SECTION III

14. People, Processes, and Places

Introduction

EMBL is an intergovernmental organisation that successfully operates to deliver excellent life sciences research and service, in an increasingly complex, scientific landscape. Since its formation, EMBL has continuously grown to forge the frontiers of life sciences in Europe. As a field, molecular biology has also become more compounded, brought about by the expansion in the number and diversity of academic disciplines that need to be brought together to answer both long-standing and novel research questions.

Across the six sites, all members of EMBL personnel (almost 1800 FTEs as of 2019 and 650-700 scientific visitors annually) rely on the highly effective support, infrastructure and professional services put in place and maintained by EMBL Administration. This operational excellence ensures EMBL remains a flexible, efficient, and internationally attractive work environment, with state-of-the-art facilities and high quality staff services. EMBL's cross-cutting operational departments within Administration include finance, human resources, grants, legal, facility management, health and safety, and executive support offices to run many of EMBL's institutional activities. By working alongside all EMBL personnel to understand the organisation's needs, communicate changes and resolve challenges, EMBL Administration ensures that EMBL can fulfil its missions. Similarly, by engaging with wider scientific and operational communities, EMBL Administration ensures EMBL acts responsibly within the necessary regulations and specific funder requirements. In doing so EMBL aims to lead a bold movement to deliver some of the world's best life science research.

The scientific directions in this EMBL Programme stand to advance scientific discovery and knowledge in many of Europe's research, service, and innovation priorities, aligned with efforts to solve global challenges such as climate change, pollution, and antibiotic resistance. To deliver on these ambitions as well as enhance and amplify EMBL's connectivity with its member states, EMBL will further develop, modernise, and synergise its operations. This will ensure that organisational structures, personnel, processes, and facilities are set up so that the research EMBL performs and the services that it offers are even more innovative, fast moving, and collaborative.

In the next EMBL Programme, EMBL will introduce new scientific management structures, modernise operational systems, outfit laboratory and engineering spaces to foster interdisciplinary research and services, develop fieldwork for the study of global and local ecosystems, sustain balanced funding schemes, recruit high calibre personnel, and support career development and progression. Planning and design for the most optimal systems, personnel and spaces have taken place with extensive consultation and discussion across EMBL and will continue to be developed as the directions of the next EMBL Programme begin to be implemented.

Scientific Organisational Structure

Each EMBL site specialises in particular research areas and scientific services, organised within management structures known as units. The nine units across the six sites are cross-disciplinary and span multiple areas of molecular biology such as genome biology, cell biology, developmental biology, tissue and organ biology, structural biology, microbiology, neurobiology, molecular medicine, bioinformatics, and computational biology (Figure PP1, inner ring). Research groups and service teams are highly collaborative, with cross-unit collaborations facilitated by a range of different initiatives such as joint faculty appointments, cross-unit postdocs, journal clubs, joint retreats, courses, and workshops. In the next EMBL Programme, all units will continue to drive forward the complex, highly connected science undertaken at EMBL, at a transnational European level, and as part of the global life science research landscape.

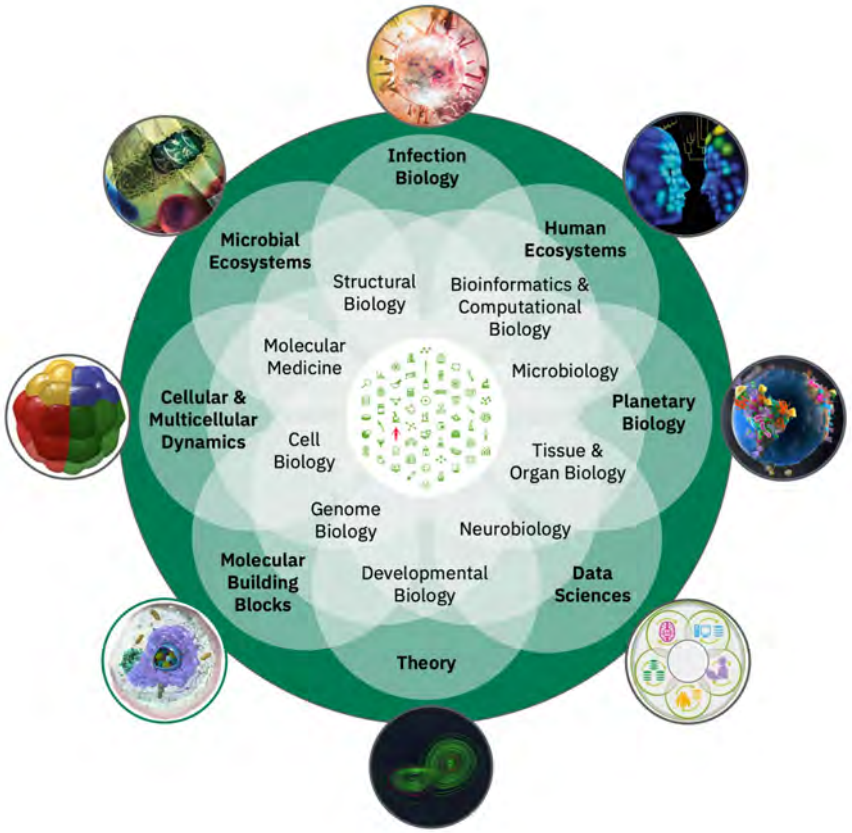


Figure PPP1 | The research themes of the Molecules to Ecosystems Programme.
EMBL's current and new research themes are represented by the inner and outer rings, respectively. EMBL will build upon its existing strengths and expertise to conduct and enable collaborative, interdisciplinary research in these areas with scientists in EMBL's member states and beyond.

Implementing the New Research Themes

In order to firmly establish and propel the new research themes described in this EMBL Programme, EMBL intends to introduce a series of new functional structures, called **transversal themes**. Transversal themes will become a formalised, funded structure overlaid on current EMBL units which will deepen the interdisciplinary science at EMBL. The potential transversal themes align with the new directions outlined within the EMBL Programme and include Planetary Biology, Human Ecosystems, Infection Biology, Microbial Ecosystems, Theory, and Data Sciences (Figure PP1). These transversal themes arose following several intensive brainstorming and cross-EMBL discussions (Appendix II: EMBL Programme Development Process),

with the operational feasibility of these particular transversal themes trialled in 2019 via several cross-unit scientific pilot projects (Chapter 1: Introduction). As described in the previous chapters, pilot projects included a coastal sampling expedition to Naples, Italy (Chapter 7: Planetary Biology), a multi-and-spatial omic investigation of the microenvironment of microbiome in colon cancer (Chapter 6: Human Ecosystems), characterisation of the host-pathogen interface (Chapter 5: Infection Biology), comprehensive (meta-) genome informatics platform for gut microbiome research (Chapter 4: Microbial Ecosystems), as well as the establishment of a short sabbatical programme for theoreticians to visit EMBL (Chapter 9: Theory at EMBL). These pilot projects led to dynamic new inter-EMBL and external relationships and collaborations, providing an opportunity to explore new areas both in terms of scientific and operational feasibility. The exciting scientific gains obtained from these cross-unit collaborative endeavours and the potential high impact that delivery of these projects could bring, have formed the basis for the choice of potential transversal themes. The Planetary Biology transversal theme will be the instrument for the Mobile Laboratory (Chapter 7: Planetary Biology, and Chapter 10: Scientific Services), which will be one of the most concrete changes to the delivery of EMBL science.

