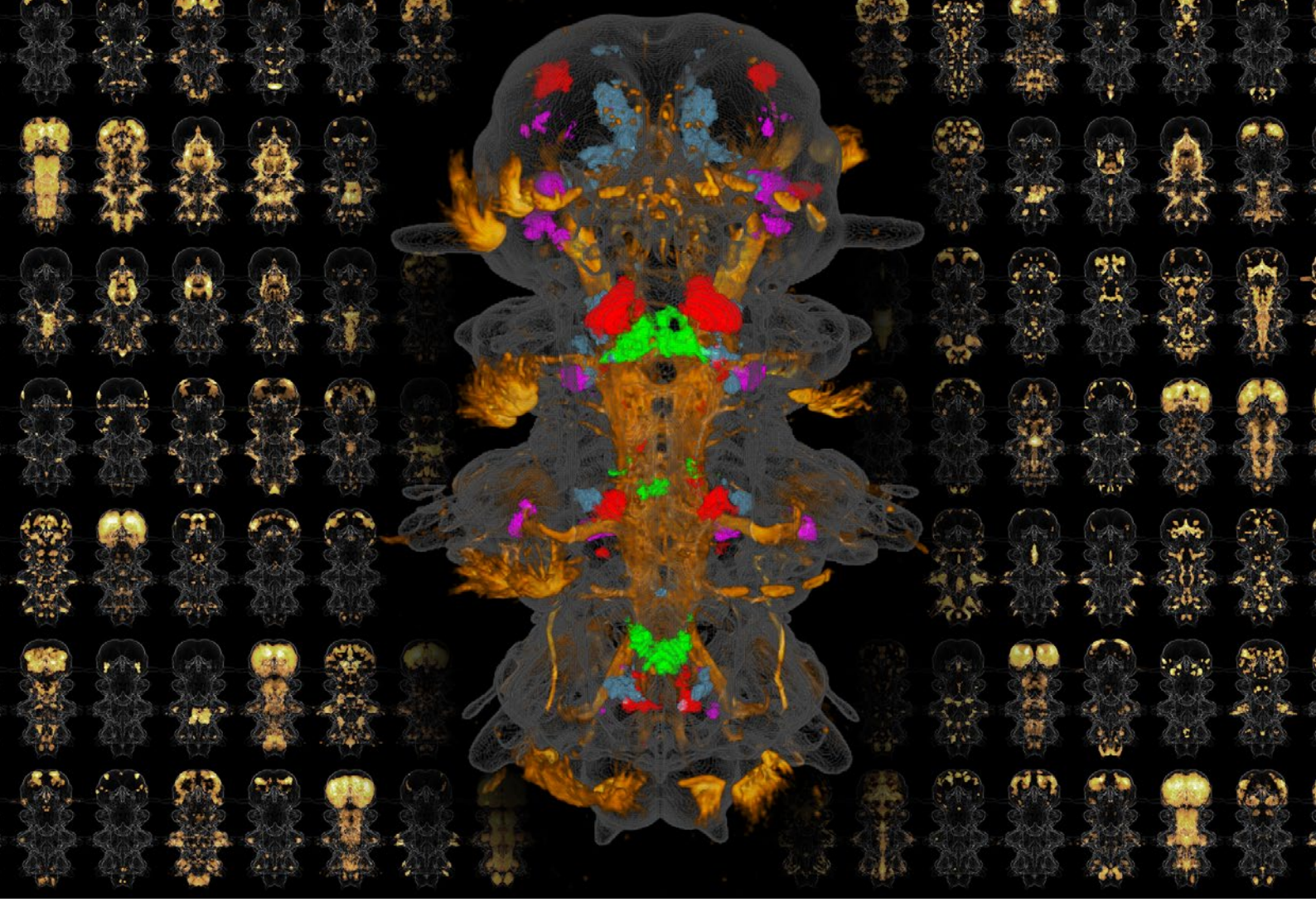
Developmental Biology

Metabolism – which provides cells with energy – is challenging to track in time and space. The strategy a cell uses to obtain energy can influence which of its genes are switched on, among other processes. In collaboration with the Schultz group in the Cell Biology and Biophysics Unit, scientists in the Aulehla group designed a fluorescence resonance energy transfer sensor that measures the amount of pyruvate – a product of metabolism – in a developing embryo. In collaboration with colleagues at ETH Zurich, the EMBL scientists also used mass spectrometry to directly measure other products of glycolysis. This strategy allowed the researchers to study the role of metabolic changes in development. Their results suggest that metabolism could be linked to – and even influence – the signalling machineries that control differentiation.

Bulusu V, Prior N, Snaebjornsson MT et al. (2017) Spatiotemporal analysis of a glycolytic activity gradient linked to mouse embryo mesoderm development. Dev Cell 40(4):331–341. doi: 10.1016/j.devcel.2017.01.015



In collaboration with the Schultz group, the Aulehla group designed a fluorescence resonance energy transfer sensor that can measure glycolysis in embryos



Gene expression in the nervous system is revealed in this image of a six-day-old Platynereis *larva, created by the Arendt group. It is a computer composite based on images of hundreds of individual specimens (background), each one showing expression of a single gene*

Researchers in the Arendt group succeeded in creating a molecular atlas of a whole organism. They studied the expression patterns of more than 100 genes in each cell of the marine worm *Platynereis dumerilii*. These genes are important during cell differentiation and can be compared to genes in different organisms to infer whether specific cell types were inherited from a common ancestor, and at what point in the history of life they first evolved.
Vergara HM et al. (2017) Whole-organism cellular gene-expression atlas reveals conserved cell types in the ventral nerve cord of *Platynereis dumerilii*. Proc Natl Acad Sci USA 114(23):5878–5885. doi: 10.1073/pnas.1610602114

Directors' Research

Inflammation plays an important role in health and disease. When specialised molecules inside the cell detect damage, a protein called ASC assembles large multi-protein complexes, called ASC specks. The formation of ASC specks plays a key role in triggering inflammation. Using CRISPR-Cas9, a powerful gene-editing technology, researchers in the Leptin group modified the zebrafish genome to insert a fluorescent label into the ASC gene. This modification allowed the researchers to observe ASC speck formation for the first time in vivo and in real time.
Kuri P et al. (2017) Dynamics of in vivo ASC speck formation. J Cell Biol 216(9):2891–2909. doi: 10.1083/jcb.201703103

EMBL Barcelona

The new EMBL site in Barcelona, which was launched in 2017, focuses on tissue biology and disease modelling. Tissue biology involves the study of processes such as the way cells interact with each other, how they respond to their surroundings, and how organs develop. Many health conditions, like cancer, diseases of the immune system and developmental disorders, involve flaws in the way cells arrange themselves and interact at the tissue level. Research in tissue biology raises the exciting prospect of being able to control, make and heal tissues and organs – approaches that could provide new means of treating many human diseases. James Sharpe, who invented a 3D imaging technique for studying tissues and organs called optical projection tomography, was recruited as Head of EMBL Barcelona. Alongside cutting-edge research, the new site will house facilities (p. 21) that will make state-of-the-art tissue imaging technologies like Sharpe's available to scientists worldwide.

EMBL-EBI

Stem cell researchers have produced one of the largest collections of high-quality human induced pluripotent stem cell lines from healthy individuals. This comes as a result of a close collaboration between the Stegle group at EMBL-EBI, the Wellcome Sanger Institute, King's College London, the University of Dundee and the University of Cambridge. The data generated by the initiative are hosted and distributed via EMBL-EBI's data resources.
Kilpinen H, Goncalves A, Stegle O, Gaffney DJ et al. (2017) Common genetic variation drives molecular heterogeneity in human iPSCs. Nature 546(7658):370–375. doi: 10.1038/nature22403

In an international endeavour to systematically identify the function of every mouse gene, researchers from the Flicek and Parkinson teams are collaborating with the International Mouse Phenotyping Consortium. The scientists characterised mutants of more than 3000 mouse genes in an effort to understand gene function. The results offer hundreds of new disease models and reveal previously unknown gene functions. The project has resulted in a series of publications describing major findings on the causes of hearing loss in humans, on embryonic development, and on sexual dimorphism and disease models.
Bowl MR, Simon MM, Ingham NJ, Greenaway S, Santos L et al. (2017) A large scale hearing loss screen reveals an extensive unexplored genetic landscape for auditory dysfunction. Nat Commun 8:886. doi: 10.1038/s41467-017-00595-4
Meehan TF, Conte N, West DB et al. (2017) Disease model discovery from 3,328 gene knockouts by The International Mouse Phenotyping Consortium. Nat Genet 49(8):1231–1238. doi: 10.1038/ng.3901
Karp NA et al. (2017) Prevalence of sexual dimorphism in mammalian phenotypic traits. Nat Commun 8:15475. doi: 10.1038/ncomms15475

A collaboration between the Beltrao group and the Wellcome Sanger Institute revealed extremely fast and broad protein regulation during the reproduction of the malaria parasite *Plasmodium*. The research will help scientists break down what happens in the parasite at the molecular level during its reproduction inside mosquitoes. It could also enable the identification of proteins that, if targeted, could stop transmission of the parasite.

Invergo BM, Brochet M et al. (2017) Sub-minute phosphoregulation of cell cycle systems during *Plasmodium* gamete formation. Cell Rep 21(7):2017–2029. doi: 10.1016/j.celrep.2017.10.071

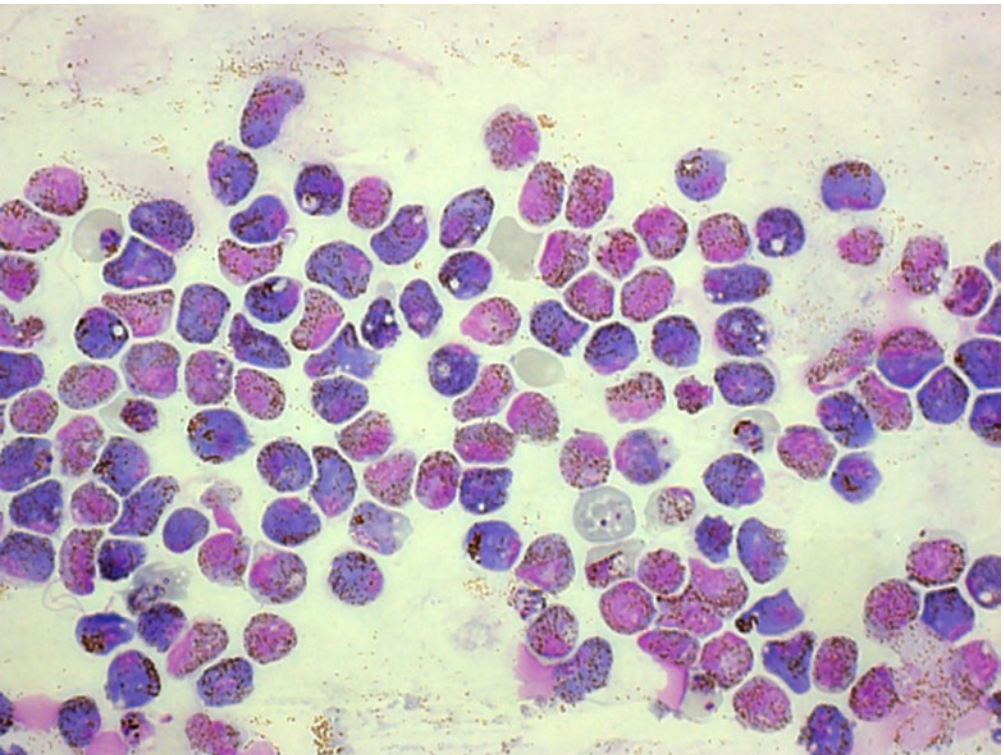
EMBL Grenoble

Enzymes accelerate chemical reactions inside cells and are essential for sustaining life. The Marcia group, in collaboration with researchers from the Italian Institute of Technology, studied a class of enzymes known as two-metal-ion enzymes. They found that enzymes in this group have similarities beyond having metal ions positioned at the same place in the active site. The research also revealed potential new drug targets.

Genna V, Colombo M et al. (2018) Second-shell basic residues expand the two-metal-ion architecture of DNA and RNA processing enzymes. Structure 26(1):40–50. doi: 10.1016/j.str.2017.11.008

In vertebrates, each side of the body is controlled by the opposite side of the brain. This means that some of the neuron's long extensions, the axons, need to cross the midline that separates the two brain hemispheres. Together with collaborators from the Grenoble-based Institute de Biologie Structurale, researchers from the McCarthy group resolved a decade-long debate by showing that the correct guidance of axons across the midline depends on a conformational change of a neural receptor called Robo.

Aleksandrova N et al. (2018) Robo1 forms a compact dimer-of-dimers assembly. Structure 26(2):320–328.e4. doi: 10.1016/j.str.2017.12.003



The formation of reproductive cells in the malaria parasite Plasmodium

EMBL Hamburg

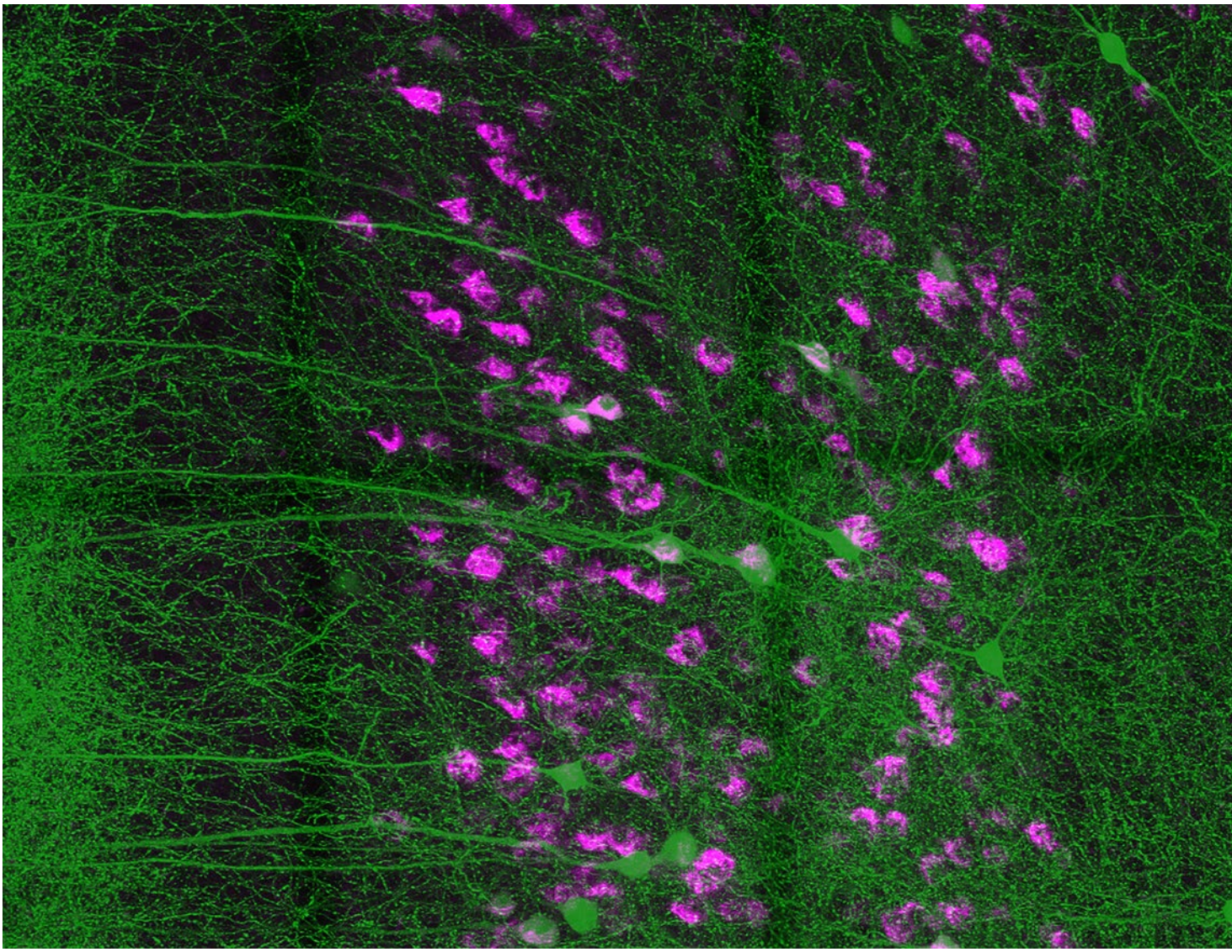
In collaboration with scientists from across Europe, researchers from the Wilmanns group revealed the overall architecture of an assembly of proteins known as type VII secretion systems, found in a group of bacteria responsible for causing diseases such as tuberculosis. These results represent a big step forward in our understanding of how some of the deadliest pathogenic bacteria function.
Beckham KSH, Ciccarelli L, Bunduc CM et al. (2017) Structure of the mycobacterial ESX-5 type VII secretion system membrane complex by single-particle analysis. Nat Microbiol 2:17047. doi: 10.1038/nmicrobiol.2017.47

