

ELIXIR

International Strategy



About this Strategy

This annually-updated Strategy describes what ELIXIR is doing to reinforce its global significance and impact. Here, the term 'International' means 'beyond Europe', with 'Europe' being defined as the countries of the European Research Area (ERA)¹.

The Strategy is articulated around four main objectives:

1. Scale-up the international user base of ELIXIR's Services,
2. Improve bioinformatics services by promoting global standards, data-sharing and data annotation,
3. Expand international Membership in, and collaborations with, ELIXIR, and
4. Reinforce recognition of ELIXIR as an infrastructure of global significance, and a trusted partner.

The audience of this Strategy encompasses users of bioinformatics services, national-level bioinformatics infrastructures, and government officials in Ministries. Also targeted are international bioinformatics-related initiatives and organisations, and intergovernmental organisations. Closer to home, the Strategy aims to raise awareness, within Member countries, of ELIXIR's global significance and guide efforts towards its implementation, in support of its long-term sustainability.

¹ http://ec.europa.eu/research/era/eraprogress_en.htm

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Research infrastructures underpin access to life science data

Modern life science research is data-intensive, with data being very heterogeneous by nature and showing exponential growth. Research infrastructures underpin user access to life science data and the various services derived from them. Hence, these infrastructures are critical to bioinformatics research and its many applications in the fields of health (e.g. personalised medicine, epidemics monitoring), food security (e.g. aquaculture, crop development) and the environment (e.g. biodiversity knowledge, pollution remediation), which have significant societal and economic benefits. Together, life science research infrastructures and bioinformatics research are important pillars supporting 150+ countries in their efforts to reach some of the UN Sustainable Development Goals they have collectively committed to (Figure 1).¹

ELIXIR is a research infrastructure for life science data

ELIXIR unites leading life science organisations in managing and safeguarding the increasing volume of data being generated by publicly funded re-

¹ <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

search. ELIXIR coordinates, integrates and sustains bioinformatics resources across its country Nodes, and enables users in academia and industry, wherever they are based on the planet, to freely access services that are vital for their work.

ELIXIR is an intergovernmental organisation of 21 Member countries, one Observer country, plus the European Molecular Biology Laboratory (EMBL) (Figures 2 and 3). It is a distributed infrastructure, with a Hub acting as the coordinating secretariat, and Nodes in each of the Member countries, plus the European Bioinformatics Institute (EMBL-EBI) acting as the “European Node” of ELIXIR.

An international perspective of ELIXIR

Bioinformatics is a global science, as evidenced by the geographic spread of its data producers, service providers, and users. ELIXIR’s Services² have a truly global user base; for instance, Orphanet, the international rare disease and orphan drug database, has around 782,000 visitors per month from most countries on the globe³. Moreover, a number of other ELIXIR Services, such as UniProt⁴ (a database on

² <http://elixir-europe.org/services>

³ <https://www.orpha.net/orphacom/cahiers/docs/GB/ActivityReportLeaflet2017.pdf>

⁴ UniProt is a collaboration between EMBL-EBI, SIB Swiss Institute of Bioinformatics and the Protein Information Resource. See list of donors at: <https://www.uniprot.org/help/about>



Figure 1. Life science research infrastructures and bioinformatics research are important pillars supporting 150+ countries in their efforts to reach some of the UN Sustainable Development Goals they have collectively committed to in particular: Goal 2 Zero Hunger; Goal 3 Good Health and Wellbeing; Goal 9 Industry; Innovation and Infrastructure; Goal 14 Life Below Water; and Goal 15 Life on Land.

protein sequence and functional information), are run as part of inter- national (i.e. beyond Europe) collaborations and funding arrangements.

ELIXIR has established formal agreements with several international bioinformatics-related initiatives⁵. For instance, it collaborates with the Global Alliance for Genomics and Health (GA4GH) in developing and promoting standards and frameworks for the responsible sharing and reuse of genomics data⁶. Finally, in the policy sphere, ELIXIR is recognised as a Research Infrastructure of Global Interest by the Group of Senior Officials on Global Research Infrastructures of the G7⁷, while the Swiss Node (SIB Swiss Institute of Bioinformatics) is a "Reference Centre"⁸ for bioinformatics of the Food and Agriculture Organization (FAO) of the United Nations, in the context of a collaboration in relation to zoonotic and animal diseases.