People for Tomorrow

The success of all EMBL science is contingent on EMBL's greatest asset: its people. EMBL personnel are foundational to the whole organisation and are comprised of scientific researchers at all career stages, scientific service staff that operate and make accessible a range of service infrastructures (Chapter 10: Scientific Services), scientific, technical, organisational, and operational support, as well as a diverse mix of training and engagement specialists. EMBL personnel across the whole organisation work together effectively to enable ambitious and world-renowned science to take place in the context of a relatively lean organisation.

EMBL's skilled and dynamic workforce is continually refreshed by EMBL's 9-year turnover model. This model, which is used as a model by other organisations across Europe (Chapter 13: Integrating European Life Sciences), means that new personnel who bring in fresh and innovative ideas are continually welcomed and nurtured. It is also a model to grow new scientific themes, ensuring that EMBL will not only remain responsive and reactive to changes within the scientific landscape, but will also help to drive fundamental scientific research into new areas. EMBL's member states also profit from this employment model as many of the skilled personnel and leaders who leave EMBL go on to take leading academic and industry positions within entities in EMBL's member states, thereby enabling a transfer of excellence to EMBL member states.

As EMBL grows, EMBL will be proactive in consistently promoting intrinsic values such as openness, inclusion, integrity, transparency, and fairness. In doing so, EMBL aims to create a workplace that allows staff members to explore their full potential and ensure EMBL holds a place amongst the best life sciences institutes in the world.

EMBL Leadership

EMBL leadership represents all sectors of EMBL's organisational structure to effectively discuss with, and advise, the Director General on scientific and institutional strategic decisions. Each unit is headed by a member of EMBL's senior leadership who lead other scientific and non-scientific faculty members. Scientific faculty lead scientific research or service and comprise group and team leaders, respectively. Hybrid leaders, who run both research groups and service teams, are also embedded within several EMBL units. EMBL will also develop new appropriate leadership roles for the transversal themes described previously.

Scientific faculty drive forward and implement EMBL's scientific themes while leading EMBL's diverse and skilled workforce with other leaders heading strategic and operational functions. **EMBL faculty** drive EMBL

science in a “bottom-up” approach by exploring science through their individual interests, expertise and skill. These leaders are highly accomplished in their speciality areas and play an integral part in driving EMBL’s widening scientific directions.

EMBL’s recruitment philosophy for **research group leaders** has always been with the aim to support independent scientists to set their own research agenda in molecular biology within a collaborative and supportive environment. This philosophy is a cornerstone of EMBL’s approach to research. As EMBL expands its research directions in the next EMBL Programme, leadership capacity in these areas will also need to be established. The 9-year turnover policy will also help facilitate the phased introduction of EMBL’s new scientific directions.

The specific skills required from **service team leaders** arise from a research need for the scientific community or from within EMBL. To help train highly-skilled leaders in these hard-to-fill roles, EMBL will embark on a new training programme to create a new generation of data and experimental service scientists. This recently funded programme, "Career Accelerator for Research Infrastructure Scientists (ARISE)", will offer dedicated training to scientists and leaders in technology development, management, and operation of advanced research infrastructures (Chapter 12: Innovation and Translation). As part of this training, short- and long-term scientific secondments will be set up within member states in partner academic, industry and healthcare organisations to enable the possibility of coordinated re-entry into the member state structures. The training is aimed to build leadership capacity for core facilities and research infrastructures, as well as speed up technology development and innovation in the life sciences, both within EMBL and across the wider scientific community.

Recruitment of Skilled and Diverse Personnel

EMBL’s international and interdisciplinary setting continues to make EMBL an attractive employer. EMBL personnel stem from more than 90 countries and collectively have a wide variety of academic backgrounds and skill sets. Interdisciplinarity is highly valued at EMBL and the crossovers between different STEM disciplines, already exemplified in many of EMBL’s personnel, will be a central component of EMBL’s future recruitment strategy.

The new scientific areas outlined within the EMBL Programme will provide a unique opportunity to attract further talent in several new disciplines including, but not limited to, engineering, physics, mathematics, chemistry, theory, and ecology. Integrating this mix of disciplines will enable interdisciplinary science to answer questions outlined in many of the themes highlighted in this EMBL Programme. As a result of EMBL’s turnover model, the experience gained by personnel in these future-facing roles can be drawn upon by member state research organisations seeking to seed new areas of research. In order to enlarge the required professional areas within EMBL, EMBL Administration aims to develop a bespoke **talent sourcing strategy** to attract graduate and experienced professionals from EMBL member states and elsewhere.

To **introduce** experts in science, technology, engineering, and mathematics (STEM) disciplines to EMBL, both online and offline recruitment strategies will be brought in. EMBL will continue to develop its employer brand to differentiate and promote EMBL’s identity to this new group of candidates. EMBL will identify journals, social media platforms, and online job boards most relevant within non-biology STEM disciplines to publicise vacancies. Offline, EMBL will select and attend relevant careers fairs within these areas to improve EMBL visibility within these disciplines.

Another aspect of this strategy is to **improve the familiarisation of non-biology STEM experts with EMBL**. This can be achieved through featured career profiles of EMBL’s current non-biology STEM professionals on

the EMBL website. Profiles will include details of staff experiences and career paths prior to EMBL, staff's current learning path, and future career aspirations.

In the longer term, EMBL will build a profile as an employer in these non-biology STEM disciplines by **developing relationships with key European institutes** with scientific goals that are aligned to those at EMBL. As part of this, EMBL will offer traineeships and internships to enable non-biology STEM experts of these institutes to visit EMBL. Working in partnership with these key European institutes, events such as hackathons and challenges could be initiated and widely publicised. Through both of these avenues, non-biology STEM experts will gain a more in-depth understanding of EMBL and the current biological challenges which their skills are vital to tackle.