The Svergun and Lemke groups collaborated to reconcile a long-standing discrepancy between small-angle X-ray scattering (SAXS) and fluorescence resonance energy transfer results in measurements of intrinsically disordered proteins.
Fuertes G, Banterle N, Ruff KM et al. (2017) Decoupling of size and shape fluctuations in heteropolymeric sequences reconciles discrepancies in SAXS vs. FRET measurements. Proc Natl Acad Sci USA 114(31):E6342–E6351. doi: 10.1073/pnas.1704692114

EMBL Rome

EMBL's Unit in Italy has changed its name to better reflect its new areas of research, while the new site name highlights its location for EMBL's international audience. Over the coming years, EMBL Rome will gradually narrow its research focus from mouse biology to neuroscience and epigenetics. Collaboration between experts in these two fields, coupled with other Units' expertise in molecular imaging, genomics and structural biology, will encourage significant advances in our understanding of the nervous system and behaviour.

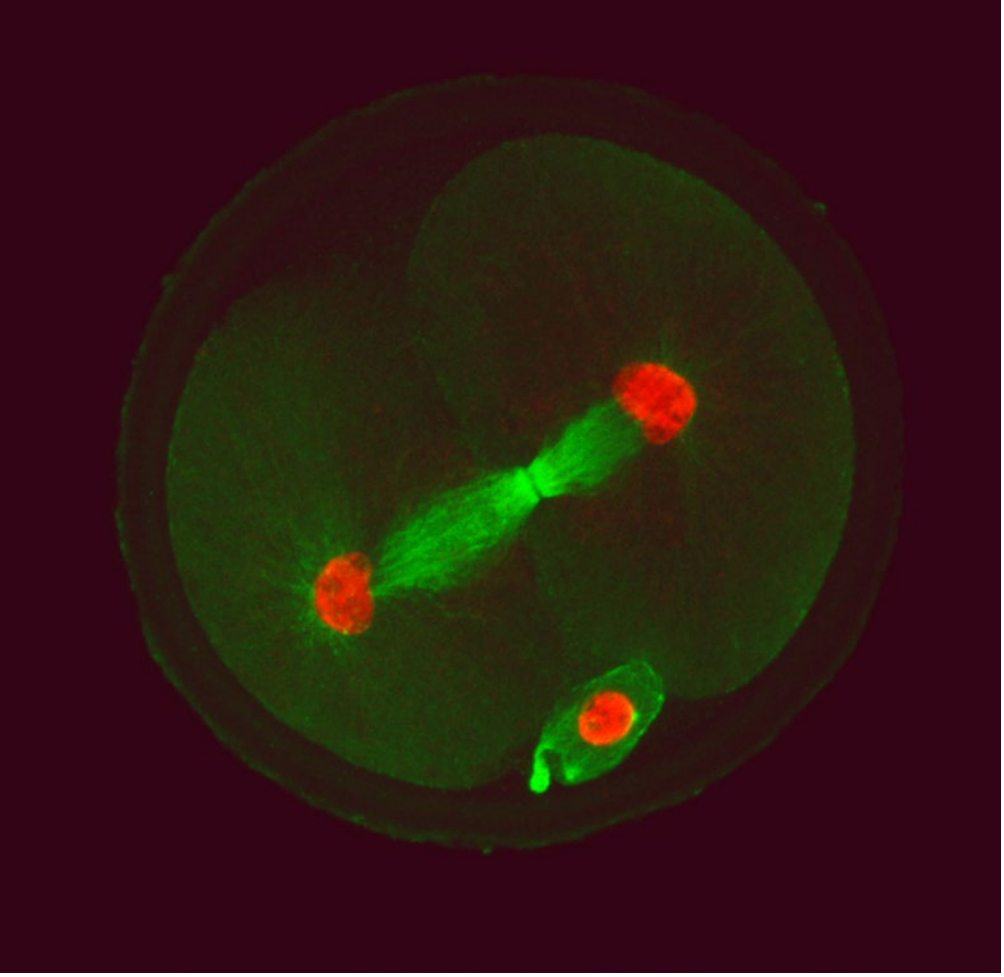
Our instincts are driven by the region at the very base of the brain, known as the brainstem. Another brain region, the prefrontal cortex, plays a role in keeping those instincts in check. But exactly how the prefrontal cortex puts a brake on the brainstem has remained unclear – until now. Scientists from the Gross group teamed up with colleagues at the MRC Laboratory of Molecular Biology in Cambridge, UK, to trace connections between neurons in a mouse brain. They discovered that the prefrontal cortex makes prominent connections directly to the brainstem.
Franklin TB et al. (2017) Prefrontal cortical control of a brainstem social behavior circuit. Nat Neurosci 20(2):260–270. doi: 10.1038/nn.4470



The Gross group discovered that the prefrontal cortex makes prominent connections (purple) directly to the brainstem, to control our instinctive behaviours

DNA from viruses that infected our ancestors millions of years ago has remained in our genome to this day. The Hackett group, in collaboration with scientists from the Gurdon Institute in Cambridge, UK, found that a viral sequence is critical for early development of the mouse embryo. The researchers also identified the protein involved in regulating this sequence and showed that mouse embryos did not survive without it. Although the study was performed on mice, similar genetic sequences could play a comparable role in human development.

Huang Y, Kim JK et al. (2017) Stella modulates transcriptional and endogenous retrovirus programs during maternal-to-zygotic transition. eLife 6:e22345. doi: 10.7554/eLife.22345



A two-cell mouse embryo during cell division, revealed by the Hackett group

Genome Biology

Scientists have known for some time that promoters – sequences of DNA that turn genes on – have a defined shape. 'Narrow' promoters turn genes on very precisely at a given position in the genome, while 'broad' promoters turn genes on in an area spanning several hundred bases. Now scientists in the Furlong, Birney and Stegle groups have revealed not only that genetic differences between individuals can affect the shape of promoters, but also that a promoter's shape influences how much its output varies from cell to cell.

Schor IE et al. (2017) Promoter shape varies across populations and affects promoter evolution and expression noise. Nat Genet 49(4):550–558. doi: 10.1038/ng.3791

In collaboration with researchers from the German Cancer Research Center (DKFZ) in Heidelberg, the Steinmetz group has developed a technology that makes it possible to find out how cells differentiate into various mature cell types in the blood. Their results contradict the traditional hierarchical tree-like structure of the differentiation process, demonstrating that blood stem cell differentiation is a continuum: stem cells are locked on to the path towards a specific cell type without passing through defined progenitor stages.

Velten L, Haas SF, Raffel S et al. (2017) Human haematopoietic stem cell lineage commitment is a continuous process. Nat Cell Biol 19(4):271–281 doi: 10.1038/ncb3493

Structural and Computational Biology

Although the ravages of the Ebola virus are no secret, the structure of some of the virus's smallest components have remained a mystery. The Briggs group created the highest-resolution 3D model of Ebola's nucleocapsid, the structure that packages its genetic material. This new information will help answer important questions about how Ebola replicates and infects new host cells.

Wan W et al. (2017) Structure and assembly of the Ebola virus nucleocapsid. Nature 551(7680):394–397. doi: 10.1038/nature24490

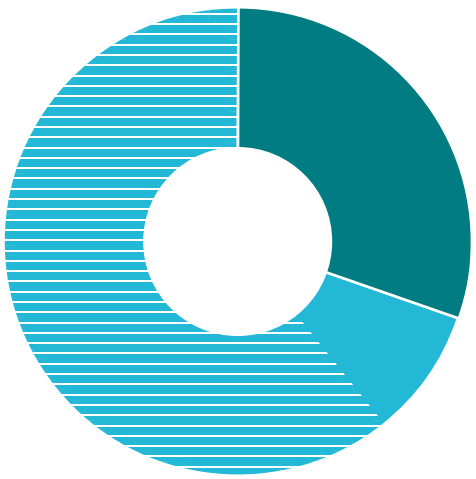
The DNA contained in a cell's nucleus would be almost two metres long if stretched out. To fit into the nucleus, the DNA coils up and creates a tightly packed structure called chromatin. Researchers in the Zaugg group and Gibson team collaborated with members of the Noh group to show for the first time how the 3D structure of chromatin has an effect on a process called RNA splicing, which can alter the proteins expressed by the cell.

Ruiz-Velasco M, Kumar M, Lai MC et al. (2017) CTCF-mediated chromatin loops between promoter and gene body regulate alternative splicing across individuals. Cell Syst 5(6):628–637.e6. doi: 10.1016/j.cels.2017.10.018

The yeast *Saccharomyces cerevisiae* ferments grape juice into wine, while other microbes are involved in making yogurt and other fermented foods. Researchers from the Patil group explained how microbes can create niches and feed each other. Their work also showed that a small change in the environment can shift the interaction from a one-way relationship to a mutual dependency.

Ponomarova O, Gabrielli N et al. (2017) Yeast creates a niche for symbiotic lactic acid bacteria through nitrogen overflow. Cell Syst 5(4):345–357. doi: 10.1016/j.cels.2017.09.002

Scientific publications in 2017



203 By EMBL

464 By EMBL in collaboration with nearly 500 organisations worldwide

405 By EMBL in collaboration with organisations in member and associate member states

667 Total

Services

Breaking ground to enable breakthroughs

Bioinformatics services

Through its renowned bioinformatics services, EMBL enables researchers worldwide to access, analyse and extract meaning from biomedical research data. EMBL-EBI hosts numerous data resources that are freely available to researchers everywhere. Both submissions to and usage of these resources continue to grow as data-generating technologies improve. At the close of 2017, EMBL-EBI had 155 petabytes of data storage capacity, up from 101 petabytes at the end of 2016. Daily requests to EMBL-EBI's websites averaged just under 38 million per day, up from 27 million per day in 2016 (see graph, p. 16). As further testimony to the value of EMBL-EBI's services for the life science community, 13 EMBL-EBI resources were featured among ELIXIR's Core Data Resources and a further eight were included in the list of archives recommended for the deposition of experimental data (p. 41).

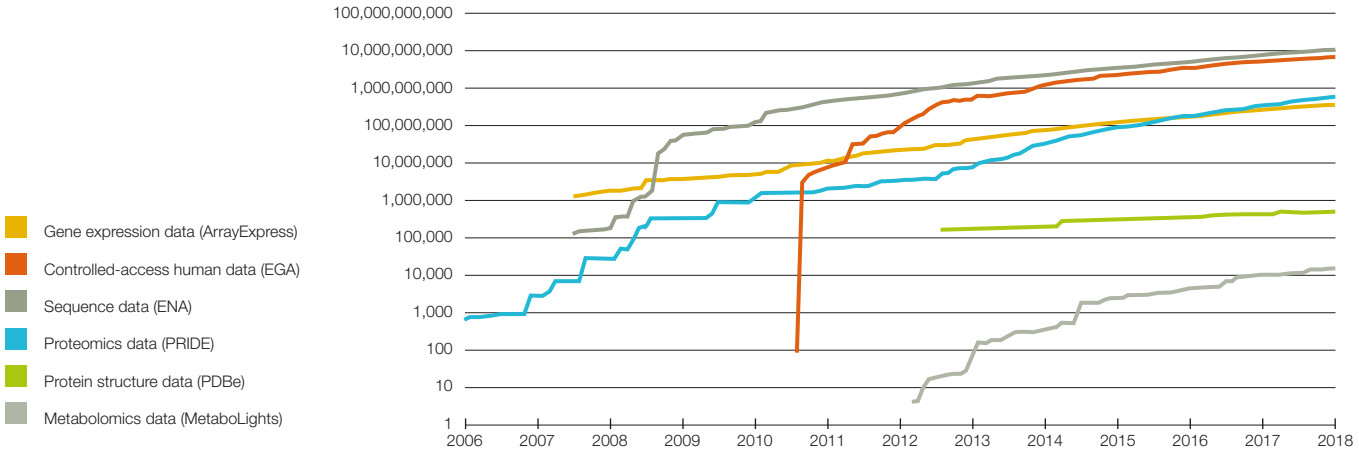
Millions of people generously give their time, blood and information to biobanks – all with the goal of improving research into human disease

EMBL-EBI is internationally recognised for its experience coordinating large-scale open science initiatives. This expertise will be brought to bear in building the Data Coordination Platform for the Human Cell Atlas, an endeavour to chart the specific genetic properties of all human cells, across all tissues and organs. To enable researchers to extract meaningful information from the tens of millions of datasets that the project will generate, EMBL-EBI, the Broad Institute and the Genomics Institute at the University of California Santa Cruz will build a cloud-based pipeline funded by the Chan Zuckerberg Initiative.

In July 2017, UK Biobank, which manages the health information of more than 500,000 people, announced that it would share genetic data in its first release via the European Genome-phenome Archive, a joint resource developed by EMBL-EBI and the Centre for Genomic Regulation in Spain. Biomedical research data come in many different formats and are hosted on a multitude of platforms. This can pose huge challenges for data analysis. EMBL-EBI launched several resources in 2017 that help address those challenges. Scientists at EMBL-EBI, the University of Dundee, the University of Bristol and the University of Cambridge launched the Image Data Resource, the first biological image repository that integrates imaging data from multiple laboratories. The size and scope of the project are expected to grow as the volumes of imaging data increase. Another resource launched in 2017 was the Ontology Xref Service (OxO), which makes it possible to combine datasets that are labelled in different ways. OxO allows private companies to map their ontologies to those in the public domain, bridging the gap between public and private research data collections. A third resource is the Omics Discovery Index, a single interface that makes data from publicly funded research more discoverable and reusable by searching 81,000 datasets from 11 repositories.