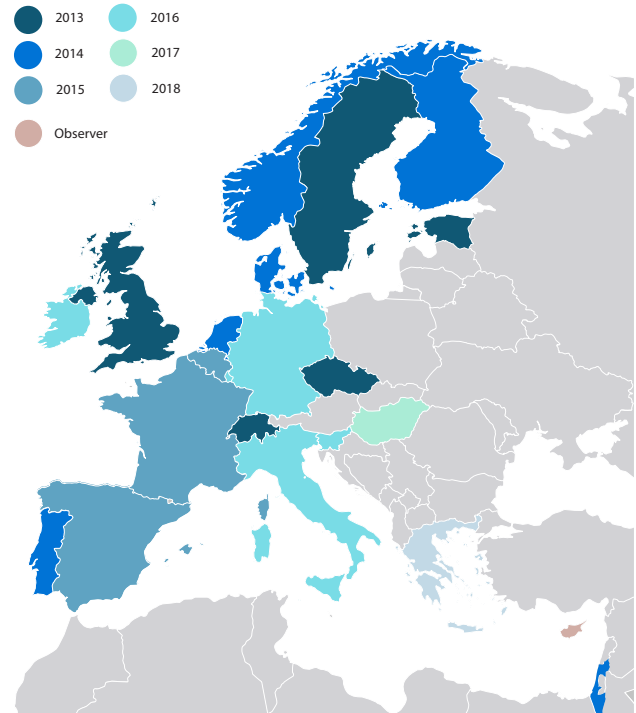


Figure 2. ELIXIR Members by their year of accession. ELIXIR is an intergovernmental organisation of 21 Member countries, 1 Observer, plus the European Molecular Biology Laboratory (EMBL). Although the current membership of ELIXIR is exclusively European, its legal framework is an intergovernmental Treaty that allows for membership of non European countries.

5 <https://www.elixir-europe.org/about-us/collaborations>
 6 <https://www.elixir-europe.org/news/elixir-and-ga4gh-agree-collaboration-strategy> (Collaboration Strategy, 2017); <https://elixir-europe.org/news/elixir-and-ga4gh-expand-collaboration> (Strategic Partnership, 2019)
 7 https://www.bmbf.de/files/151109_G7_Broschere.pdf (2015); https://ec.europa.eu/research/infrastructures/pdf/gso_progress_report_2017.pdf (2017)
 8 https://www.eurekaalert.org/pub_releases/2015-02/siob-sdto21015.php