Regular **high-level training for current staff** in recruitment is also required to ensure skilled interview techniques. EMBL's recruiters are the gateway into EMBL for all candidates, therefore it is vital to ensure that the interview process is positive, whether or not the candidate is successful. As EMBL is an international employer, it is highly likely that new staff will need to move city or even country to begin working at EMBL. It is therefore necessary to clarify the attractiveness of EMBL as a place to work.

Career Development

The professional development of all EMBL personnel is essential to ensure EMBL continues to be a leading life sciences institute in Europe. It is important that every member of personnel takes ownership of their professional development, and equally important that managers and senior leadership support team members to develop and progress. As such, it is EMBL's goal to revitalise its career development programme to grow and equip personnel with the necessary skills to progress professionally. Career development opportunities will be provided equitably across all parts of the organisation, to people at all career stages and within all sectors of EMBL, whether scientific, technical, or operational. This is particularly important given EMBL's enforced turnover model, as the application of competencies that personnel have developed at EMBL is a significant benefit to the new employer, to the member states, and to EMBL itself given the ambassadorial role of EMBL alumni.

Currently, all EMBL staff can benefit from the EMBL General Training and Development Programme. EMBL is also proud of the high-quality training offered to PhD students and postdoctoral fellows and seeks to expand this strength to include all EMBL personnel. Together, human resources and EMBL International Centre for Advanced Training (EICAT) will create a holistic programme addressing the needs of all personnel. Career development will be enabled by consistent classification of roles across the organisation and appraisal processes which will facilitate professional development and progression.

EMBL will also implement a comprehensive approach to professional development, supported by an **organisational competency framework** (Figure PPP2), which will establish a common language around professional competency and support personnel at all levels across the organisation to continuously improve. As well as core and leadership competencies, specialist competencies for scientific, technical, and operational personnel will enable the pursuit of ambitious professional development goals in different specialisms. In leveraging existing training schemes and experiential development to lead to a more well-rounded and impactful workforce at EMBL, EMBL also aims to be a role model for life sciences research organisations with similar needs.

Figure PPP2 | A sample organisation competency framework that can be adopted by EMBL.

Equality, Diversity, and Inclusion

EMBL is committed to creating an inclusive environment where diversity is celebrated and everyone is treated fairly, regardless of gender, gender identity, disability, ethnic origin, religion or belief, sexual orientation, marital status, transgender status, age, or nationality. Diversity nourishes creativity and allows knowledge, discoveries, and innovation to flourish. By reflecting the diversity of the world, EMBL is best positioned to tackle global challenges through fundamental science.

EMBL's founding treaty provides a high level of autonomy in deciding whom to hire worldwide, and EMBL has been the leading European institute for international recruitment. Looking forward, EMBL aims to progress in all aspects of equality, diversity, and inclusion (EDI). This includes: reviewing internal policies which have the potential to affect EDI; creating a focussed and effective EDI strategy; striving for EDI in personnel recruitment; and enabling personnel to act as role models, within and beyond EMBL.

Within this framework, EMBL is raising awareness of the importance of EDI by supporting LGBTQ+ campaigns and training. EMBL is also committed to achieving gender balance at all levels within the organisation. The number of women recruited to take on group and team leader roles is rising. Between 2015 and 2018, 40% of group and team leaders hired were women, compared with 14% between 2011 and 2014, as a direct result of coordinated efforts across EMBL. To further improve, EMBL will continue to publicise activities promoted and run by the Women in Science working group, whose main goal is to coordinate and increase visibility across EMBL of initiatives and events for the advancement of women in science. In addition, the Equality and Diversity Committee with the support of philanthropic donations by the Friends of EMBL initiative will launch LEAP, a mentoring programme for women in science. This project aims to support women who want to pursue a career in academia by providing them with mentorship, coaching, training, and networking. Increasing equality and diversity among EMBL personnel and fostering awareness and skills relevant to its promotion will both contribute to research excellence at EMBL.

Connected Processes and Systems

As a growing scientific entity embedded within a complex, global, unique, intergovernmental framework it is necessary for EMBL to utilise a number of administrative systems and processes. These systems enable the smooth running of the organisation, by navigating and adhering to internal and, where applicable, external policies. To improve on these systems, a strategy to further connect administrative support systems across EMBL will be developed. Operational models put in place by EMBL Administration ensures that EMBL remains a flexible, efficient, and internationally attractive work environment, with state-of-the-art facilities and high quality staff services.

An upgraded enterprise resource planning (ERP) system will seek to integrate various organisational systems. The purpose of this interconnected system is to maintain and further improve upon the operational efficiency and agility of the organisation as a whole. The pilot projects based on the new directions in the EMBL Programme also highlighted a need for operational processes at EMBL to be modified to facilitate the smooth running of cross-unit projects. To enable the success of the transversal themes, it is envisaged that current processes, mechanisms, and infrastructures, such as budgetary processes and personnel assignment, will need to be adapted for the effective delivery of such projects.

Updated and **modern digital systems** will help manage business processes taking advantage of software and technology developments, including the automation of standardised, repetitive processes. Fairness and transparency of these systems and processes will also be kept as a core consideration when developing these improvements. It is critical that intuitive, mobile, and cost-effective administrative systems are adopted. Equally so is the need for end-users of these systems to receive training in their use. Updated and modern digital systems will enable personnel within EMBL Administration to focus on implementing new models for effective business and people partnering throughout the organisation.

The rise of technology and its complexity has been an important driver for the rise of **data protection** laws like GDPR. These regulations are largely spurred by the increase in the variety of technological methods as well as an increase in the specific ways technology is used. A cohesive approach to data protection at EMBL allows for an integrated and systematic approach to the complexity of technologies. For EMBL, meeting data protection and privacy principles is also an essential part of being a leader and innovator in molecular biology. EMBL will continue to integrate data protection principles and practices into activities including administrative tasks, IT systems, provisioning, lab work, and software design. Training staff in data protection in research, administration, production of data and metadata, processing, sharing, and use of data, will also be essential to ensure EMBL scientific and operational staff are equipped to deal with all aspects of data protection. EMBL will also contribute to the international discussions on data protection to find inter-disciplinary policy approaches and generate a consensus on developing and deploying digital technologies.

Supporting Field Sampling Projects

Future projects at EMBL will include increased efforts to collect specimens from different types of places and environments to molecularly profile model systems. Projects that include fieldwork will warrant increased demands on operational personnel and systems, particularly those of the size and scale of the TREC and other projects via mobile labs (Chapter 7: Planetary Biology). Mobile labs will bring EMBL's research, services, training and outreach into the member states through coastal and river sampling projects. The scale and complexity of fieldwork required for these types of projects will result in a number of operational matters that would require effective and scalable implementations to ensure safe personnel travel and efficient collection and movement of collected samples.