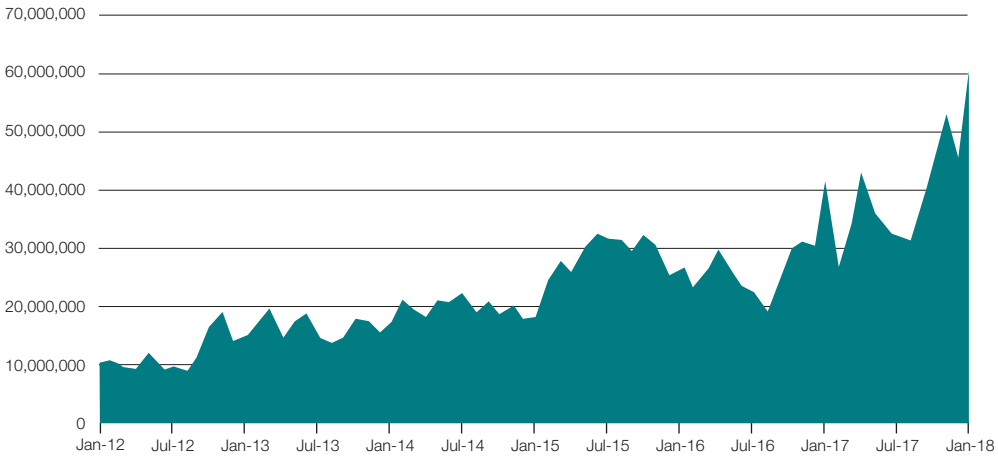
Growth of data by type

Volume of data (megabytes)

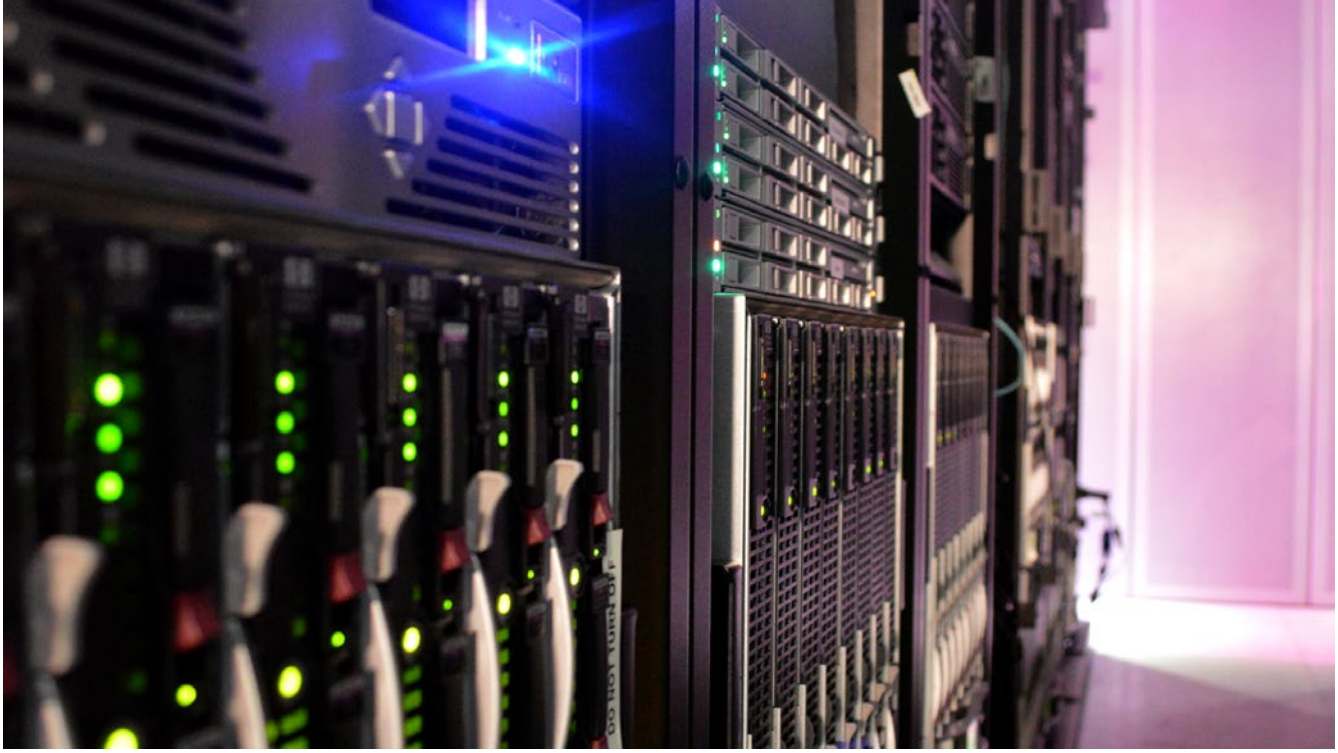


Usage of EMBL-EBI websites

Web requests per day, 2012 through 2017



The BioModels team worked closely with researchers from the KTH Royal Institute of Technology in Stockholm and other collaborators to curate and annotate 6753 patient-derived genome-scale metabolic models of 21 types of cancer. Researchers studying cancer can now use these freely available models as a starting point to explore what happens in tumours at a molecular level and understand variability among patients and between different types of tumours.



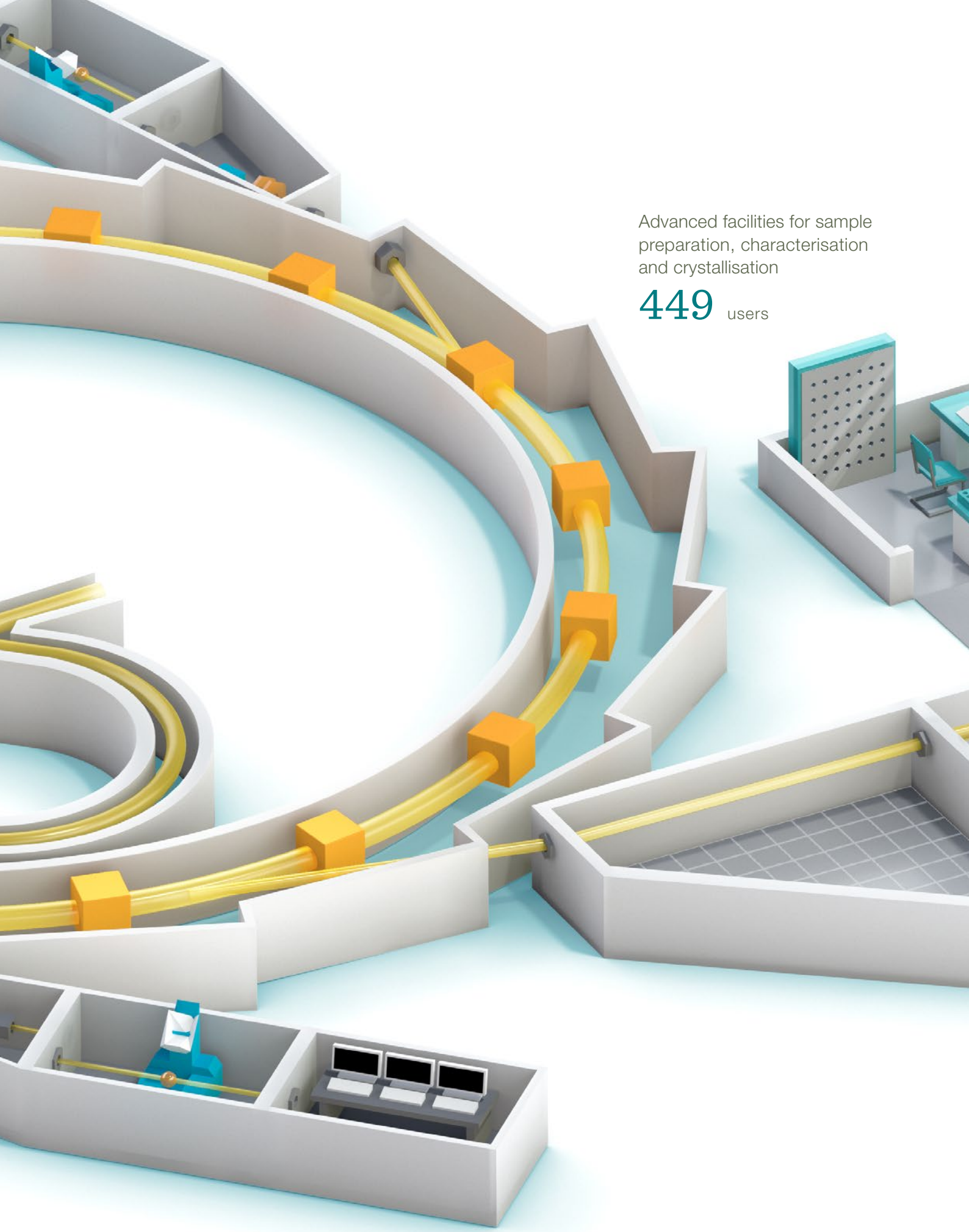
EMBL-EBI data centre in Hinxton, UK

Structural biology services

At the European Synchrotron Radiation Facility (ESRF) in Grenoble and the German Electron Synchrotron (DESY) in Hamburg, EMBL provides infrastructure for structural biologists from all over Europe. At both EMBL Grenoble and EMBL Hamburg, the synchrotron beamlines for macromolecular crystallography (MX) and SAXS are complemented by advanced facilities for the preparation, characterisation and crystallisation of biological samples and by computational resources and EMBL-developed software packages for the analysis of structural data. Through these integrated resources and facilities, EMBL offers access to services, expertise and user training across the entire structural biology workflow (pp. 18 – 19).

EMBL Grenoble

In 2017, EMBL and ESRF reinforced their commitment to working together, extending their bilateral collaboration agreement until 2021. Under the Joint Structural Biology Group agreement, EMBL and ESRF scientists and engineers have automated most instruments on the X-ray beamlines in Grenoble, allowing users to collect diffraction data more easily and efficiently from increasingly small crystals. One recent joint success was the full automation of the process of protein structure determination, which was achieved by combining the world's first fully automated protein crystallography beamline, MASSIF, with CrystalDirect, the robot developed by EMBL scientists that automates crystal harvesting. This combined pipeline is garnering interest from pharmaceutical companies as well as academic users, as it will be particularly useful for systematically studying how small molecules bind to proteins – an important step of the drug development process.

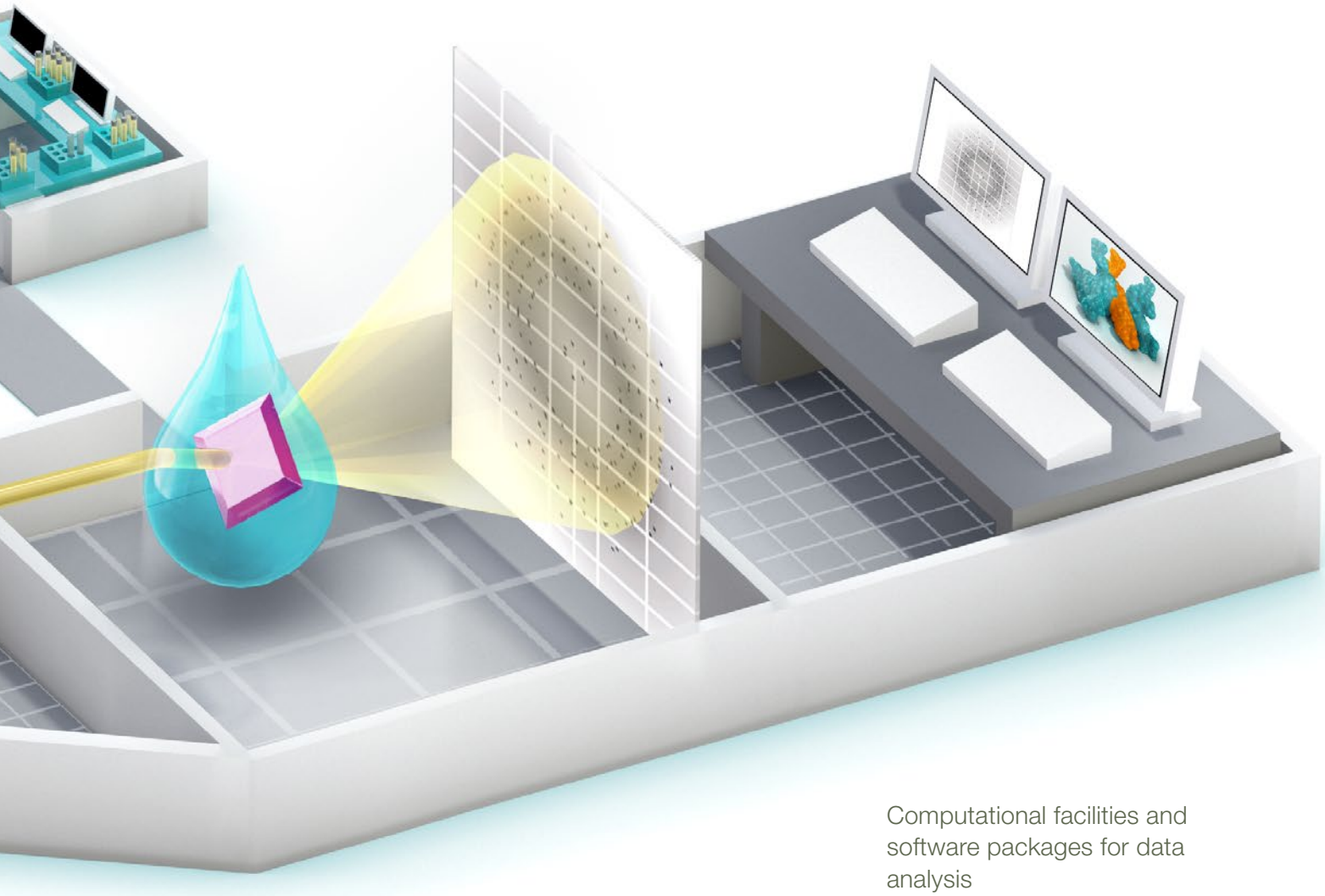


Advanced facilities for sample preparation, characterisation and crystallisation

449 users

Structural biology services in 2017

EMBL's facilities in Hamburg and Grenoble (where beamlines are operated together with ESRF) support users throughout the whole process of biological structure determination.



Beamline services

3,459 users

Computational facilities and software packages for data analysis

10,104 users

Alongside X-ray crystallography, cryo-electron microscopy (cryo-EM) is increasingly becoming a standard approach for structural biologists. To make it available to scientists from around the globe, ESRF, EMBL and the Institut de Biologie Structurale opened a major new facility for cryo-EM on the European Photon and Neutron science campus. Funded largely by the ESRF, the project is run by the three institutes, with a team of three scientists – one from each institute – on hand to support users. The new facility is open to the institutes' researchers, as well as scientists from ESRF's 22 partner nations, with access granted through a peer-review system on the basis of scientific merit.

EMBL Hamburg

In Hamburg, 2017 heralded the opening of two institutes where EMBL scientists will play a key role in paving new paths for biomedical research. In June, the Centre for Structural Systems Biology (CSSB) was officially inaugurated. The CSSB is a joint initiative of ten research partners, including EMBL. The centre is housed in a new building specifically designed to enhance collaboration, innovation and mentoring opportunities for young researchers. The construction of the building was financed by the Federal Republic of Germany, the City of Hamburg, the Federal State of Lower Saxony and the Federal State of Schleswig-Holstein. Two EMBL groups will be among 180 international researchers working at the centre. CSSB researchers will work on some of the most challenging projects in structural biology: the functioning of viruses, bacteria and parasites. EMBL will also provide services to all CSSB researchers, as EMBL Hamburg's Sample Preparation and Characterisation Facility has been extended to include two Core Facilities at CSSB: one for high-throughput crystallisation and one for sample characterisation. The extensions are supported by the German Ministry for Research and Education with close to €3 million in funding for new instruments and staff support over an initial phase of five years.