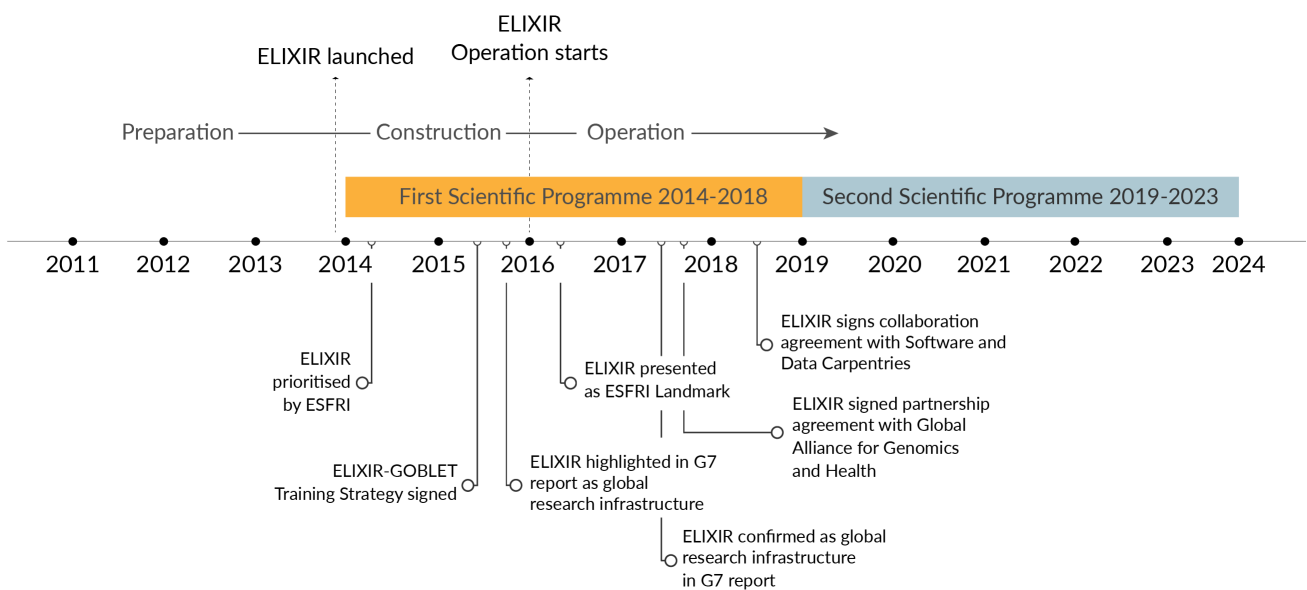






Figure 3. ELIXIR became operational in 2014, and is currently implementing its second Scientific Programme (2019-2023).

Objectives and stakeholders of the International Strategy (Table 1)

Table 1. Objectives of the International Strategy, and the stakeholders they target.

	Strategic objectives	Target stakeholder(s)
	1. Scale-up the international user base of ELIXIR's Services	Users of ELIXIR's Services in countries beyond Europe
	2a Improve bioinformatics services by promoting global standards, data-sharing and data annotation through formal/concrete collaborations with...	...national-level bioinformatics service providers in countries beyond Europe (in support of Objective 3)
	2b	...international bioinformatics-related initiatives and organisations (e.g. the Global Alliance for Genomics and Health)
	3 Expand international Membership in, and collaborations with, ELIXIR	Government officials in Ministries of countries beyond Europe, with support from the country's bioinformatics community (outcome of Objective 2b)
	4 Reinforce recognition of ELIXIR as an infrastructure of global significance, and a trusted partner	Intergovernmental organisations, including policy-makers, (e.g. the Food and Agriculture Organization of the United Nations)

Key Organisations, Initiatives and Projects

For the benefit of those unfamiliar with ELIXIR, and to allow for readers to identify quickly the areas they are likely to be interested in, this section is divided as follows: Core infrastructure, Health, Food security, Environment, and Research infrastructure policy.



Core infrastructure

The activities of ELIXIR's Scientific Programme¹ are organised around five 'Platforms' (i.e. domains of implementation), and a growing number of Communities driving the development of ELIXIR services². Table 2 lists the 'international' (i.e. beyond Europe) organisations, initiatives and projects which ELIXIR actively engages with, to help ensure that synergies are exploited, effort duplication avoided, hence ultimately a better return on public investment in these.

¹ <https://elixir-europe.org/about-us/what-we-do/elixir-programme>

² Platforms: <https://elixir-europe.org/platforms> (Data, Tools, Interoperability, Compute, Training); Communities: <https://elixir-europe.org/communities> (at the time of writing: Human Data, Rare Diseases, Marine Metagenomics, Plant Sciences, Metabolomics, Proteomics, Galaxy, Human Copy Number Variation)




Table 2. 'International' (i.e. beyond Europe) organisations, initiatives and projects with which ELIXIR engages actively as part of the work carried out via its Platforms (domains of technical implementation) and Communities (use cases driving service development). 'Focal point(s) in ELIXIR' either refers to an existing focal point, or a 'natural fit' in ELIXIR.