High-level and regular legal support will be needed to establish legal links with countries which EMBL plans to travel to and sample from. This will include ensuring health and safety compliance, as well as appropriate customs clearance and appropriate visas, insurance, travel authorisations, and permits for the handling of dangerous goods or sensitive samples. Here, EMBL will partner with experienced organisations like the European Marine Biology Resource Centre (EMBRC), a research infrastructure of a network of renowned marine biological stations and institutes across EU and EU-Associate countries. By organising access to these state-of-the-art facilities, EMBRC provides the necessary and relevant services, facilities, and technology platforms to study marine organisms and ecosystems (Chapter 13: Integrating European Life Sciences). Experience gained from EMBL's collaboration with *Tara* in establishing appropriate sample protocols, setup of sample recording, tracking systems and data hubs will also be leveraged. As well as an increase in legal expertise, global surveillance projects will also need recruitment in a wide range of expertise, from researchers, engineers, technicians, data scientists, project managers, and operational staff.

The delivery of open scientific data faces challenges from many new directions. Currently there is pressure around Access and Benefit-sharing requirements relating to the Convention on Biological Diversity's Nagoya Protocol and the developing UN Biodiversity Beyond National Jurisdictions convention. Implementation plans for many of the new directions in this EMBL Programme will need to consider these requirements, which aims to ensure that the benefits from the utilisation of genetic resources from nature's biological assets and associated traditional knowledge are shared equitably. In each case, as in previous collaborations, EMBL has to take a responsible approach in which the ethical landscape, stakeholder interests, and technical possibilities are considered. If needed, demonstrator projects in new areas that set out to track data use and reuse and to assess impact can be proposed.

EMBL IT Infrastructures

EMBL IT infrastructures are at the heart of the Laboratory's data-driven research involving big data analytics and large-scale bioinformatics service provision, that critically underpin almost all of EMBL's research activities.

The IT infrastructure across the EMBL sites is designed to serve the local needs. The two largest EMBL IT facilities, in Heidelberg and Hinxton, operate advanced IT services including high-end compute clusters and data storage, large-scale cloud services and web service hosting. The hosted IT infrastructure serves the needs of more than 2,000 users at EMBL sites and remote collaborator institutes. Primarily focused on research, it also provides central administrative IT services, for example, to support the processes in finance, human resources, purchasing, and departments linked to research information management and reporting. Heidelberg IT Services operate about 1 MW of state-of-the-art data centre capacity on campus, which is flexibly upgradable in terms of power and cooling. As of today, it hosts about 80 petabytes of data storage, 17,000 compute cores and 170 GPUs powering HPC clusters and compute clouds to support large data analysis and AI driven data analytics.

The Hinxton IT capacity needs are driven by EMBL-EBI's very large external-facing data services component and the need to produce the data resources behind these services as well as to support the computational research groups in Hinxton. The IT infrastructure managed by EMBL-EBI's Technical Services Cluster is spread over three data centre locations providing resilience and flexibility in service provision. It includes a Tier III+ data centre that provides the infrastructure for operating the public-facing web services and data resources. This data centre encompasses over 40,000 compute cores and 300 petabytes of storage currently supporting roughly 5 million unique users each year and 65 million web requests each day, accessing its services from around the world. Local IT services at the Barcelona, Grenoble, Hamburg, and Rome sites mainly focus on providing core infrastructure involving networking, desktop, email, mid-range computing and storage, and on supporting the specialised scientific demands of the respective sites.

Increased collaborative and integrated research based on large data sets across EMBL and within international scientific consortia, coupled with the exponential growth of experimental data volumes driven by new technologies, will continue to pose enormous demands on the Laboratory's IT infrastructure. In order to fully exploit these, investment in physical infrastructure such as networking, data storage, and compute power also needs to be matched by an investment in IT staff and in software development, training, support, and consultancy staff across EMBL.

To better connect EMBL across campuses and to enable researchers at all sites to efficiently access a wide range of internal and external IT resources, EMBL will need to invest in high bandwidth and low latency external network connectivity. As efficient network links already exist between Heidelberg and EMBL-EBI, dedicated and faster network links will need to be implemented to other EMBL sites. Most importantly, this will support free and easy flow of data as well as consistent data management across the whole Laboratory, allowing a more efficient tracking of research data and metadata, use of common workflows, and data exchange between EMBL services and groups.

The newly established Imaging Centre at EMBL Heidelberg will bring about greater demands on analysis capacity. Image data analysis heavily and increasingly relies on machine learning, a technology which at the same time is increasingly used also in other domains of scientific data analysis (Chapter 8: Data Sciences). Hence, the GPU capacities both within the compute clusters and also for on-demand visual data processing as in the EMBL 3D Cloud will need to be further developed and expanded. As data throughput for GPU-based computation is extremely high there is a need to further develop and implement parallel storage systems with very high data input/output with the capability to also enable users to store and process data (partially remotely) on demand.

It can be expected that cloud technology will play an even bigger role in the coming years. It might serve as an efficient strategy in dealing with large data volumes, due to its enormous potential to simplify connecting and federating distributed IT infrastructures. The concept of an "EMBL Science Cloud" initially builds on existing infrastructures such as the EMBL-EBI Embassy Cloud and the 3D-Cloud in Heidelberg. While large-scale compute clusters deliver the main compute capability for Heidelberg and Hinxton, the potential of integrating internal and public clouds with innovative commercial cloud services is essential if EMBL's IT activities are to continue to scale with the organisational need.

Engagement with service providers from elsewhere in the research and commercial sectors (e.g. European Open Science Cloud (EOSC), EIROforum organisations) also provide valuable opportunities to deliver the infrastructure needed to support EMBL's data-intensive science both internally and externally. A most recent example is the European COVID-19 Data Platform for data/information exchange that will be connected to EOSC. The platform is being built on Data Hubs implemented within the Embassy Cloud that can be created for specific communities or member states to co-analyse specific elements related to research on COVID-19 data from different disciplines.

Buildings and Facilities

EMBL comprises six sites hosted by five countries. The facilities management department is dedicated to maintaining and improving the state-of-the-art facilities across all EMBL sites. In response to and in preparation for growth in science activities or innovation, expansion or renovation in some form is needed at all sites. Plans will include mechanisms to more efficiently house scientific groups and facilities as well as dedicated laboratory spaces and engineering workshops to make modern fabrication technologies available for new technology developments at EMBL. Additionally, new ancillary facilities are planned for most sites, including more nursery places and on-site accommodation where this is feasible. EMBL places great importance on the fair and, as far as possible, equal provision of services and support via social infrastructure to all EMBL staff, regardless of location. In the cases where EMBL has less influence over host infrastructure, EMBL will offer different forms of support. All of these expansion activities, along with the specialist equipment required to facilitate the research within them, will take into account sustainability and the existing infrastructure and will require additional coordination, facilities and health and safety support across the EMBL sites.