At the inauguration ceremony for the Centre for Structural Systems Biology (CSSB), Matthias Wilmanns (Head of EMBL Hamburg and CSSB Scientific Director, centre) receives the key to the building

The second of the two new institutes, the European X-Ray Free-Electron Laser Facility (European XFEL), officially opened for researchers in September. Throughout the groundwork for the facility's launch, scientists from EMBL Hamburg have been committed to contributing to XFEL-based biology infrastructures. EMBL has become a prominent partner of the XFEL Biology Infrastructure Laboratory, a facility for sample preparation, handling, testing and scoring of biological samples to be measured at the European XFEL.

At all three EMBL beamlines at Petra III, time-resolved experiments are on the rise. Increasingly, researchers are using X-ray crystallography and SAXS to address key aspects in structural dynamics, in addition to obtaining the more traditional, 'static' high-resolution structural information. To empower this trend, the instrumentation teams at EMBL Hamburg implemented a series of crucial technical upgrades on beamline equipment in 2017. As part of EMBL's commitment to serving the scientific community worldwide, in 2017 the MX beamlines joined the SAXS beamlines in offering users the option of remote access.

Core Facilities and IT services

In 2017, over 1000 scientists took advantage of the state-of-the-art equipment and expert support that are the trademark of EMBL's Core Facilities. From Advanced Light Microscopy to Genomics, Flow Cytometry to Protein Expression and Purification, the facilities play a crucial role in enabling scientists from EMBL and its member states to achieve ambitious research goals. In addition, Core Facilities staff share their knowledge and expertise with the broader scientific community by organising courses, workshops and meetings, often in cooperation with partners in academia and industry. Thanks to funding from EMBL's Corporate Partnership Programme (CPP), the Core Facilities also provide dedicated support to young scientists from EMBL member states through the Christian Boulin Fellowships.

From the intricate make-up of molecules to the coordinated complexity of an organism, imaging technologies are changing how scientists see life. EMBL has ambitious plans to enable scientists worldwide to harness the potential of these technological developments. In 2017, plans were unveiled for a new imaging centre, to be hosted at EMBL Heidelberg. This new centre for light and electron microscopy will be a unique facility, uniting cutting-edge equipment, data analysis and expert support. Scientists from EMBL and beyond – in both academia and industry – will have the opportunity to use the very latest technologies, even before they are commercially available, thanks to close cooperation between EMBL and leading microscopy companies. The centre is expected to begin operations in 2021.

At EMBL Barcelona (p. 8), the new Mesoscopic Imaging Facility – which will start serving the community in 2018 – will be one of the few places in the world where scientists can access state-of-the-art microscopy and modelling technologies specifically designed for studying tissues.

Architectural rendering of the new EMBL Imaging Centre, to be completed in 2021

These techniques can reveal critical information, as they offer the organ-wide context that enables researchers to look beyond what happens within individual cells and see the whole picture.

As biology moves ever further into the digital realm, EMBL's IT Services teams ensure that the institute is equipped with the best possible solutions – even if that means creating them themselves. Working closely with scientists and EMBL's Core Facilities, EMBL's IT Services developed the EMBL 3D Cloud, a flexible, scalable virtualisation infrastructure that enables users to process microscopy data without having to move large datasets multiple times. Alongside the seemingly limitless deluge of data, the increasing adoption of cloud computing technology is another trend in biomedical research. With this in mind, EMBL-EBI's Technical Services Cluster ran a successful course on how to efficiently move pipelines from traditional scientific computing into the cloud.

In keeping with EMBL's mission to integrate life science research throughout Europe, the institute's IT teams have been involved in a variety of activities related to the European Open Science Cloud, a European Commission (EC) initiative that aims to build a cloud-based platform for Europe's research communities. One of the most visible elements of this work has been the use of three different clouds – including the EMBL-EBI Embassy cloud – to analyse the data from the international Pan-Cancer Analysis of Whole Genomes project.

Technology

development and transfer

Translating fundamental research into far-reaching applications

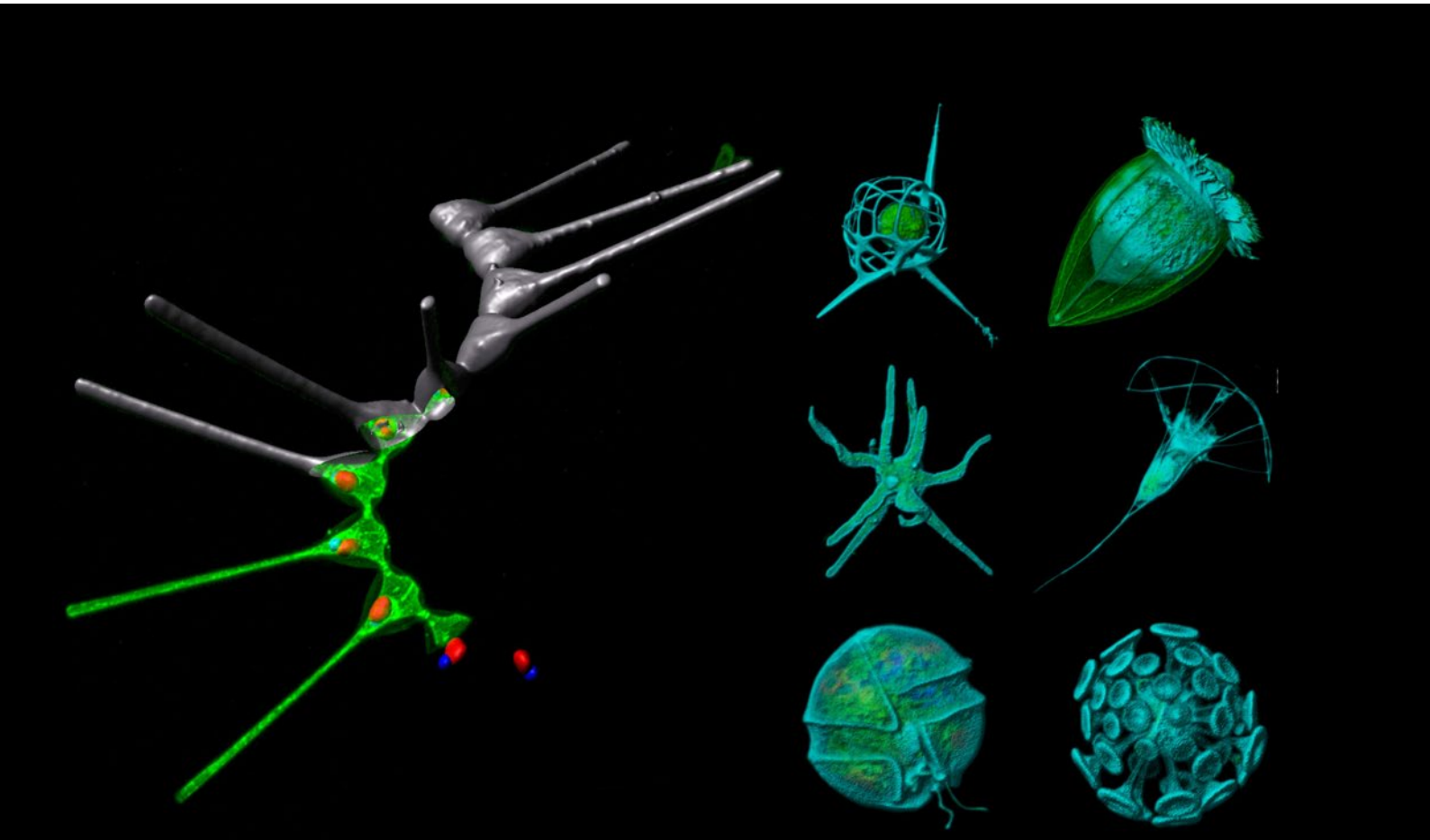
Technology development

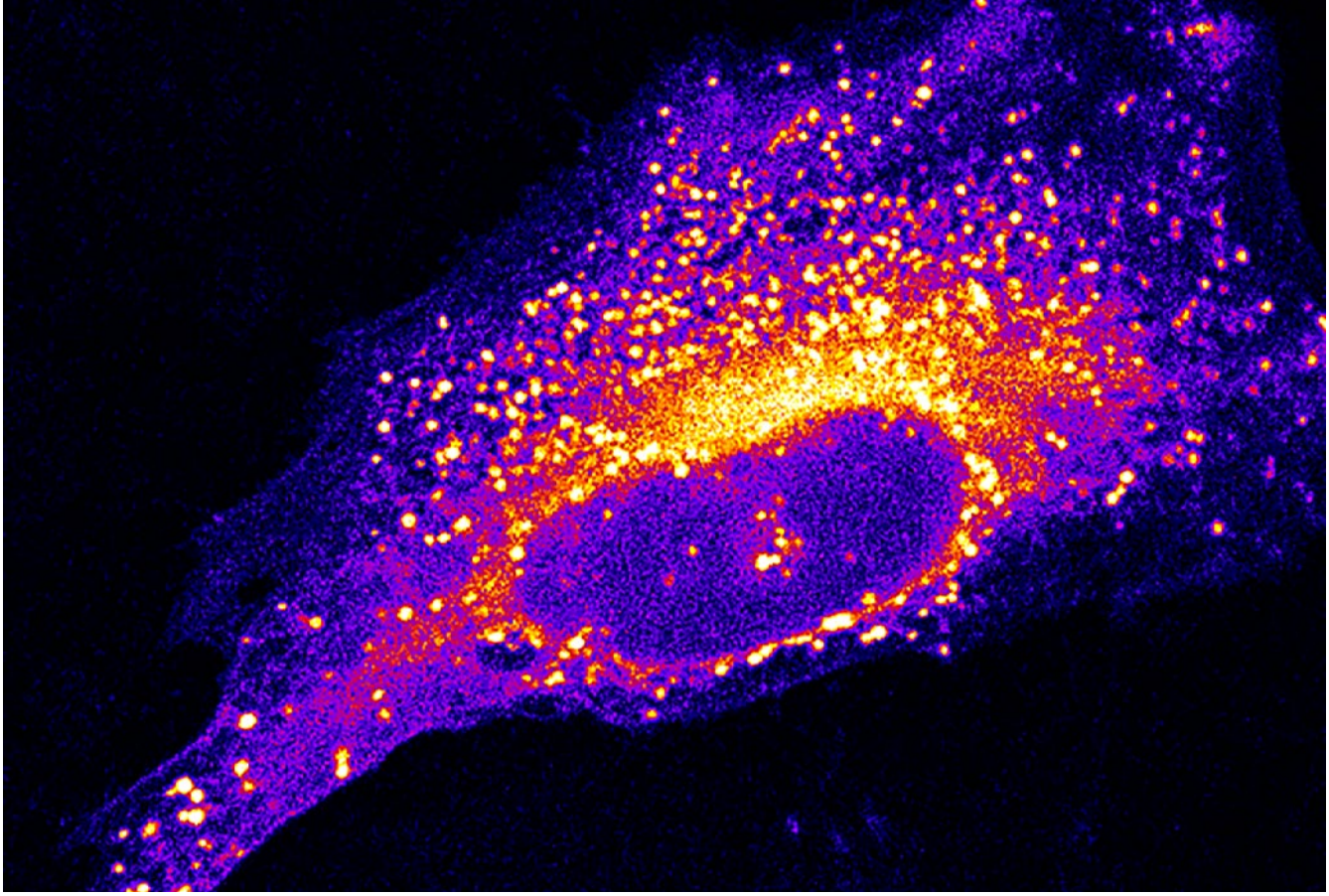
Scientists at EMBL often seek innovative ways to answer biological questions, frequently developing new technologies and methods as part of the process. The benefits of these advances are then made available to a broader community of researchers via our Core Facilities or other services in areas such as structural biology or bioinformatics.

In 2017, developments in imaging methods have continued to represent one of EMBL's great strengths. A team of researchers, including members of the Bork group, with assistance from EMBL's Advanced Light Microscopy Facility, developed a method for high-throughput 3D imaging and classification of microscopic organisms in samples taken directly from the environment, such as seawater samples from the Tara Oceans expedition. EMBL scientists from the Merten group, along with researchers at the École Supérieure de Physique et de Chimie Industrielles in Paris and the International AIDS Vaccine Initiative, created a high-throughput microfluidic system for sorting HIV viruses according to the proteins on their surface. This system makes it possible to carry out screening at a rate of hundreds of viruses per second, which could help to dramatically speed up the process of vaccine development for HIV.

The Schultz group continued to develop chemical tools that offer new insights into fundamental biological processes. They devised a method for studying the interactions of lipids with other molecules in the cell, which enables them to observe processes occurring on timescales of only a few seconds – much shorter than was previously possible. The researchers also found a way to accurately measure the release of insulin from single cells, allowing them to examine the fundamental biology behind this process and opening up new possibilities for testing drugs to control it, which could help in the development of treatments for type 2 diabetes.

Examples of high-throughput 3D images generated using a technique developed by members of the Bork group with assistance from EMBL's Advanced Light Microscopy Facility





A new method developed by the Schultz group uses a fluorescent chemical group to reveal the position of lipids in the cell

Finally, EMBL scientists from the Alexandrov team and their collaborators developed and made available a standardised method for mapping molecules on a range of surfaces, including the human body, plant leaves and man-made objects. They developed intuitive open-source software for creating 2D and 3D visualisations of the resulting data, raising interest in areas as diverse as cosmetics, forensics, ecology and agriculture.

Technology transfer and industry relations

EMBL's technology transfer arm, EMBLEM, manages the process of translating EMBL's fundamental research into practical applications, making the discoveries, technologies and methods developed at EMBL commercially available. This includes identifying and protecting intellectual property, facilitating the establishment of EMBL spin-off companies, developing collaborative research agreements, licensing technologies to third parties, and marketing and contracting scientific consultancy services.

EMBLEM has enjoyed continued success with these endeavours in 2017. The microfluidic technologies developed at EMBL – which were used, for example, to develop a high-throughput system for screening viruses (p. 24) – led to the establishment of a new start-up company, Velabs Therapeutics. Their technology makes it possible to test millions of antibodies in only a fraction of the time required by other approaches, shortening the time for pre-clinical development of new therapies.

In May, EMBL spin-off company Luxendo, launched in 2015, was acquired by scientific instrument manufacturer Bruker Corporation. Luxendo develops microscopes that use the single plane illumination microscopy (SPIM) technique developed at EMBL, allowing highly sensitive and fast 3D imaging of large samples while causing minimal damage. Bruker will make SPIM even more widely available, accelerating access to this important technology. Another EMBL spin-off, Savira Pharmaceuticals – which aims to develop new drugs for treating influenza – signed a major licence agreement with Swiss pharmaceutical company Roche.

In February, EMBL and GlaxoSmithKline (GSK) signed a collaboration agreement, aiming to use their combined skills to enhance understanding of disease and drug mechanisms and to advance drug discovery. The alliance, negotiated by EMBLEM, will run initially for five years, with GSK also providing funding for a joint EMBL-GSK postdoctoral programme. The first call for postdoctoral projects was completed in September. Four proposals were selected, in the areas of 3D tissue imaging, cryo-EM, high-throughput screening and microfluidics. Engagement between scientists from EMBL and GSK was also strengthened by the first EMBL-GSK Collaboration Day, which took place at EMBL Heidelberg in July. Leaders from both organisations presented challenges and perspectives on a range of topics including the genetics and epigenetics of disease and current and future technologies in drug discovery.