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
Committee on Data of the International Council for Science (CODATA)	Promote global collaboration to improve the availability and usability of data for all areas of research	Contribute to global discussions on data resources, access to tools and services, and sustainability of global initiatives. Run and sponsor joint events, develop curriculum and training materials in collaboration with CODATA-RDA Research Data Science Schools ¹	Interoperability, Compute and Tools Platforms, Marine Metagenomics Community	
Common Workflow Language	Enabling the reuse, extension, scaling, and reproducibility of scientific workflows	Support collective efforts around global interoperability of work-flows and tools, promote key cloud enabling technologies including AAI (Authorization and Authentication Infrastructure), Task and Workflow Execution Services	Compute Platform, Tools Platform, Marine Metagenomics Community	
CyVerse	Design, deploy, and expand a national Cyberinfrastructure for Life Sciences research, and to train scientists in its use	Ensure mutual awareness of activities	Hub, ELIXIR UK	
Galaxy	A platform for data intensive biomedical research	Via the ELIXIR Galaxy Community, make it easier to import data into Galaxy instances, help develop and share Galaxy tools and workflows, provision container instances on cloud compute and increase the provision of Galaxy training	Tools Platform, Training Platform, Compute Platform, ELIXIR Communities	
Global Biodata Coalition ²	Towards coordinated international support of core data resources for the life science	Contribute to collective efforts to ensure the long-term sustainability of core data resources, notably via identifying a host organisation for the coordination efforts and awareness raising with the Heads of International Research Organizations HIRO .	Data Platform	
GOBLET (Global Organisation for Bioinformatics Learning, Education and Training)	Unite, inspire and equip bioinformatics trainers worldwide	Take forwards a training strategy ³ to support complementary activities between GOBLET and ELIXIR, thereby strengthening international training links	Training Platform	
Human Proteome Organisation (HUPO) Proteomics Standards Initiative (PSI)	Define community standards for data representation in proteomics to facilitate data comparison, exchange and verification	Ensure implementation of HUPO standards across the ELIXIR Proteomics Community and input into standards development	Proteomics Community, EMBL-EBI	
Metabolomics Society	Promote the growth, use and understanding of metabolomics in the life sciences	Ensure mutual awareness of activities, promote and develop open standards for data reporting	Data Platform, Interoperability Platform, Tools Platform, ELIXIR UK, Metabolomics Community	

1 <http://www.codata.org/working-groups/research-data-science-summer-schools>, <http://indico.ictp.it/event/8706/>

2 <https://www.elixir-europe.org/news/elixir-among-signatories-call-action-global-coalition-sustain-core-data-resources>, <https://www.biorxiv.org/content/early/2017/04/27/110825>, <https://www.biorxiv.org/content/biorxiv/early/2019/04/15/598318.full.pdf>

3 <https://www.elixir-europe.org/news/elixir-and-goblet-publish-joint-training-strategy>

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
Research Data Alliance (RDA)	Research data sharing without barriers	Support collective efforts towards the global interoperability of data, notably via the ELIXIR Bridging Force Interest Group ⁴ and the FAIRsharing Registry (previously BioSharing) Working Group ⁵ . Run joint events, develop curriculum and training materials in collaboration with CODATA-RDA Research Data Science Schools	All ELIXIR Platforms, Human Data Communities	
schema.org	Create, maintain, and promote schemas for structured data on the Internet	Support collective efforts around data repository descriptions, and data findability and accessibility, for instance via bioschemas.org	Interoperability Platform, Data Platform, all ELIXIR Communities	
The Carpentries	Teach foundational coding and data science skills to researchers worldwide	Run joint workshops on Software Carpentry and Data Carpentry Foundations, train instructors and continue developing training materials ⁶	Training Platform	

4 <https://www.elixir-europe.org/about-us/collaborations/rda>



5 <https://rd-alliance.org/group/fairsharing-registry-connecting-data-policies-standards-databases.html>

6 <https://www.elixir-europe.org/news/elixir-carpentries-agreement>

Health



Applications of bioinformatics in the field of health are well recognised, ranging from disease diagnostic (e.g. rare diseases) and prevention (e.g. certain cancers), to personalised medicine (or precision medicine), and the development of new treatments. Table 3 lists health-related international organisations, initiatives and projects which ELIXIR actively engages with.

Table 3. International (i.e. beyond Europe) organisations, initiatives and projects of relevance to health and with which ELIXIR actively engages. "Focal point(s) in ELIXIR" either refers to an existing focal point, or a 'natural fit' in ELIXIR.

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
Global Alliance for Genomics and Health (GA4GH)	Enabling responsible genomic data sharing for the benefit of human health	Through a Strategic Partnership ¹ , support global efforts towards a suite of coordinated interoperable standards underpinning the archival, access, and analysis of sensitive human data, (e.g. ELIXIR Beacon Driver Project ² , Cloud Workstream and Authorization and Authentication Infrastructure), working groups, event sponsorship)	Compute Platform, Interoperability Platform, Tools Platform, Human Data Communities	
Human Cell Atlas	Enabling the reuse, extension, scaling, and reproducibility of scientific workflows	Ensure mutual awareness of activities	Compute Platform, Tools Platform, Federated Human Data Community	