Building Sustainable Campuses

EMBL's commitment to a better environment is reflected not only in the study of ecosystems at the molecular level but also in its strengthening of green practices across all sites. With the urgency of issues such as climate change and effects of human-made pollution, the initiation and implementation of sustainable practices is an ongoing process throughout which all personnel need to take responsibility. Indeed, the enthusiasm for sustainability across EMBL has been driven by coalescing, bottom-up groups across the sites, collectively called **Green EMBL**. Since the initiation of this movement, the importance of achieving a sustainable or green EMBL has been widely profiled and prioritised. Several *ad hoc* changes have been driven, including the switching of EMBL Heidelberg's electricity provider to green energy. Longer-term strategy and planning is being led by the EMBL Environmental Officer to ensure the most effective and cross-site implementation of these initiatives as well as to fulfil EMBL's aim to be a leader in developing novel ways of carrying out responsible scientific research practices, which are environmentally conscious.

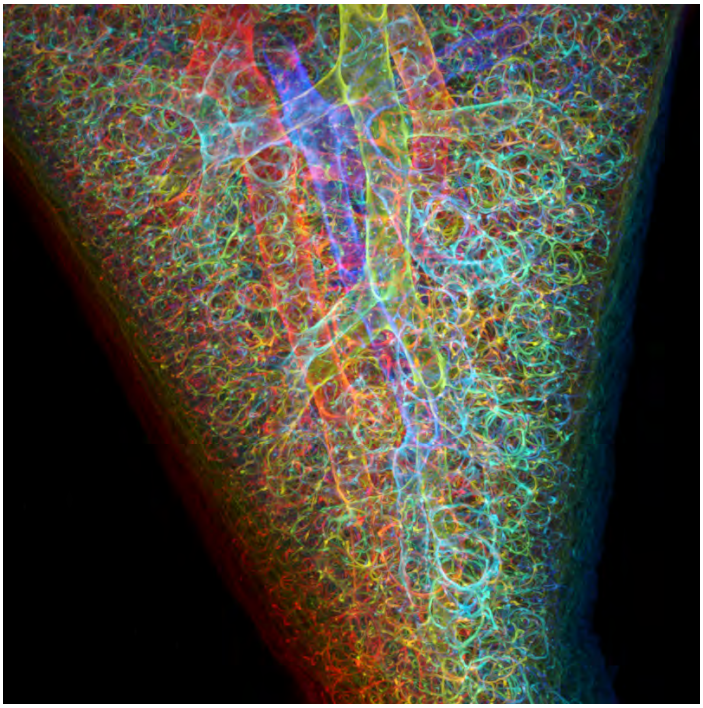
To create an environmentally friendly workplace, many areas of the organisation where sustainability could be improved will be addressed. EMBL plans to establish **travel guidelines** to cultivate responsible travel practices. Considering the quantity of travel required to enable EMBL's full operation, including on-site training and recruitment, it is expected that the new guidelines will make a meaningful contribution. State-of-the-art **videoconferencing and streaming capabilities**, which are being piloted in response to site closures during the COVID-19 pandemic, will be used wherever possible, including new models for delivering courses and conferences. In the future, as EMBL research themes produce novel discoveries and mechanistic knowledge, EMBL aims to expand its Environmental Office (Chapter 1: Introduction) to enable high impact, global initiatives to be achieved and further facilitate the use of research data to generate innovative and creative solutions for planetary health.

Places: EMBL Sites

Each EMBL site contributes individually and collectively to the delivery of all five EMBL missions and strategic priorities whilst specialising in particular research areas and scientific services. In the EMBL Programme, Molecules to Ecosystems, all EMBL sites will implement the scientific directions described in the previous chapters with the transversal themes going across sites, whilst building collaborations and networks that fully realise these ambitions. A key component of these will be the creation of the data science centre to enable coordinated data science and bioinformatics research (Chapter 8: Data Sciences). The centres will provide services and infrastructure, including data research management and analysis at EMBL and with member state communities in the form of facilities and data resources. They will offer internal and external data science training across all levels from students to PIs, as well as opportunities for collaboration and coordination with both academia and industry.

All sites except EMBL Heidelberg are embedded in campus structures run by organisations within EMBL's host countries. Developed at each of EMBL's six sites are **strategic local alliances** which stimulate close collaboration between the stakeholders and facilitate the coordination of all activities taking place on campus. They emerged from the desire of all institutions involved to share good practices, offer holistic user support and complementary techniques. The alliances spearhead the creation of a critical mass of life sciences research within the local area that, in turn, promotes scientific collaborations, joint initiatives, technology development of instrumentation, and training.

EMBL Barcelona



EMBL Barcelona, the youngest of the EMBL sites, focuses on tissue biology and disease modelling, from questions about the molecular control of embryonic tissues to applied projects which model a wide range of disease types using 3D *in vitro* human tissues. Since its opening in 2017, the unit has created a strong brand for itself in the field of **multicellular engineering**. This perspective of 'reconstructing biology' runs through its research: cells are coaxed into re-building 3D tissues showing, for example, dynamical oscillations of gene expression, spatial patterns of cartilage formation, or functional vasculature through which blood cells can be perfused. Putting cells back into their true environmental context - as multicellular tissue collectives with emergent behaviours - allows the study of tissues in health and in disease, such as human congenital defects, cardiovascular disease and malaria infection of the blood-brain barrier. An interdisciplinary mix of technical expertise supports this vision: microfluidics engineering, state-of-the-art mesoscopic imaging technologies, and increasingly the use of mathematical and computational models, in line with EMBL's goal to strengthen the area of theory.

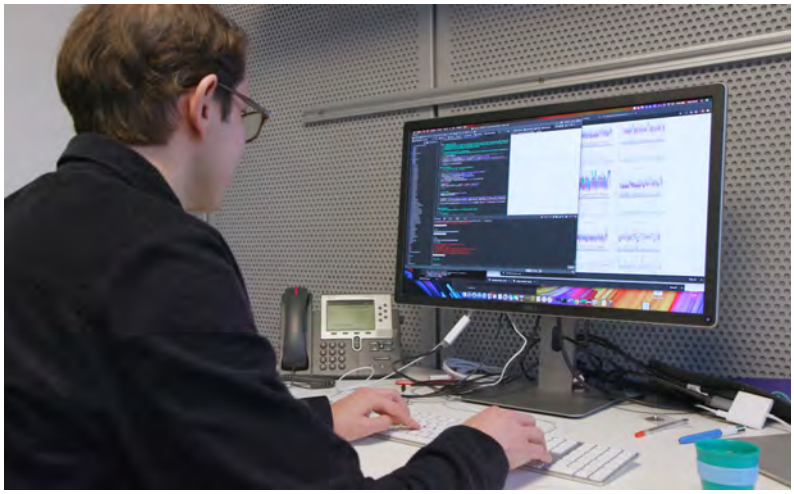
EMBL Barcelona is hosted in the Barcelona Biomedical Research Park (PRBB), one of the largest infrastructures in Southern Europe dedicated to translational research. In this highly collaborative, interdisciplinary and international environment, EMBL researchers benefit from its partnership with the Centre for Genomic Regulation (CRG) which offers opportunities for collaboration with this pioneering research institute. From its focus on engineering approaches, EMBL Barcelona also has a strategic alliance with the Institute for Bioengineering of Catalonia (IBEC), a cutting-edge multidisciplinary research centre that connects engineering, mechanobiology, and life sciences to generate new knowledge and applications in biomedicine.