A two-year collaboration between EMBL and pharmaceutical company AbbVie Germany was announced in August. The partnership combines the expertise of AbbVie and EMBL's Gavin group, aiming to better understand the mechanisms that lead to Alzheimer's disease and opening up the possibility of developing new therapeutic and diagnostic approaches.

In November, EMBL entered into an agreement for a three-year collaboration with the building materials company HeidelbergCement to encourage beneficial knowledge exchange and drive innovation in areas related to the reduction of CO_2 emissions.

In December, in an interaction facilitated and negotiated by EMBLEM, public-private initiative Open Targets announced that it would be joined by Takeda, a pharmaceutical company with expertise in oncology, gastroenterology and central nervous system disease. The other members of Open Targets are EMBL-EBI, the Wellcome Sanger Institute, GSK and US biotechnology company Biogen. The initiative aims to use human genetics and genomics data to systematically identify new drug targets and prioritise them for further study. Open Targets also has a commitment to openly share the information and experimental data it gathers, benefitting the scientific community.

EMBL-EBI's sequence families team entered into a collaboration with fast moving consumer goods company Unilever to examine the effects of various products on the microbiome. EMBL-EBI's European Nucleotide Archive and Sequence Algorithm groups collaborated with Oxford Nanopore Technologies on data format development and sequence analysis methods.

Celgene, a US biotechnology company that manufactures drug therapies for cancer and inflammatory disorders, joined the EMBL-EBI Industry Programme in 2017. The subscription-based programme is aimed at global companies who make significant use of the data and resources provided by EMBL-EBI as a core part of their research and development. Members include many of the world's largest pharmaceutical companies and several major agriculture, nutrition and healthcare companies.

The CPP continues its work to promote advanced training collaborations and community-building initiatives to connect industry and academia. In February 2017, EMBL Heidelberg hosted its first industry workshop, Imaging in Pharma R&D, which brought together scientists from academia and the pharmaceutical industry to explore the technical and biological questions that will shape the next generation of imaging technology. February was also the month for the CPP's annual meeting, which involved a strategic discussion with founding partners Leica Microsystems and Olympus that focused on neurobiology and neuroepigenetics. In July, the CPP welcomed its latest member, New England Biolabs – a world leader in the discovery, development and commercialisation of enzymes for genomic research, and a provider of tools for genome editing, synthetic biology and next-generation sequencing.

EMBLEM technology transfer in numbers 2017

€ 9 900 000
Income

36
Invention disclosures

12
Priority patent applications filed

410
Licence & collaboration contracts concluded

23
Patents granted

Training and outreach

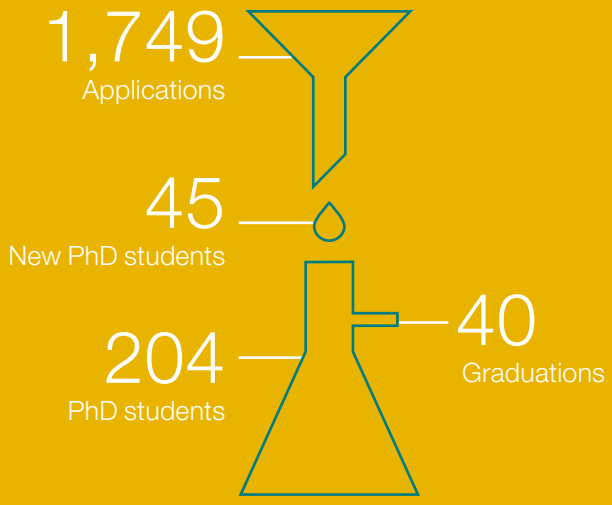
Training and inspiring the next generation of leading scientists

Internal training

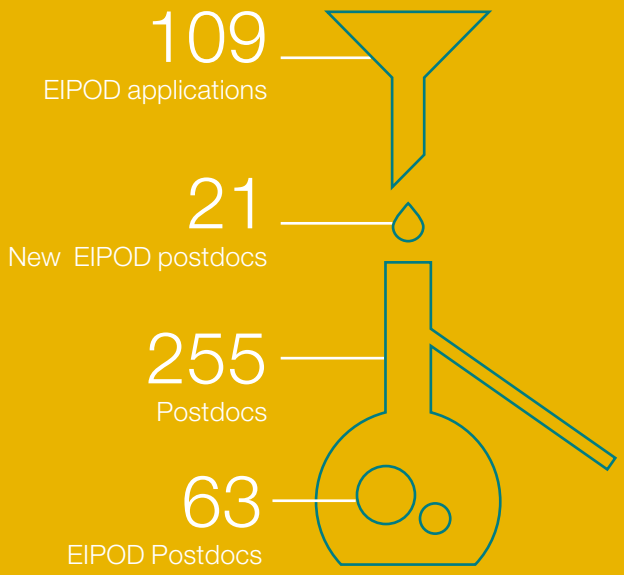
One of EMBL's core missions is to offer advanced training through its prestigious PhD and postdoctoral programmes. Both programmes leverage EMBL's interdisciplinary and dynamic scientific environment, hosting a total of more than 500 PhD students and postdoctoral fellows at any given time. From January 2017, the PhD and postdoctoral programmes are overseen by the new Head of Internal Scientific Training and Dean of Graduate Studies, Monika Lachner.

Internal training in numbers 2017

EMBL International PhD Programme



EMBL Postdoctoral Programmes



EMBL's commitment to training young researchers is reflected in its flagship International PhD Programme (EIPP). This highly competitive programme combines dedicated mentoring and creative freedom to support early independence. Since its establishment over 30 years ago, the EIPP has served as a model for institutions in Europe and globally. This strong tradition of sharing best practices continued as the EIPP office met with leading European PhD programmes in the life sciences to discuss current concepts and future ideas in graduate training over the course of the year. In 2017, the programme also further extended its network of partner universities to include the University of Iceland and the University of Milano.

Thanks to a generous donation, EMBL established the Manfred and Lilo Fuchs Fund in 2017. The aim of the fund is twofold: to offer support to fellows should they find themselves in unforeseen, challenging situations; and to foster professional development of PhD students.

EMBL's postdoctoral programme provides a platform for fellows to broaden their skill sets and advance their careers, and it therefore has a strong focus on the development of new training and career development formats. In 2017, the new 'Applying for industry' and 'Dissemination and outreach' workshops were developed for fellows interested in career opportunities outside academia. The latter course was originally developed in the framework of the EI3POD programme, the third generation of EMBL's Interdisciplinary Postdoc Programme (EIPOD), co-funded by the EC Marie Skłodowska-Curie actions. EIPOD fellows are hosted by (at least)

Participants and teachers in this year's EMBO practical course, 'Advanced Electron Microscopy for Cell Biology'

two EMBL laboratories to pursue self-designed interdisciplinary research projects and, in addition, may choose to collaborate with an external partner from industry or academia.

The EI3POD programme has been instrumental in fostering collaborations within and outside EMBL and in promoting the mobility of young researchers. In 2017, EMBL welcomed 21 new EIPOD fellows from 17 different countries, illustrating the impressive global reach of the programme.

External training

EMBL celebrated its 40th anniversary of scientific training in 2017, as the first-ever training course – on electron microscopy – was held in Heidelberg in July 1977. EMBL's training programme has since grown to around 25 conferences and 40 courses per year in Heidelberg alone. Training events are also held at all other sites, particularly at EMBL-EBI, whose bioinformatics training programme celebrated its tenth anniversary this year.

The 2017 international conference programme at the EMBL Advanced Training Centre (ATC) in Heidelberg comprised an outstanding scientific portfolio, presenting conferences on research topics under investigation at EMBL and beyond. Over 6000 scientists came from all over the world to attend these conferences, and their feedback was overwhelmingly positive. A particular highlight of the 2017 programme was the 'Perspectives in Structural Biology' conference, organised in November to honour what would have been the 100th birthday of EMBL founder and first Director General Sir John Kendrew. The course programme included over 60 events, covering a vast range of cutting-edge topics from single-cell omics to synthetic biology. The bioinformatics courses at EMBL-EBI featured a number of new additions, such as 'Bioinformatics for Core Facility Managers', 'Foundation Skills for High-Performance Computing in Computational Biomolecular Research', and 'Data Resources and Tools for Immunologists'.

In addition to course and conference attendees, EMBL hosted 650 scientists in 2017 who visited EMBL laboratories and Core Facilities through internships or to collaborate on specific research projects. EMBL's contribution to training the international scientific community was further enhanced as EMBL faculty participated in the organisation of nearly 40 courses, conferences and workshops in 16 different countries, and delivered lectures and seminars at universities and research institutes in 39 countries. EMBL also took a major step in expanding its online training services by launching a new e-learning portal for advanced training in 'wet-lab' research topics; the first two courses cover optogenetics and cryo-EM. Online bioinformatics training, provided through EMBL-EBI's TrainOnline resource, was also enriched with 38 new webinars and 11 new tutorial-based courses in 2017.

EMBL-EBI is the lead partner in CABANA, a new project funded by the Global Challenges Research Fund from 2017 to 2021, which aims to accelerate the implementation of data-driven biology in Latin America through a sustainable capacity-building programme. An international consortium of ten organisations, CABANA combines research secondments, workshops, train-the-trainer activities and e-learning to strengthen research in three challenge areas of particular relevance to Latin America: communicable disease, sustainable food production and protection of biodiversity. EMBL-EBI is also a partner in RItrain, an innovative training programme for managers of research infrastructures.

Off-site training by EMBL group and team leaders 2017

37
Courses, conferences and workshops organised in 16 countries

478
Lectures and seminars delivered at universities and research institutes in 39 countries

110
PhD students supervised at institutions in 17 countries

Outreach, communications and education

EMBL aims to inspire and educate people about the complexity and beauty of life and engage them in a dialogue about the importance and applications of life science research and the role of science in and for society. To allow EMBL to reach and engage with a variety of stakeholders in its member states – ranging from scientists and industry partners, policy makers, journalists, students and educators to the general public – EMBL's Strategy and Communications team operates a host of different communications channels and formats. In 2017, EMBL developed ambitious long-term plans to strengthen its digital platforms, through a redesign of its websites and intranet and by intensifying its presence on diverse social media. Getting EMBL onto the radar of journalists around the world and introducing new formats to improve internal communication across the organisation's six sites have been additional priorities in 2017. In support of these and other communication activities, EMBL is also working to revamp its visual identity.

While digital channels and mass media likely reach the largest audience, they cannot replace the invaluable face-to-face interactions with stakeholders. For this reason, EMBL organised and participated in a range of public outreach events across its sites in 2017. In the Heidelberg region, EMBL took part in the 'Explore Science' Festival organised by the Klaus Tschira Foundation for over 35,000 children, families and science enthusiasts. Other highlights of outreach events at EMBL Heidelberg include an annual reception that last year brought together more than 150 researchers, policy makers, journalists and other members of the local community; the 2017 EMBL Women's Night, a networking event for women from science, business and politics; and the fourth EMBL Science Movie Night, in which EMBL scientists and 200 science fiction enthusiasts took a closer look at the science behind the movie classic 'The Matrix'.

External training in numbers 2017

25
Conferences
at EMBL sites

62
Courses
at EMBL sites

6,669
Participants
across EMBL sites

Networking time at EMBL's 2017 Annual Reception.

The annual 'Pint of Science' festival in Cambridge gave participants the opportunity to engage with EMBL-EBI scientists about recent breakthroughs in the genetics of social influences and how DNA can be used to store big data. In Hamburg, EMBL scientists offered beamline tours and family-friendly activities exploring protein crystals as part of the biennial Hamburg Night of the Sciences, which attracted over 20,000 visitors to the DESY campus. The 'Fête de la Science' science festival at the European Photon and Neutron campus in Grenoble gave EMBL scientists an opportunity to explain structural biology research to more than 1800 curious visitors. At EMBL Rome, a two-week 'Summer in Science' school brought 20 school students from all over Italy together with life science researchers from EMBL, Italy's National Research Council and Sapienza University in Rome, to learn laboratory techniques and carry out hands-on experiments.

EMBL's education facility, the European Learning Lab for the Life Sciences (ELLS), engaged with over 200 science teachers, 2000 students and 5000 members of the general public from 32 different countries throughout 2017.

Participants from
86
countries

76%
from EMBL member and associate member states

Science fiction enthusiasts at the fourth EMBL Science Movie Night

In practical courses, ELLS trained European secondary-school teachers in topics related to molecular biology research, such as genome engineering, with a pilot online training course and a practical course on gene editing technologies held at EMBL Heidelberg. EMBL School Ambassadors inspired hundreds of students in the life sciences by visiting schools in Italy, France, Germany, the Philippines, Bulgaria and Turkey, while a programme was also introduced offering guided visits for schools to EMBL. For 2017's Insight Lecture, EMBL Hamburg's Senior Scientist Thomas Schneider explored the basic principles of protein crystallography with 1300 students and 135 teachers from 16 countries.

Integral to EMBL's mission of promoting the life sciences at all levels, the Science and Society programme organised numerous events throughout the year. Particular highlights were the EMBL Science and Society symposium on genome editing technologies in Heidelberg, and the tenth annual EMBL-EBI symposium in Cambridge, which explored the impact of bacteria on human health.

Private support

In 2017, the German state and federal governments signed a letter of intent to support the EMBL Imaging Centre, the planned new centre for high-resolution microscopy at EMBL Heidelberg (p. 21). EMBL's Office of Resource Development facilitated donations totalling €6.5 million from the Boehringer Ingelheim Foundation and HeidelbergCement towards the construction and operation of this one-of-a-kind service centre for scientists.

In November 2017, EMBL carried out its first email fundraising campaign to celebrate UNESCO World Science Day for Peace and Development. The campaign was conducted to help fund the ELLS Microscopes in Action project, which aims to make fluorescent microscopes available to schools in the Heidelberg region. A sum of €32,500 was collected to make this project a reality. Together with the 2017 Friends of EMBL donations, €66,000 in total was raised in support of ELLS educational activities.

Integrating life sciences

in Europe and across the world

Fostering collaboration among international research communities

Member state relations

EMBL proactively engages with major life science institutions and with the scientific communities in its members states, continuously striving to promote and strengthen European life science research. In 2017, EMBL – and the European research landscape – marked a historic development when the new EMBL site dedicated to tissue biology and disease modelling came into being in Barcelona (p. 8). EMBL Barcelona is EMBL's sixth site and the first new site to be established in almost 20 years. Located on the campus of the Barcelona Biomedical Research Park, it was officially inaugurated in April 2017 with a ceremony during which EMBL and the Spanish government, represented by the Ministry of Economy, Industry and Competitiveness, signed an agreement to host the new site.

EMBL Director General, Iain Mattaj, and Spanish Secretary of State of Research, Development and Innovation, María Carmen Vela Olmo, at the EMBL Barcelona signing ceremony

EMBL's membership also continued to grow in 2017: following completion of its national ratification process, Hungary transitioned from prospect member to full member, officially becoming EMBL's 23rd member country in May. Just days earlier, Hungarian delegates and EMBL representatives gathered for a ceremony in Budapest to officially kick off the Hungarian Centre of Excellence for Molecular Medicine, an important collaboration with EMBL to share expertise and work together. Funded under the Horizon 2020 Teaming instrument, as well as by the Hungarian universities and government, the new Centre will have a strong focus on translational medicine, particularly in the areas of cardiovascular, tumour and inflammatory diseases.