1 <https://elixir-europe.org/news/elixir-and-ga4gh-expand-collaboration>

2 <https://www.elixir-europe.org/about-us/implementation-studies/beacons> ; <https://www.ga4gh.org/news/ga4gh-announces-new-interoperability-standards-for-genomic-data-sharing/>

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
International Rare Diseases Research Consortium (IRDiRC)	Enable all people living with a rare disease to receive an accurate diagnosis, care, and available therapy within one year of coming to medical attention	Collaborate on common outreach and communication activities, e.g. during innovation events, coordinated through the Orphanet ³ resource and the RD-Connect platform ⁴	Rare Diseases Community	
RD-Connect	Facilitate research on rare diseases by connecting databases, patient registries, biobanks and clinical bioinformatics data into a central resource for researchers worldwide	Link ELIXIR tools, service and expertise to the RD-Connect platform ⁵	Data Platform, Interoperability Platform, Human Data Communities	

3 <https://www.orpha.net/consor/cgi-bin/index.php>




4 <https://rd-connect.eu/about-rd-connect/>

5 Engagement is also via the RD-Connect Community Executive Board, where ELIXIR is represented (since August 2018)




Food security

Successful applications of bioinformatics to food production can be found in agriculture, farming and aquaculture, and are key to ensuring security of food supplies globally. Furthermore, resistance to pests and pathogens greatly helps to reduce the cost of food production. Table 4 lists international organisations, initiatives and projects of relevance to food security and with which ELIXIR engages actively.

Table 4. International (i.e. beyond Europe) organisations, initiatives and projects of relevance to food security and with which ELIXIR actively engages. "Focal point(s) in ELIXIR" either refers to an existing focal point, or to a 'natural fit' in ELIXIR.

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
Breeding API (BrAPI)	Enable interoperability among plant databases used for breeding and plant environment studies for climate change adaptation	Collaborate on the development and adoption of the Breeding API (Application Programming Interface)	Plant Sciences Community, ELIXIR France, ELIXIR Netherlands	
DivSeek	Unlock the potential of crop diversity so that it can be utilised to enhance the productivity, sustainability and resilience of crops and agricultural systems	Ensure alignment of ELIXIR and DivSeek's activities around crop diversity	Plant Sciences Community	
Food and Agriculture Organization (FAO) of the United Nations	Achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives	Continue being a "Reference Centre" in bioinformatics of the FAO for the screening, monitoring and follow-up of zoonotic diseases (or zoonoses), and for animal diseases	ELIXIR Switzerland ¹	

1 https://www.eurekalert.org/pub_releases/2015-02/siob-sdto21015.php

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
Global Open Data for Agriculture and Nutrition (goDAN)	Promote the proactive sharing of open data to make information about agriculture and nutrition available, accessible and usable	Carry out outreach and communication activities	ELIXIR Netherlands, Hub	
International Plant Phenotyping Network (IPPN)	Support the exploitation of crop genetic diversity, plant traits and the analysis of genotype performance in current and future agro-climatic scenarios	Collaborate on systems and services development and collaborate on data standards development, in particular MIAPPE ² . This is conducted in direct collaboration with the European plant phenotyping infrastructure (Emphasis ³) which belongs to IPPN	Plant Sciences Community, ELIXIR France, ELIXIR Belgium	
International Wheat Information System (WheatIS)	Support the wheat research community by building an International Wheat Information System	Collaborate on systems and services development	ELIXIR France	




2 Minimum Information About a Plant Phenotyping Experiment: <http://www.miappe.org/>

3 <https://emphasis.plant-phenotyping.eu/>

Environment

The environment, including biodiversity and ecosystem services, is probably the area where bioinformatics applications have the greatest unrealised potential to date. Bioinformatics can, for instance, provide solutions for pollution control and remediation, whilst metagenomics is about to revolutionise our biogeographic knowledge of species and habitats, having already provided hope for the development of new antibiotics. Table 5 lists international organisations and initiatives of relevance to the environment and which ELIXIR actively engages with.



Table 5. International (i.e. beyond Europe) organisations, initiatives and projects of relevance to the environment and with which ELIXIR actively engages. "Focal point(s) in ELIXIR" either refers to an existing focal point, or to a 'natural fit' in ELIXIR.