EMBL Barcelona will embark on several new initiatives in the context of ecosystems at the molecular level, for example, partnering with the Pompeu Fabra University and Alicante University in a project called SYNTERRA whose goal is to take the first steps in exploring ecological engineering, or terraformation of arid soil ecosystems. Within the context of Planetary Biology, EMBL Barcelona is also partnering with the Institute of Evolutionary Biology (IBE), the Barcelona Zoo, and the CRG, to create a global reference European Cryo-Zoo for a cell line biobank which supports the study of biodiversity at the omics level. EMBL Barcelona will create iPS cell lines for selected species, creating a unique cellular resource. These stem cells will be used in various *in vitro* tissue engineering projects, thus allowing comparative studies of tissue structure and function across multiple species.

To capitalise fully on the collaborative potential that is enabled through the local alliance, EMBL is in discussions with the CRG to establish a new joint activity that is expected to benefit not only EMBL and the CRG, but also the broader local and national research ecosystem: the EMBL-CRG Collaborative Environment for Data-Driven Predictive Modelling. Combining EMBL and CRG researchers with visiting fellows and sabbaticals, this exciting new initiative would be purely theoretical or dry-lab, focused on computational modelling and related topics and thus be a key part of EMBL's distributed initiative to strengthen Theory within this EMBL Programme.

EMBL-EBI

EMBL's European Bioinformatics Institute makes the world's public biological data freely available to the scientific community via a range of data services and tools, whilst performing basic research and providing professional training in bioinformatics. EMBL-EBI Services maintain and openly host more than 40 core biological data resources such as the European Nucleotide Archive (ENA), UniProt, Ensembl and InterPro, as well as emerging resources like the BioImage Archive, which continues to be developed to serve as the central bioimage data repository for the scientific community. These databases and tools help scientists share data efficiently, perform complex queries and analyse the results in different ways. Included within these data resources are data on the genome, proteome, cell types, literature and many more. The use of EMBL-EBI's websites continues to grow exponentially, with data resource websites accessed by the global research community on average 64 million times per day in 2019. At the close of the year, EMBL-EBI had more than 300 petabytes of data storage capacity. EMBL-EBI data services are used either directly or indirectly by nearly every life scientist in the world. EMBL-EBI Research performs active

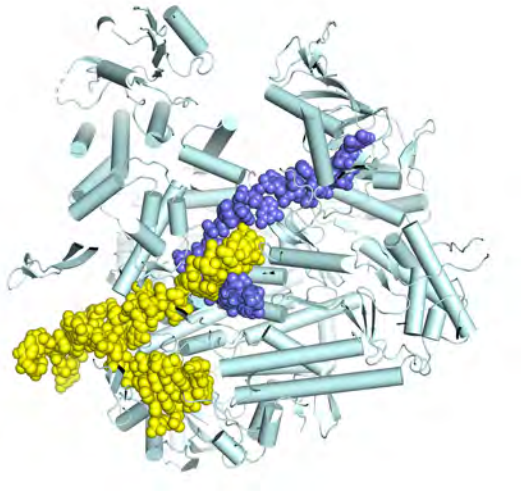


data science research in biology and broadly mirrors the areas of EMBL-EBI's data services. Independent group leaders use the large-scale data and associated compute to make novel inferences of the world.

EMBL-EBI is situated on the Wellcome Genome Campus in Hinxton, Cambridge, UK, alongside the Wellcome Sanger Institute, a charitably funded, genomic research centre focused on understanding the role of genetics in health and disease. This campus is one of the world's largest concentrations of scientific and technical expertise in genomics. EMBL-EBI has had a long-term partnership with the Wellcome Sanger Institute, with the proximity between both institutes permitting the fostering of close collaborations such as the Darwin Tree of Life Project, an effort to sequence 66,000 UK species and where EMBL-EBI will play a key role in the annotation and distribution of this collected data. The early adaptation of the EMBL-EBI SARS-CoV-2 Data Hubs to organise the flow of SARS-CoV-2 outbreak sequence data from Europe and beyond and provide comprehensive open data sharing for the European and global research communities is a further example of the benefits that accrue from these collaborations.

To provide for the growing volumes of biomolecular data, the diversity of biological applications, and the diverse needs of a growing and global scientific community, EMBL-EBI will focus on five strategic priorities which aim to (i) increase the usage, utility, and application of bioinformatics; (ii) extend collaboration and coordination activities; (iii) grow the culture of continuous improvement to maximise efficiency;(iv) build bioinformatics capacity and capability; and (v) support the global sustainability of biomolecular resources. This structured approach to change also helps to focus and distribute resources sensibly, while building on EMBL-EBI's strong foundations as a technology innovator, cross-sector collaborator, and neutral intermediary across various communities. One new initiative EMBL-EBI will implement in the next EMBL Programme is a bespoke, multi-component service, the Genomic Medicine Platform, that will engage with individual national healthcare initiatives, to advise and proactively transfer knowledge and technology into those EMBL member states that have embarked on bringing precision medicine into their healthcare systems.

EMBL Grenoble



EMBL Grenoble is situated on the European Photon and Neutron (EPN) Campus, along with three other research institutes, the European Synchrotron Radiation Facility (ESRF), the Institut Laue-Langevin (ILL, focussing on neutron scattering), and the Institut de Biologie Structurale (IBS). Operating as the Partnership for Structural Biology (PSB), these institutes create a dynamic and multidisciplinary environment that provides a uniquely comprehensive range of structural biology platforms for both in-house research and external users. EMBL Grenoble and the ESRF jointly develop and operate the beamlines for macromolecular crystallography (MX) and small-angle X-ray scattering (SAXS). After a long shutdown for refurbishment, the ESRF restarted in early 2020 as the world's first high-energy, fourth-generation synchrotron. The increase in brilliance and coherence of the X-ray beams by up to 100 times, opens up new exciting opportunities including microsecond-scale serial crystallography and high-resolution X-ray imaging. In addition, EMBL Grenoble participates in a joint cryo-electron microscopy facility on the EPN campus, currently with one Krios machine, that, given the power and importance of this technique, is likely to develop further in the future.