EMBL hosted several visits and actively engaged with political representatives of its host countries during the year. EMBL-EBI welcomed the Ambassador of France to the United Kingdom, Sylvie-Agnès Bermann. Fruitful discussions led to the establishment of a joint internship programme for bioinformatics training of French university-level students at EMBL-EBI. A 'Parliamentary Breakfast' was organised in February at the German Federal Parliament in Berlin to present EMBL's contribution to science in Germany and its member states. High-level representatives of the German state and federal governments also attended an official ceremony at EMBL Heidelberg in August, signing a letter of intent relating to the funding of the planned EMBL Imaging Centre (p. 21). Theresia Bauer, Minister of Research of the federal state of Baden-Württemberg, and Dr. Georg Schütte, State Secretary in the Federal Ministry of Education and Research, were joined by representatives of industry and foundations including Thermo Fisher Scientific, Leica, ZEISS, the Boehringer Ingelheim Foundation and HeidelbergCement, who all support this ambitious project. In Italy, EMBL, the Ministry of Education, Universities and Research and the National Research Council (CNR) agreed on renovation of the EMBL site in Rome, to which the Italian government will contribute €7.6 million.

Hungary became EMBL's 23rd member state

Intense scientific exchange was fostered throughout the year with the research communities of EMBL's member states. EMBL hosted visits by scientific delegations from the University of Malta and the Erasmus Medical Centre in Rotterdam, Netherlands, to explore topics of potential collaboration with EMBL researchers. A scientific workshop to promote

opportunities at EMBL for young researchers was organised in collaboration with the French Ministry of Higher Education, Research and Innovation at the Institut Curie in Paris at the beginning of the year. In November, EMBL and the Centre d'Immunologie de Marseille-Luminy, an internationally renowned scientific hub dedicated to immunology, marked an important first step in scientific collaboration at a workshop at EMBL Heidelberg. A successful Systems Biology Ireland-EMBL scientific meeting was held in Dublin in September 2017. A memorandum of understanding for scientific collaboration with La Sapienza University was signed in May to provide a framework for joint activities and further strengthen existing ties with EMBL. Finally, EMBL entered into an agreement with the Portuguese Foundation for Science and Technology for on-the-job training of Portuguese technical graduates in technologies available at EMBL. Closer links were also built between EMBL structural biology researchers, the University of Vilnius, Lithuania, and King's College London, UK; between EMBL Core Facilities, BIOCEV in the Czech Republic and the Catholic University of Leuven in Belgium; as well as with Karolinska Institute in Sweden and the Biosystems and Integrative Sciences Institute in Portugal.

EMBL prepared to welcome Poland among its member states. A very successful workshop at the Adam Mickiewicz University in Poznan further confirmed the strong interest in EMBL from Polish researchers and was the prelude to Poland's formal application to transition from prospect to full member state, which EMBL Council endorsed at its Summer Meeting in June. Another step towards expanding EMBL membership

Representatives from state and national government, industry and foundation partners were joined by EMBL scientists at the signing ceremony for the EMBL Imaging Centre

was made when an EMBL delegation visited Montenegro in April 2017. Intense discussions with the country's scientific community and political leadership resulted in Montenegro's application for EMBL membership, which was received and approved by EMBL Council in November. Poland's and Montenegro's membership of EMBL will enter into force once the countries' national ratification processes are completed.

EMBL partnerships

EMBL's institutional partnerships create a network of centres of excellence in Europe and beyond. EMBL has close cooperative affiliations both locally, with institutions on or near EMBL campuses, and remotely, with institutes in other EMBL member and associate member states.

In 2017, EMBL's partnership in systems biology with the Centre for Genomic Regulation in Spain was expanded to encompass all the Centre's units and turned into a local EMBL partnership following the birth of EMBL Barcelona. After the establishment of EMBL's most recent partnership with the Hubrecht Institute, Netherlands, in 2016, the first joint EMBL-Hubrecht workshop took place in April 2017 in Heidelberg, where nearly 30 group leaders from both institutions came together to explore common ground for potential collaborations. Also in April, one of EMBL's oldest partners institutes, the Sars Centre for Marine Molecular Biology in Norway, marked its 20th anniversary with a dedicated scientific event. In September, the eighth annual meeting of the Nordic EMBL Partnership for Molecular Medicine was hosted by the Institute for Molecular Medicine Finland in Helsinki. Following his election during the meeting, Bernt Eric Uhlin, Director of the Laboratory for Molecular Infection Medicine Sweden, was announced as the partnership's new speaker.

Representatives from South Africa's Department of Science and Technology visited EMBL Heidelberg in March 2017

The EMBL Australia Partnership Network was joined by the Garvan Institute of Medical Research in Sydney, the QIMR Berghofer Medical Research Institute in Brisbane, and the Australian National University in Canberra. The laboratory network expanded from 9 to 15 research groups, also thanks to the international recruitment of three group leaders that was supported by the expertise of EMBL scientists.

Further broadening our horizons

Acknowledging that science is a global endeavour, EMBL builds links and fosters strategic cooperation with countries outside Europe to promote integration in the life sciences. Building on a long-standing research relationship, India submitted an application for associate membership in EMBL that was unanimously endorsed by EMBL Council in June 2017. The membership will enter into force following completion of national procedures. In the meantime, EMBL and the Indian Department of Biotechnology jointly organised the scientific event 'Towards India's associate membership of EMBL' in New Delhi in October 2017 to reinforce links with the local scientific community.

In recent years, EMBL has engaged in a fruitful collaboration with South Africa. In March, representatives from the country's Department of Science and Technology visited EMBL – an important milestone in the implementation of the two parties' Declaration of Collaborative Intent, which has been in place since 2015.

In November 2017, the visit of an EMBL delegation to Singapore triggered initial relations with the Asian city-state. EMBL faculty participated in a precision medicine workshop at the Center for Big Data and Integrative Genomics, and EMBL leadership met with representatives of the Agency for Science, Technology and Research (A*STAR) and other national research institutes, as well as with government representatives, to discuss establishing stronger links between EMBL and Singapore.

EU relations

By pursuing its missions, EMBL makes important contributions to the European Research Area. It engages in a broad collaboration with the EC, implemented through biennial work plans that address areas of common interest and key challenges in health and life science research and infrastructure, open science, recruitment and training. At the beginning of the year, EMBL participated in the public consultation launched by the EC and published a position paper on the interim evaluation of the European Union (EU) Framework Programme for Research and Innovation Horizon 2020.

Following an internal consultation process, EMBL outlined its views and recommendations for the 9th Framework Programme for Research and Innovation (FP9) in another position paper, in October 2017. The paper calls for stronger support for instruments with a clear added value for European research, such as the European Research Council (ERC), the Marie Skłodowska-Curie actions and Research Infrastructures, and concludes that the FP9 should be guided by scientific excellence, support for the data-driven science revolution, multidisciplinarity, and a focus on long-term impact. In addition, the EMBL Director General and several prominent EMBL researchers spoke at EC policy conferences to highlight the importance of the life sciences in the future funding programme.

EIROforum

EIROforum is a consortium that unites eight of Europe's largest intergovernmental research organisations from different disciplines in promoting the quality and impact of European research. EIROforum also plays an important role in the formulation of European science policy and, through dialogue with the EU institutions, offers advice on issues such as the long-term sustainability of research infrastructures, open science, innovation potential, mobility and more. Under EMBL chairmanship in 2017, EIROforum produced several position papers, on the broader value of Research Infrastructures, FP9 and the engagement of its member organisations in the European Open Science Cloud (p. 22). These documents were shared with the EC to contribute to the ongoing process of science policy making in the EU.

European research infrastructures

EMBL is closely involved in the development of Biological and Medical Sciences projects and has coordinated two large, distributed research infrastructure projects on the European Strategy Forum on Research Infrastructures (ESFRI) roadmap: Euro-BioImaging and ELIXIR.

In 2017, EMBL continued to drive the implementation of Euro-BioImaging, which will give European researchers open access to innovative biological and medical imaging technologies. 2017 marked the second year of the Preparatory Phase II project, aimed at submitting the application to the EC for Euro-BioImaging to become a European Research Infrastructure Consortium (ERIC) and at finalising the legal, financial, managerial and technical tools and procedures for its operation. The first-step ERIC application was submitted to the EC in March 2017. EMBL's role in the consortium will be to coordinate biological imaging and to host Euro-BioImaging's image data resources and services. Over the past year, Euro-BioImaging's Hub and Node Candidates also refined the operational

framework in interim operation, which began in 2016 and supported over 85 research projects using 36 different imaging technologies until the end of 2017.

EMBL also coordinates the EC-funded sister project Global BioImaging with the goals of establishing Euro-BioImaging's international collaboration and developing common services and practices with imaging infrastructure partners around the globe. During the year, these efforts resulted in formal collaboration agreements with the Australian Microscopy and Microanalysis Research Facility and India BioImaging.

The pan-European life science infrastructure project CORBEL issued an open call for applications from European researchers who want to access the services provided jointly by the 13 Biological and Medical Sciences Research Infrastructures on the ESFRI roadmap, spanning disciplines from structural biology and genomics to translational medicine and clinical trials. Twenty advanced user projects were selected for access to more than one infrastructure.

ELIXIR, the ESFRI research infrastructure to coordinate bioinformatics services across Europe, continued its successful operation and initiated many new activities during 2017. Hungary joined early in the year, consolidating ELIXIR's position as the largest ESFRI landmark infrastructure in terms of membership by countries. ELIXIR continued to drive many developments in the European Open Science Cloud (p. 22), and also established three new communities of experts in proteomics, metabolomics and Galaxy software for managing bioinformatics workflows.

EMBL-EBI plays a key role in contributing to ELIXIR's activities. In June 2017, the first set of ELIXIR Core Data Resources – databases of fundamental importance to the wider life science community – was published, with EMBL-EBI hosting the vast majority. An additional list of recommended ELIXIR Deposition Databases was also released to guide researchers, funders and journals in using the most appropriate databases for experimental data.

EMBL alumni

EMBL's 8,000 ambassadors

The benefits of working at EMBL extend well beyond one's stay at the institute, as EMBL alumni attest. Many alumni highlight the lasting impact that their time at EMBL has had on their careers, thanks both to the knowledge and skills they develop at EMBL and to the alumni community they join and actively participate in afterwards. EMBL alumni also benefit the national research communities and contribute to EMBL's success, as evidenced by the Alumni Impact Report published in 2017. Based on responses to a survey conducted in 2015, the report is a first attempt to measure the impact of EMBL through its alumni: seeding the world with highly trained individuals who share the EMBL networks, training, resources and culture with their new communities.

One of the ways in which alumni impact national scientific communities across EMBL member states and beyond is the 'EMBL in...' events. These events have grown beyond occasions for alumni to network and connect with EMBL to become discussions of the opportunities and resources at EMBL that are available for the life science community worldwide. In 2017, these events took place in five countries – four of which were member states – across three continents, including the first event in the USA. They reached a broader audience than ever, with attendees from outside the EMBL community outnumbering EMBL staff and alumni two to one.

Participants at the 'EMBL in Norway' event

To further harness the energy and commitment of EMBL's alumni, Alumni Relations recruited an Alumni Volunteer Officer in 2017 to assess existing volunteer activities with the aim of formalising, communicating and strategically expanding them.

Every year, the EMBL Alumni Association celebrates the achievements and potential of EMBL alumni through the John Kendrew and Lennart Philipson Awards. In 2017, the John Kendrew Young Scientist Award, which recognises excellence in science and science communication, was awarded to Philipp Keller for his groundbreaking work on light-sheet microscopy and computational technologies that allow whole-animal imaging. Matthias Mann received the Lennart Philipson Award, which recognises outstanding contributions to translational research and technology development, for making mass spectrometry a mainstream approach for biologists.

Sadly, 2017 also brought moments of sorrow to the EMBL alumni community, who mourned the loss of former colleagues including Fotis Kafatos, Riccardo Cortese and Konrad Müller.
It was with great sadness that EMBL learned of the passing of Fotis Kafatos, former EMBL Director General, who died on 18 November 2017 at the age of 77.

Fotis Kafatos was EMBL's third Director General

In remembrance of Fotis Kafatos

Fotis was EMBL's third Director General, from 1993 to 2005, and he went on to become the founding president of the ERC, as well as a member of its Scientific Council. His contributions to science and the scientific community over five decades in the USA and Europe had a significant influence on the advancement of molecular biology on both sides of the Atlantic.

Before joining EMBL, Fotis became a professor of biology at Harvard University at the age of 29, the youngest full professor in the university's history. He was among the first to apply molecular biology along with genetics to study animal development. His group also developed important techniques in DNA synthesis, cloning and sequencing that were widely adopted. While at Harvard, Fotis remained very committed to European science, founding the Institute of Molecular Biology and Biotechnology at the Research Centre of Crete in 1982 and directing it until 1993.

Fotis had a rare ability to bring together people, ideas and disciplines. During his time at EMBL he worked passionately to accomplish excellence, inclusiveness and cooperation. He led the establishment of the Developmental Biology Unit at EMBL Heidelberg and the Mouse Biology Unit (now the Neurobiology and Epigenetics Unit, EMBL Rome), as well as pursuing the conversion of the Data Library into EMBL-EBI, a move that had been decided under his predecessor but was largely implemented under his leadership. He drove the development of Core Facilities, training, outreach, technology transfer, industry collaboration and many groundbreaking pan-European research initiatives, which have transformed the way life scientists around the world work together.

During his tenure at EMBL, Fotis continued to carry out his own research, focusing on the study of malaria and its major insect vector, *Anopheles gambiae*. He also led studies on the *Drosophila* genome and is recognised as a pioneer in the development of comparative and functional genomics. After leaving EMBL in 2005, Fotis took up a position at Imperial College London, where he held the Chair of Insect Immunogenomics. He was elected as ERC President in 2007.

Fotis had a huge impact at EMBL and in the life sciences in general. The scientific community has lost a deeply caring colleague, friend and leader.

Administration

Building a place where staff thrive

The launch of EMBL's first new site in almost 20 years made 2017 a busy year for EMBL's Administration. Following extensive work throughout EMBL in the lead-up to the launch of EMBL Barcelona, a Head of Administration and an administration team were recruited for the new site. The team has been establishing essential processes, from health and safety policies and procurement procedures to ensuring implementation of EMBL's legal status. EMBL staff at all levels have been establishing crucial connections with local authorities, international organisations in Spain and local research institutes. On site, refurbishment of relevant premises began. Preparations for the Mesoscopic Imaging Facility (p. 21) were completed, while work on the laboratory and office spaces is expected to be finished in early 2018.

More-established EMBL sites also endured construction and refurbishment activities in 2017. In Heidelberg, construction of a new building to house high-end cryo-electron microscopes was completed. Initially, the building will complement the experimental facilities of the Structural and Computational Biology Unit that house EMBL's new cryo-EM service platform – which will begin operations in 2018 – and will provide teaching facilities until completion of the planned EMBL Imaging Centre.