A particular strength of EMBL Grenoble is its leading expertise in designing and building automated sample-handling instrumentation for synchrotron MX and SAXS, providing innovative technologies that benefit the structural biology community worldwide. The same expertise is now being applied to cryo-EM sample preparation. High-throughput methods have also been introduced upstream of data collection, including the unique CrystalDirect system which performs automated crystal mounting and cryo-cooling. This has prompted development of highly efficient, fully automated crystallisation to structure-determination pipelines that are being exploited for large-scale ligand screening campaigns by academia and the pharmaceutical industry, as an aid to drug development.

Research at EMBL Grenoble focuses on structural biology of complexes involved in RNA biology, gene-expression, signalling, and host-pathogen interactions, mainly in eukaryotic systems. EMBL Grenoble uses the full spectrum of structural biology technologies available on the site, as well as proteomics and cell biology approaches. Many projects have developed a translational aspect in collaboration with EMBLEM.

With the opportunities offered by the new synchrotron source, as well as by the rapid developments in cryo-EM, EMBL Grenoble is in the exciting position of being able to drive forward a future in integrated structural biology with broad applications in fundamental and translational research. Additional services that should be developed include *in situ* cryo-EM tomography, serial crystallography, molecular and ligand modelling, and X-ray imaging. Reinforced or newly formed links with the Université Grenoble Alpes (UGA), the French Alternative Energies and Atomic Energy Commission (CEA), and the Institute for Advanced Biosciences (IAB) in Grenoble can help drive forward the scientific directions, particularly in infection biology, planetary biology, human ecosystems, and microbial ecosystems.

EMBL Hamburg

EMBL's unit in Hamburg has existed since the founding of the laboratory to pursue a long-standing aim to harness the enormous potential of synchrotron radiation for applications in the life sciences, in a strategic alliance with the Deutsches Elektronen-Synchrotron (DESY). EMBL Hamburg operates its own synchrotron radiation beamlines for applications in macromolecular X-ray crystallography (including a new instrument dedicated for time-resolved studies) and small angle X-ray scattering for applications in the life sciences, for use by external research groups, mostly from EMBL member states. EMBL Hamburg also operates an associated Sample Preparation and Characterisation facility, suitable for a broad range of mostly biophysical characterisation approaches and automated crystallisation and also participates in the operation of a laboratory for sample preparation for experiments on the European X-Ray Free Electron Laser (X-FEL). The current beamlines at the PETRA III storage ring, representing one of the most powerful synchrotron infrastructures globally, provide robust, high-end services to a large and growing user community. EMBL Hamburg also supports the wider scientific user community through additional service activities such as software suites for structural analysis, as well as various technical developments on beamline and instrument operation.

The main research focus of the Hamburg Unit, in cooperation with research groups from the neighbouring Center for Structural Systems Biology (CSSB), is in the field of studying infection processes from pathogenic bacteria by structural/functional approaches. Research programmes at EMBL Hamburg

address questions such as the structures of membrane transport proteins, complex networks and pathways such as the influenza virus infection cycle, and advanced modelling based on core principles of protein structure and dynamics. EMBL Hamburg also has strong research links with groups at the Universität Hamburg, the Center for Free Electron Laser Science (CFEL), and the Hamburg Advanced Research Centre for Bioorganic Chemistry (HARBOR).

EMBL's strategic partner in Hamburg, DESY, has recently started to plan a major upgrade of the present synchrotron PETRA III to PETRA IV, which is expected to have world-leading capability in terms of spectral brilliance and coherence, with an expected completion around 2026/27. EMBL Hamburg, which is centrally involved in the planning especially for applications in the life sciences, views this as a major future opportunity for both upgrading research activities where there is already a strong, long-term record (X-ray crystallography, SAXS) and also for further diversifications, where the application of different structural and imaging technologies to related questions and systems has the potential to allow researchers to achieve a holistic and integrated view of organisms. Key to these endeavours is the availability of correlated multiscale and dynamic structural information from molecules and cells to tissues and organisms, where EMBL Hamburgis planning to contribute by establishing a new activity in X-ray imaging, with superior perspectives for thick specimen penetration and throughput.

As EMBL Hamburg is presently located in different areas of the DESY campus, the unit plans to bring together all activities for the operation and use of research infrastructures under one roof: a new Hamburg Hub for Integrative Structural Biology (HISB), during the timeframe of the next EMBL Programme. This applies in particular to the operation and constant further development of synchrotron measuring stations, including the operation of online data evaluation and data interpretation, relevant research projects and the operation of a future user facility for electron microscopy and tomography of biological samples. The HISB project is embedded into one of the largest city development projects in Europe, the new "Science City Bahrenfeld".

EMBL Heidelberg

EMBL Heidelberg is the first and largest of EMBL's six sites and brings together the most diverse range of life sciences disciplines including molecular, cellular, and structural biology. The current units are Cell Biology and Biophysics, Developmental Biology, Genome Biology, and Structural and Computational Biology.

Many of the directions in the new EMBL Programme will need to bring together various technologies and fields of research in specialised laboratories of the planned Molecular Biology Centre for Human and Planetary Health, in order to examine organisms, microbial communities, and ecosystems at the molecular level. EMBL Heidelberg plans to expand its research into specialised laboratory systems that can be environmentally controlled (micro- and mesocosms) in order to test the findings of global field research in nature, with specific experiments that allow for long-term investigation of organisms and their ecosystems under near-natural, but controlled, conditions.

To achieve a molecular understanding of complex ecosystems, it is necessary to integrate innovative molecular biological methods of genomics, transcriptomics, proteomics, and metabolomics and state-of-the-art imaging technology across several spatial scales, and to analyse the resulting large data volumes with bioinformatics. Here, EMBL Heidelberg plans to develop new integrative spatial omics methods for the quantitative analysis of DNA, RNA, proteins, and metabolites in cells, tissues, organisms, and biocoenosis and of their spatio temporal changes due to critical environmental parameters.

Experimental scientific services at EMBL Heidelberg are currently driven by the Core Facilities which enable scientists to access cutting-edge technologies and the expertise required to effectively gain high-quality data. Services which span imaging and structural biology techniques will be further enhanced by the opening of the EMBL Imaging Centre in 2021. The ability to develop new technologies within the EMBL Imaging Centre will be further accelerated through technology development partnerships between on-site research groups and industry partners, with the aim to be the European hub for introducing the latest pre-commercial imaging technologies to ground-breaking life science applications. Spin-outs, public-private partnerships, and proof of concept projects generated by the scientific activities within molecular-level ecosystems for the development of new technological advances (such as molecular sensors for environmental measurements, biomarkers that can enable evaluations of ecosystem collapse, new drug targets as well as software and databases that allow for modelling of human and planetary ecosystems) are also envisaged.

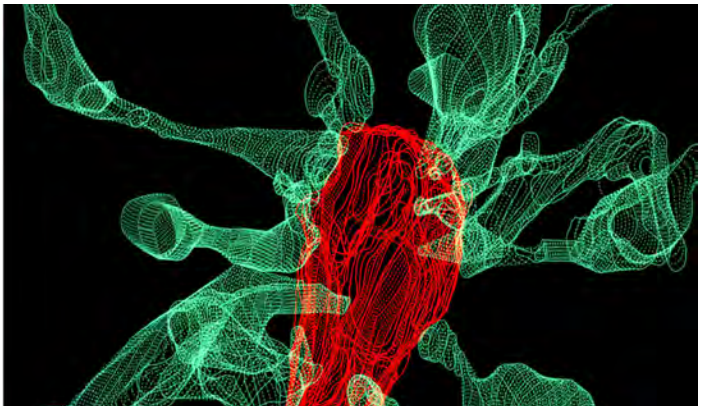
With the planned growth in data sciences across the organisation, EMBL Heidelberg will enlarge its IT infrastructure to support centres in Heidelberg and the other sites, which will enable the management, integration and interpretation of data for molecular-level ecosystems, with emphasis on machine learning and artificial intelligence approaches. Taking advantage of the large data volumes and novel experimental labs, will be the Theory at EMBL strand, aimed at uncovering the general principles in living systems on Earth. These capabilities will be key to EMBL's role in German initiatives such as Cyber Valley Health in Tübingen and EMBL's leadership in the establishment of the German Human Genome Phenome Archive. EMBL Heidelberg also houses much of EMBL's external training, with the vast majority of EMBL's on-site courses and conferences held within the Advanced Training Centre. Many new courses and conferences are planned in the topics that emerge from the study of ecosystems at the molecular level, to train researchers in the latest methods in the life sciences.

Many bilateral links between scientists at EMBL and other Heidelberg research institutions have been established. Alongside these, EMBL participates in several larger projects with the German Cancer Research Centre (DKFZ) and the Max Planck Institute for Medical Research. A joint venture with the Medical Faculty of the University of Heidelberg which drives innovation and its translation into medicine is also facilitated by the Molecular Medicine Partnership Unit (MMPU), which will be furthered under the human ecosystems direction.

EMBL Rome

Research at EMBL Rome focuses on the interface between epigenetics and neurobiology. In particular, the unit provides an anchor for neurobiology research across all EMBL sites and has extensive links to chromatin biologists, *in vivo* imaging technologists, and bioinformatics experts across the organisation. Key areas of inquiry at present include understanding how internal brain states (e.g. hunger, activity, anxiety, territoriality, social experience) adapt to drive context-specific, instinctive behavioural programmes and how these internal states impact sensory processing. The unit is also working to resolve long-standing questions about the causal relationship between chromatin marks (e.g. DNA methylation, histone modifications) and gene transcription and trying to understand how these mechanisms can store and transmit information about the environment across generations. Several joint projects between epigeneticists and neurobiologists at the unit are exploring the peculiar role of chromatin modifications in neural tissues and plasticity and these links will be deepened with additional faculty hires at the interface between these fields during the next EMBL

Programme. *In vivo* research in the laboratory mouse is a core strength of the unit, supported by a series of core facilities, including advanced gene editing, viral gene delivery, and imaging approaches. Recent advances in *in vivo* gene editing technologies have dramatically increased the precision and speed with which genetic and epigenetic perturbations can be introduced into the mouse genome, including viral-mediated cell-type specific knockout and tagging, and humanised and point mutant mice and these are routinely produced at the unit for internal and external researchers.



As part of a major programme to enhance links to Italian research centres, EMBL Rome has established a three-way joint interdisciplinary postdoctoral programme with EMBL-EBI and the Italian Institute of Technology (IIT) in the areas of nanotechnology, genomics, and systems neuroscience. In addition, EMBL Rome has close local links and collaborations with Sapienza University with whom it runs a highly successful seminar series in epigenetics and neurobiology. As part of a strategy to build on these collaborations and leverage its unique expertise linking genomics, environment, and neuroscience, EMBL Rome plans to establish a Centre for Human Brain Phenomics. This bioinformatics initiative will carry out research to develop novel methods to link human genetic and environmental variation to brain and behaviour-relevant phenotypes and make these available to the research community. The close integration of EMBL Rome's Centre for Human Brain Phenomics with IIT and Sapienza will provide critical mass and complementary expertise and will sow the seed for further life sciences research initiatives in Rome.

Although discrete entities in their own right, EMBL's six sites are highly connected through scientific collaboration, overlapping operational processes as well as professional and personal networks forged through EMBL-wide initiatives. Each site contributes to EMBL's success by adding its distinct specialism and expertise. These specialisms allow the sites to easily integrate into their own local scientific landscapes. Thereby, through local collaborations, partnerships and engagements, the sites continue their positive exchanges with local institutes, regions, and national initiatives.

Going forward, EMBL will both deepen its interactions on these six sites and also broaden the interface to the wider life sciences expertise across Europe. The deepening will be due to joint programmes in regional, national, European, and global contexts, aiming to deliver on EMBL's scientific missions from a transnational European base. The broadening will be due to a series of innovations: firstly, increased research collaborations with both partner institutes across Europe (Chapter 13: Integrating European Life Sciences) and to diverse European collaborators; secondly, via revitalised or new instruments explicitly with collaborative components, such as the EIPOD and ARISE programmes (Chapter 11: Training); and thirdly, via the new aspects of sabbaticals and secondments with member states. By working together across Europe, with these six physical sites united in a single legal structure, and with deep connections across all its member states, EMBL will deliver a new era of critical scientific missions for the benefit of society.

With the ambitious scientific directions set out in the new Programme, EMBL will strengthen European science, tightly connecting its member states and providing new services, technologies and expertise, from molecules to ecosystems. Ultimately, this knowledge economy should enable a comprehensive understanding of the molecular basis of human and planetary health, and the emergence and spread of disease in populations and individuals. These discoveries, including improved understanding of biodiversity and ecosystems, are vital to foster change at the public and political levels. In doing so, EMBL's aim is to help Europe become the scientific leader in this new interdisciplinary area, to help both human and planetary health.