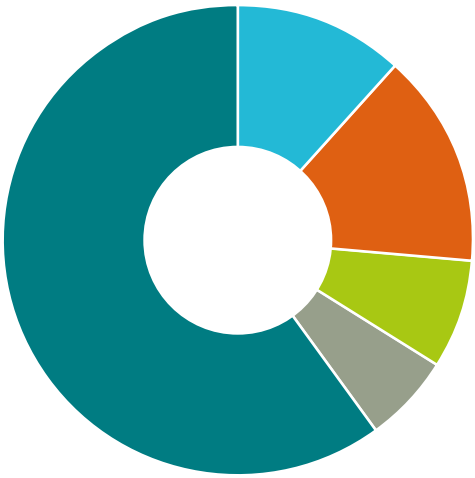
After that, the building's longer-term use will be decided. In the first half of 2018, construction of another new building will be completed; it will house the EMBL Archive, Ombuds Office, Staff Association, Facility Management and Technical Security. In the Heidelberg canteen, refurbishment and expansion work commenced to enable the space to meet increased demand. In Rome, too, work was undertaken to enhance the dining options available to staff. Refurbishment work on the CNR canteen on campus started in December 2017. The work, which should be completed in early 2018, involves a major overhaul of the kitchen area as well as renovation of the food distribution and eating areas.

Alongside these high-profile projects, EMBL Administration continued to pursue less visible but no less important activities, updating procedures and guidelines relating to recruitment, the EMBL health insurance scheme, group leader training, and more. In line with EMBL's commitment to integrity, a Data Protection Officer was recruited.

With support from Administration and many other entities and individuals throughout EMBL, the Staff Association coordinated a number of charity activities in 2017. In July, members of EMBL's Bike Club cycled from EMBL Heidelberg to EMBL Grenoble and raised nearly €14,000 in support of the University Children's Hospital in Heidelberg. In autumn, an EMBL-based charity that helps researchers around the world gained a new name and a new impetus. Founded in 2005 as Adéquation Germany, the charity is now called Aid for Labs. Working with institutions around the globe, Aid for Labs recycles unwanted functional equipment and ships it to researchers in need. Past projects have helped researchers from Brazil to Burkina Faso, and material collected in 2017 will be shipped in early 2018 to help set up laboratories in Argentina and Indonesia.

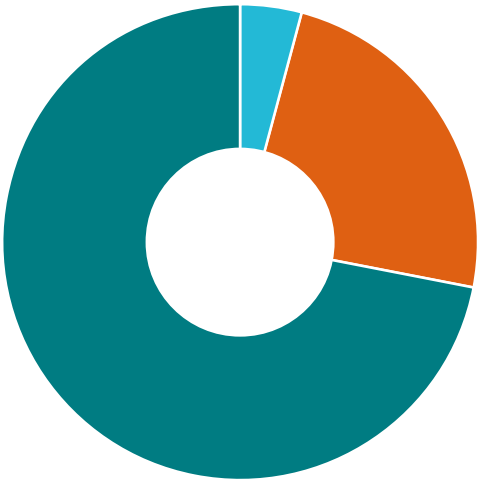
EMBL's cycling team arriving in Grenoble

Personnel statistics



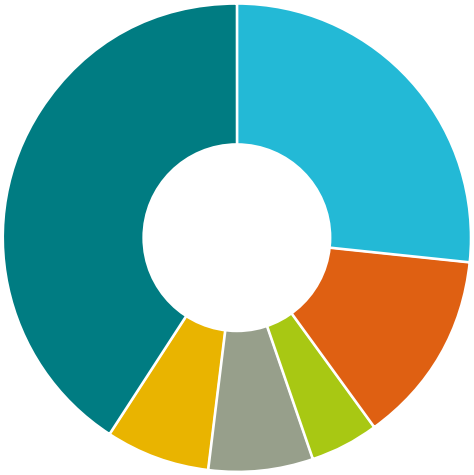
Personnel
in 2017 in FTE

1,041	Staff members
204	PhD students
255	Postdocs
132	Supernumeraries and ancillaries
102	Diploma students and trainees
1,734	Total



Staff nationalities
in 2017 in FTE

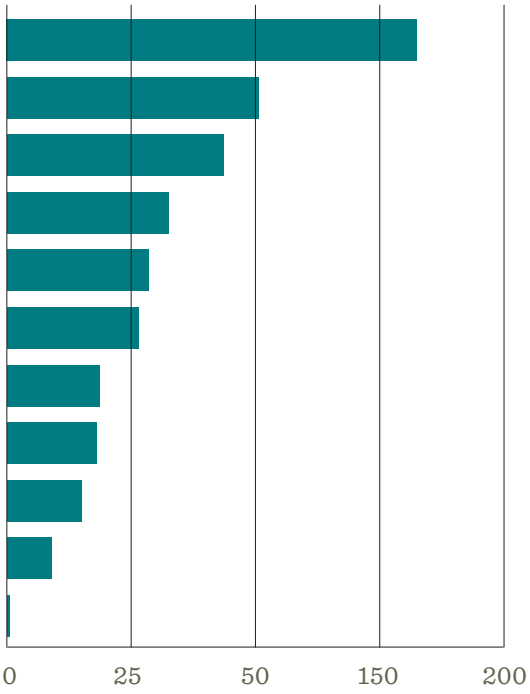
1,252	EMBL member and associate member states
69	EMBL prospect member states
413	Non-member states
1,734	Total



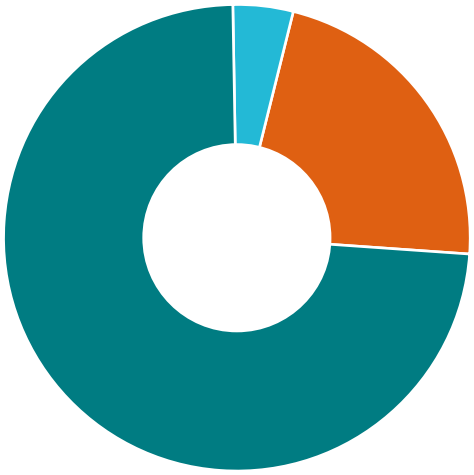
Staff categories
in 2017 in FTE

709	Research
463	Scientific services
230	Scientific or technical support
86	Training and outreach
122	Administrative support
124	General support
1,734	Total

Scientific visitors to EMBL units
in 2017



165	EMBL-EBI
101	Core Facilities
87	Structural and Computational Biology
65	Genome Biology
57	Cell Biology and Biophysics
53	EMBL Rome
37	Developmental Biology
36	Directors' Research
30	EMBL Hamburg
18	EMBL Grenoble
1	EMBL Barcelona
650	Total



Scientific visitors' nationalities
in 2017

479	EMBL member and associate member states
28	EMBL prospect member states
143	Non-member states
650	Total

Financial report

EMBL total income in 2017

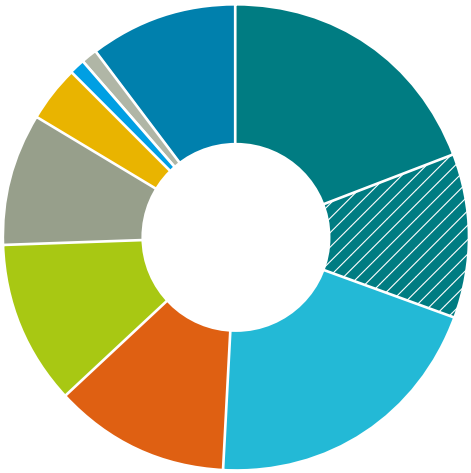
€ 237 million

Income
in 2017

46 %	Member state contributions
3 %	Member state special contributions*
16 %	Internal tax
24 %	External grant funding
3 %	Other external funding**
8 %	Other receipts***

EMBL external grant funding in 2017

€ 56 million

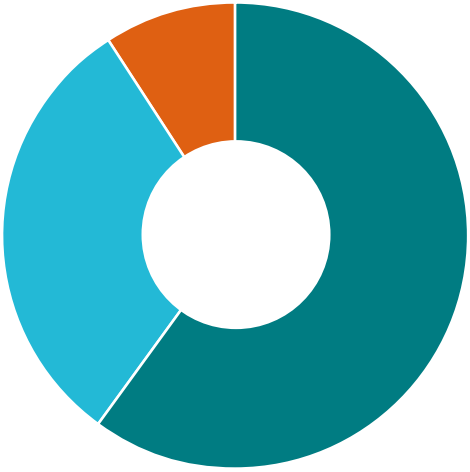


External grant funding
in 2017

19 %	EC	9 %	BBSRC
11 %	ERC	4 %	DFG
20 %	NIH	1 %	MRC
13 %	Wellcome Trust	1 %	ANR
11 %	BMBF	11 %	Others

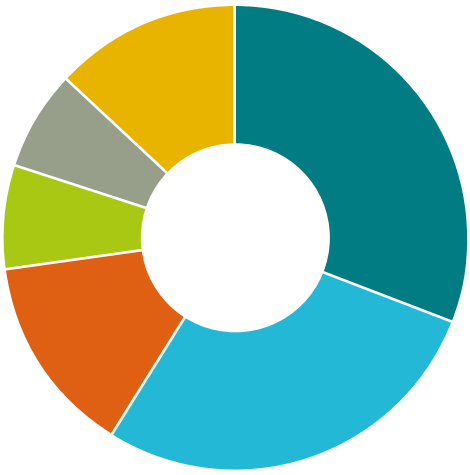
EMBL total expenditure in 2017

€ 235 million



Expenditure
in 2017

60 % Staff costs
31 % Operating costs
9 % Equipment expenditure incl. depreciation



Expenditure by area of activity
in 2017

31 % Research
28 % Scientific services
14 % Scientific or technical support
7 % Training and outreach
7 % Administrative support
13 % General support

* Includes additional contributions from the UK Government for the construction of the Technical Hub and European Data Centre on the Hinxton campus and from the German Government for the extension of the Heidelberg campus

** Includes Elixir member state contributions

*** Includes income from operational entities such as contributions from EMBO, course and conference fees, canteen and cafeteria, guesthouses, etc.

Member state contributions

	2017 x € 1,000	%
Ordinary contributions		
Austria	2,370	2.3
Belgium	2,904	2.8
Croatia	294	0.3
Czech Republic	996	0.9
Denmark	1,908	1.8
Finland	1,416	1.3
France	15,990	15.2
Germany	21,736	20.7
Greece	1,311	1.2
Hungary	197	0.2
Iceland	73	0.1
Ireland	1,132	1.1
Israel	1,657	1.6
Italy	11,869	11.3
Luxembourg	210	0.2
Malta	37	0.0
Netherlands	5,075	4.8
Norway	3,020	2.9
Portugal	1,206	1.1
Spain	7,833	7.5
Sweden	3,313	3.2
Switzerland	4,142	3.9
United Kingdom	16,346	15.6
	105,035	100%
Currency adjustment		
for Sterling contributions	(609)	
	(609)	
Entry fees		
Czech Republic	140	
	140	
Associate member state contributions		
Australia	3,169	
Argentina	1,374	
	4,543	
Additional contributions		
from United Kingdom	7,366	
from Germany	554	
	7,920	

Reviews of scientific units

Research and service units are evaluated every four years by members of the Scientific Advisory Committee and additional experts

EMBL-EBI Research review

EMBL-EBI's research activities were reviewed on 28 to 30 March 2017 by a panel of 15 experts including three members of SAC. The review was chaired by Edward Marcotte, Institute for Cellular and Molecular Biology, University of Texas, Austin (USA). The Chair of SAC and three delegates to EMBL Council attended the review as observers.

Evaluation summary

EMBL-EBI conducts world-class research across the spectrum of computational biology – from genome analysis, gene expression and proteins through to networks and systems, chemistry and metabolism. The panel found the quality of EMBL-EBI's research to be outstanding and consistently at the cutting edge of bioinformatics, with scientists from the unit participating, and frequently leading, the most significant advances in the field. EMBL-EBI's publication output, community participation, international standing, and training environment for young scientists were all regarded as exceptional, and the panel was impressed by the strong connections between EMBL-EBI researchers and other EMBL units, most notably the Genome Biology Unit at EMBL Heidelberg.

EMBL-EBI's research unit has seen a high level of turnover in the last four years, with several group leaders moving on to new positions or adopting shared positions, and the recruitment of two new group leaders. Perhaps the most important change over the review period was the change in leadership from Janet Thornton to the joint directorship of Rolf Apweiler and Ewan Birney, with research activities being led by Ewan Birney and supported by EMBL-EBI Research Coordinator Nick Goldman, who played the same role with Janet Thornton. While acknowledging that the current leadership model works well, the review panel largely concurred with the EMBL-EBI Directors that the recruitment of a dedicated Head of Research would be beneficial for directing the overall research efforts and faculty mentoring within the unit.

Given the high level of turnover in the unit, partially also due to the high desirability of computational researchers at other institutions, it is important that the unit continue to actively recruit group leaders. While hiring firstly based on excellence in computational biology, these recruitments would focus on increasing connectivity among the groups, addressing issues of gender balance and increasing capacity in developing areas of bioinformatics such as single-cell analysis, image analysis and translational bioinformatics. In this context, the panel noted an interest in expanding the number of research group leaders as well as the predoctoral and postdoctoral programmes at EMBL-EBI, and recommended that EMBL management be flexible in allowing for this expansion as feasible over time.

Finally, in the context of mentoring and creating optimal conditions for the development, particularly of junior group leaders, the panel encouraged the unit management to work actively to ensure that researchers' needs for experimental 'wet lab' research can be accommodated.

Response to the panel's recommendations

I would like to thank the panel for their time and effort in reviewing EMBL-EBI's research activities, as well as for their constructive feedback. I am gratified by the highly positive evaluation of EMBL- EBI's research performance and would like to congratulate the unit members and the unit leadership. This review corresponds to a 'coming of age' for the EMBL-EBI research activities which started slowly of (financial) necessity. In particular, credit should go to Janet Thornton for her tireless work and commitment in shaping EMBL-EBI's research over many years, laying the foundations for the current programme, to Rolf Apweiler and Ewan Birney for their efforts in driving the unit forward and their continuing leadership success over the last two years and to Nick Goldman for the excellent role he has played in supporting the development of the research activities on site.

In relation to the recommendations of the review panel, perhaps the most strategically important concerns the possible appointment of a Head of Research at EMBL-EBI. Given the other commitments of those who are currently responsible and the requirement for continued, strong, research-specific leadership, we have already advertised this position. Unfortunately, we were not successful in attracting the candidate we wished to appoint. On the advice of the panel, we will continue to search for a suitable appointee. The person we seek will have leadership skills and an outstanding record in some aspect of bioinformatics research.

A second recommendation was to consider increasing the number of research groups and of the PhD programme at EMBL-EBI. These recommendations need to be considered in the context of EMBL as a whole, including the balance between different sites, as well as against a background of what will essentially be decreasing real-terms member state funding over the next five years. Against this background, I see no realistic prospect for the recommended increases in the predictable future.

The review panel stressed the importance of accommodating group leaders' needs for conducting experimental 'wet-lab' research, which are not currently catered for on EMBL-EBI's current premises. The issue was discussed in depth and, while there are strong arguments both for and against providing in-house space and resources for experimental research, I agree with the panel's recommendation that – especially for young researchers – every attempt should be made to connect them to experimental capacity. Such connections are currently enabled through various mechanisms, for example via collaborations or by embedding researchers in teams with overlapping research interests located in other institutes or research units (e.g. laboratories of the Wellcome Sanger Institute, the University of Cambridge and the Genome Biology Unit at EMBL Heidelberg). Together with the unit leadership, I will of course carefully monitor the success and suitability of these mechanisms and periodically reassess the need for creating dedicated in-house experimental capacity for EMBL-EBI researchers in the future. It is possible that a new building planned on the Hinxton campus may provide this opportunity.

One serious general issue raised by the postdoctoral fellows was that of parental leave at childbirth. This is an issue which, provided it is viewed as a priority by the EMBL Staff Association, we will discuss with the next EMBL Council working group on terms and conditions of employment. Other matters raised by the pre- and postdoctoral fellows will be discussed further in the appropriate local or EMBL-wide context.

I close by congratulating my EMBL-EBI colleagues on a very positive review, reflecting the excellent research they are pursuing across a broad set of biological fields. I look forward to their further success.

Professor Iain W. Mattaj, FRS, FMedSci
Director General

24 May 2017

Cell Biology and Biophysics Unit review

The Cell Biology and Biophysics Unit at EMBL Heidelberg was reviewed on 9 to 11 May 2017 by a panel of 19 experts including seven members of SAC. The review was chaired by Susan Gasser, Friedrich Miescher Institute for Biomedical Research, Basel (CH). The Chair of SAC and the Norwegian delegate to EMBL Council attended the review as observers.

Evaluation summary

Overall, the Cell Biology and Biophysics (CBB) Unit was rated as outstanding based on the quality of its research and services, the training and development of young scientists and its contribution to integrated activities in European life science research. The CBB Unit holds a unique position within EMBL, integrating and developing technologies for imaging and quantitative biology to address important biological questions. Accordingly, its faculty is composed of physicists, chemists and biophysicists in addition to biologists. The panel regarded this mixed constellation as unique and extremely powerful in enabling truly interdisciplinary research.

While considering the Unit's commitment to work at the interface of biology, physics and technology development laudable and very positive in itself, the panel noted that this commitment comes with some challenges. In particular, they stressed the importance that physicists, who apply and develop technologies to explore biological problems, focus on the truly important questions in their chosen area of biology, in order to ensure that their research is of the highest level. Since this research sometimes requires collaboration, the panel recommended broader mentoring of the technology- oriented group leaders to aid them in identifying biological collaborators who are truly at the forefront of their fields. The panel noted that this is not a problem for internal collaborations and thus recommended that the three upcoming recruitments be used to maintain a strong biological focus in the unit, since, by chance, several of the group leaders involved in turnover at this time are from the more 'biological' side of the CBB Unit. While acknowledging ongoing efforts in this area and welcoming the recent recruitment of two female group leaders, the panel also stressed that continuing to improve gender balance should also be a strong focus of future hires, and suggested potential strategies to increase the number of female faculty in the Unit.

One concern raised by the panel was that contributions that reflect technology development – despite being crucial to individual projects and taking long years to develop – may not receive adequate recognition, especially through senior authorship on 'biological' publications. Recommendations in this respect included monitoring and reviewing authorship guidelines to address this particular issue, as well as specifically profiling physical and technological achievements through EMBL's communications channels.

The panel found the leadership and mentoring within the Unit by Jan Ellenberg to be outstanding. Rainer Pepperkok's role as Head of Core Facilities, an additional responsibility that he took on in 2014, was also highly appreciated. Great praise went to the Unit's efforts in making their newly developed technologies and innovations available to the broader European research community – both through commercialisation and by collaborating, sharing and providing training in these methodologies. In this context, the panel welcomed EMBL's proposal to seek funding for an Imaging Technology Centre, which would serve as a further platform for the dissemination of innovative imaging technologies, methods and approaches developed in both the Cell Biology and Biophysics and the Structural and Computational Biology units. This would enable EMBL to broaden its support to the community in the area of cross-scale integrated imaging, offering access to a unique facility.

As part of the review, the panel engaged in in-depth discussions with predoctoral and postdoctoral fellows on their experience, desires and perspectives. Overall, they found fellows in the CBB Unit to be strikingly content relative to many at peer institutions. Their conversation with the postdoctoral fellows highlighted the need for additional support in advanced computational image analysis, and resulted in a recommendation by the panel that EMBL strengthen and centralise efforts in this area.

A specific complaint raised by the postdoctoral fellows regarded the lack of regular faculty attendance at the Unit's internal seminars. In response to this, the panel recommended that participation of all Unit members – and particularly of group leaders – in all pan-unit activities and seminars be strongly encouraged.

Response to the panel's recommendations

I would like to begin by thanking the panel for their thorough review of the activities of the CBB Unit. They clearly grasped the specificities of the Unit, which are distinct from most other EMBL research units, and provided very detailed and constructive critique to the group leaders under review. I am very pleased with their very positive opinion of the Unit's performance, while also acknowledging their suggestions for further improvement.

With regard to the future composition of the Unit, and thus its strategy, the panel recommended that the current balance between more technology-oriented and more biology-oriented groups be maintained by recruiting strong biologists in the near future. The intention is indeed to recruit with this profile firmly in view. As noted by the review panel, there are challenges to maintain a unit with the diversity of CBB, which encompasses not only cell biology, biophysics, physics and technology development, but also chemistry, modelling and simulation, and service provision in light and electron microscopy. This not only requires a certain minimal size but also researchers who have the right interdisciplinary mindset. We will search for such individuals with the understanding that the intention is not to

recruit 'like-for-like', i.e. not necessarily to replace those leaving with others with the same expertise. There are however areas currently only represented in CBB that are important to maintain somewhere at EMBL, like experimental chemical biology, and general EMBL recruitment should attempt to maintain these areas. I agree with this recommendation.

The panel stressed that scientists in the Unit who engage in the development of technologies that are instrumental to biological discoveries should receive adequate recognition, particularly through senior authorship on publications. I acknowledge that this issue is important as it can impact on the career of both students and postdocs, who may not obtain a first-author publication within their fellowship, and of group leaders when they seek suitable positions on leaving EMBL. The difference in publication culture between different research domains needs to be borne in mind, but if the ambition of the CBB group leaders and fellows is to go on to work in a top life science environment, it is crucial that they publish visibly, i.e. as senior or first authors, according to the culture in this field.

Scientific exchange and cross-feeding are crucially important in fostering research that is truly interdisciplinary. This holds particularly true for the CBB Unit, where connections must be strengthened between scientists that have very diverse backgrounds and orientation. In view of this I share the panel's concern regarding the low attendance to pan-unit seminars and activities, and have discussed this issue with the Unit leadership. They are aware of this problem and have changed the structure and organisation of the Unit seminar series, aiming to ensure that future attendance improves.

Regarding the panel's recommendation to provide additional support in advanced image analysis, this is an issue that both myself and Jan Ellenberg are aware of and have been addressing. A computational scientist within CBB formerly provided support to Unit members in this area by, among many other things, collecting software developed in-house and ensuring its availability and robustness so that it became accessible to the entire internal community. Following his departure in 2016, we have unfortunately not found a suitable candidate to fill the position. We will persist in our attempts to recruit this specific expertise, which is of great value not only to the CBB Unit but to the whole of EMBL. This function may be better associated with the Advanced Light Microscopy Facility in order to embed it more firmly in the normal service turnover system.

I would like to join the panel in acknowledging the many external training and organisational activities undertaken by the faculty of the CBB Unit, including Jan Ellenberg's leadership of the European Strategy Forum on Research Infrastructures' (ESFRI) Euro-BioImaging project preparatory phases. These are greatly appreciated in the community and reflect EMBL's commitment to broadly serving biomedical researchers.

I conclude by congratulating Jan Ellenberg, the Senior Scientists and the entire Cell Biology and Biophysics Unit for a very strong performance and for their remarkable achievements over a very broad domain during the last four years.

Professor Iain W. Mattaj, FRS, FMedSci
Director General

7 June 2017

EMBL Grenoble review

EMBL Grenoble was reviewed on 16 to 18 October 2017 by a panel of 12 international experts, including three members of EMBL's Scientific Advisory Committee. The review was chaired by Titia Sixma, Netherlands Cancer institute (Amsterdam, NL). Edith Heard, Institut Curie (Paris, FR) attended the review as an observer.

Evaluation summary

The overall performance of EMBL Grenoble was rated as outstanding based both on the quality of its research and services and the training and development of young scientists. The unit continues to operate at the cutting edge of structural biology, creating innovative, enabling technologies for life scientists. In this context, the review panel noted the development of fully automated crystallographic X-ray data collection using the MASSIF beamline and the development of the revolutionary CrystalDirect technology for automated crystal harvesting as particularly noteworthy highlights. These developments are the first of their kind in the world, and make realistic the massively high-throughput screening of small-molecule ligands for proteins of therapeutic interest. Among the many remarkable advances in structural and molecular cell biology by the unit's research teams, the elucidation of the mechanism of influenza viral RNA replication and transcription was singled out for special praise.

The review panel applauded the unit's continuous efforts in developing and operating vital facilities that benefit the structural biology community in Europe and beyond. Significant improvements to the beamlines were developed over the review period to make use of the enhanced capabilities of the ESRF upgrade, with a focus on the local strength in fragment screening and automation. In addition, EMBL Grenoble's services successfully adapted to the rapidly evolving structural biology research landscape and changing user demands, most notably by establishing – in collaboration with the ESRF and IBS – a new facility for high-end cryo-EM that will be operated similar to a beamline. It was the review panel's opinion that, in view of these developments, the impressive expertise and experience of the technical teams at EMBL Grenoble might be leveraged to develop innovative and more automated solutions for cryo-microscopy sample handling and data collection, which are currently time-consuming manual processes.

The last review period has seen significant changes in the composition of the unit's faculty, with the departure of four group and team leaders and three new arrivals. The new group leaders all have a strong – although rather traditional – structural biology orientation. While being enthusiastic about the quality of the individual new recruits, the review panel expressed concerns that these may further narrow the unit's research focus on RNA/protein interactions and the structural analysis of large complexes. They therefore recommended that the last group leader recruitment be used to acquire new expertise in currently underrepresented areas of structural

biology. While multiple possibilities were outlined, computational analysis – perhaps with an interest in small-molecule screening – was highlighted as a clear area of potential focus for the new group leader; such a research profile could bridge the gap between the strong method development teams and the structural analysis groups and broaden the combined scope of the unit's activities.

The review panel engaged in wide-ranging discussions with predoctoral and postdoctoral fellows over many aspects of research, training, mentoring and work/life balance at EMBL Grenoble. A general concern expressed by the fellows regarded an insufficient level of support from group leaders for attending conferences. The committee suggested potential strategies that could be implemented to improve the situation and ensure that fellows are exposed to scientific meetings appropriately. Other issues raised, particularly by the postdocs, included a need for more centralised general lab support staff and a desire for assistance in dealing with some logistical aspects related to childcare. In spite of these constructive criticisms, the fellows were generally very positive and enthusiastic about EMBL's training programmes and the research environment at EMBL Grenoble.

Response to the panel's recommendations

I begin by thanking the review panel for their detailed evaluation of the activities of EMBL Grenoble. I am delighted with their overwhelmingly positive report of the unit's performance. The unit's success has depended to a considerable extent on the work of the Head of EMBL Grenoble Stephen Cusack. The review panel rated his leadership of the unit as outstanding – an opinion that reflects my own.

Among the general recommendations provided by the review panel the most important was to try to widen the research and method development focus of the unit, especially by leveraging the remaining group leader position to acquire expertise in computational analysis and methods. I note and largely agree with the review panel's suggestion, and believe that a stronger presence in this area would greatly benefit the research-oriented as well as the technical teams at EMBL Grenoble. Although both of very high quality, these two aspects of the unit have diverged somewhat in their focus and the entire unit would benefit from a recruit who can help bridge this gap. I have discussed the matter with the unit leadership and we will make an extra effort during the ongoing recruitment process to identify an excellent candidate with the suggested profile. I note however that researchers with the appropriate expertise are rare and therefore difficult to find.

While welcoming the recent developments at EMBL Grenoble, and on the Grenoble campus as a whole, in the area of cryo-EM, the review panel was of the opinion that this joint effort will require monitoring and, very likely, expansion. The most urgent requirement they identified at present is for new high-quality instrumentation for 2D cryo-EM screening. We will discuss, also with our partners on campus, whether and when this investment is feasible.

In relation to the concerns voiced by the PhD students and postdocs, I regard the requirement that fellows attend scientific conferences as very important. Participation in these events is crucial for their scientific development and networking opportunities, and is required of fellows enrolled in EMBL's training programmes. EMBL management has already made clear that fellows should expect to attend at least two scientific meetings during their time at EMBL. Nevertheless, similar comments have been made in other evaluations. I will bring up the issue with EMBL Group Leaders, encouraging them to balance budgetary constraints with the fellows' need to attend scientific meetings, and discuss with them the specific suggestions provided by the review panel in this respect.

Similarly, I will address other matters raised during the review of EMBL Grenoble, which I do not go into in detail in this response, in the appropriate local or EMBL-wide contexts.

I would like to conclude by congratulating the unit leadership and all of its members on their excellent performance and very positive outcome of the review.

Professor Iain W. Mattaj, FRS, FMedSci
Director General

9 November 2017

Publisher
EMBL

Photography/images
page 2, 30, 33, 37, 38 Marietta Schupp/EMBL
page 5 Tremani and Cees Dekker lab TU Delft
page 6 Vinay Bulusu/EMBL
page 7 Hernando Martínez Vergara/EMBL
page 9 Oliver Billker/WTSI
page 11 Livia Marrone/EMBL
page 12 Monica Di Giacomo and Jamie Hackett/EMBL
page 15 CRG
page 17 EMBL-EBI
page 20 T. Mavric/CSSB
page 22 gerstner architekten, Heidelberg,
Visualisation: Render Vision
page 24 Luis Pedro Coelho/EMBL
page 25 Schultz group/EMBL
page 34 Hugo Neves/EMBL
page 36 Ivan Paulick
page 43, 44 EMBL
page 47 Wiebke Manuela Schulze/EMBL

Design
Designyard, Amsterdam

Printed by
ColorDruck Solutions, Leimen

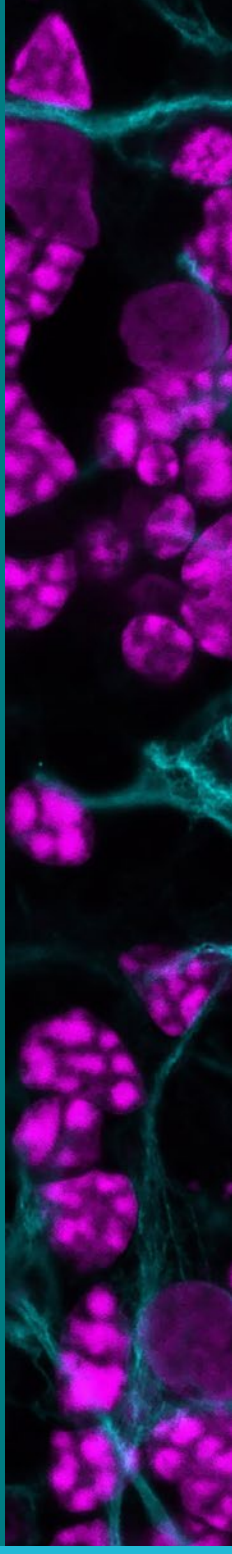
www.embl.org

EMBL member states and associate member states

Argentina
Australia
Austria
Belgium
Croatia
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Luxembourg
Malta
Montenegro
Netherlands
Norway
Portugal
Slovakia
Spain
Sweden
Switzerland
United Kingdom

Prospect member states

Lithuania
Poland



European Molecular Biology Laboratory