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
Global Biodiversity Information Facility (GBIF)	Provide anyone, anywhere, open access to data about all types of life on Earth	Enrich species occurrence data and the GBIF taxonomy with information derived from genetic sequences	Hub, EMBL-EBI, ELIXIR Germany, ELIXIR Biodiversity Working Group	
Group on Earth Observations Biodiversity Observation Network (GEO BON)	Improve the acquisition, coordination and delivery of biodiversity observations and related services to users including decision makers and the scientific community	Scope possible synergies with the activities of the 'Genetic composition Working Group' and GLOMICON (Global Omics Observatory Network)	Hub, EMBL-EBI, Interoperability Platform	
Ocean Biogeographic Information System (OBIS)	Facilitate free and open access to, and application of, biodiversity and biogeographic data and information on marine life	Enrich species occurrence data with information derived from genetic sequences	Hub	

Research infrastructure policy

Research infrastructures are typically sustained via large public investments. This is particularly true in the life sciences, where services from these infrastructures are as a result generally free to users (via open data policies, open software licenses). It is hence naturally in the countries' interest to work together and ensure that good practices are shared, 'internationalisation'¹ opportunities identified, and impact is demonstrated. Table 6 lists intergovernmental organisations with which ELIXIR engages in relation to global research infrastructure policy, particularly in relation to discussions on funding models, impact and sustainability.

Table 6. Intergovernmental organisations with which ELIXIR engages actively in relation to global research infrastructure policy.

Organisation, initiative, or project	Mission, vision, or goals	Purpose of engagement	Focal point(s) in ELIXIR	Main objective
G7's Group of Senior Officials (GSO) on Global Research Infrastructures	Explore cooperation opportunities in Global Research Infrastructures	Continue to be a partner of choice ² in GSO activities related to research infrastructure, for instance sharing good practices, and identifying internationalisation opportunities. Facilitate ELIXIR Membership of G20 countries beyond Europe	Hub	
Organisation for Economic Co-operation and Development (OECD)	Promote policies that will improve the economic and social well-being of people around the world	Continue to be a visible partner of choice in OECD Global Science Forum ³ activities related to "Optimising the operation and use of national research infrastructures", "Digital skills for data-intensive science", and interoperable data platforms ("LODES" project)	Hub	

1 Several countries contributing to building one infrastructure, to use collectively, leading to economies of scale

2 E.g. https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures/group-senior-officials-gso/gso-toolkit_en

3 <http://www.oecd.org/sti/inno/global-science-forum.htm#current-projects>

Relations with countries beyond Europe

Expanding ELIXIR's Membership beyond Europe is undoubtedly the most effective way of raising ELIXIR's international profile. Proceeding towards ELIXIR Membership is ultimately the decision of a national government¹, but it usually is the result of interest shown by the national bioinformatics community of the country. Although the current membership of ELIXIR is exclusively European, its legal framework, the 'ELIXIR Consortium Agreement'², is an intergovernmental Treaty that allows for membership of any country³. Membership, however, is not always the end target, and significant mutual benefits can be achieved before membership negotiations are considered or even relevant.

Where relevant and desired, ELIXIR will work towards expanding Membership beyond Europe, acknowledging that this process can take years. In other cases, ELIXIR will develop formal/concrete collaborations with national-level bioinformatics infrastructures, for mutual benefit. See Table 7 for a selection of countries with which ELIXIR has emerging or existing dialogue, formal/concrete collaboration(s) or potential interest in Membership.



1 <https://www.elixir-europe.org/about-us/who-we-are/how-countries-join>

2 https://www.elixir-europe.org/documents/elixir_consortium_agreement

3 Whilst any country in the world can apply for Membership, the ELIXIR Board will review each application against a set of predefined criteria.

Table 7. Selection of countries with which ELIXIR has emerging or existing dialogue, formal/concrete collaboration(s) or potential interest in Membership.

Country	Status or aim of engagement	Focal point(s) in ELIXIR	Focal entity, project, initiative, at country-level	Main objective
Australia	Formal/concrete collaboration(s), with potential interest in Membership	Hub	Australian Bioinformatics Commons (Bio-Commons); EMBL Australia Bioinformatics Resource (EMBL-ABR); Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures	
Canada	Formal/concrete collaboration(s), with potential interest in Membership	Hub, Human Data Community, a number of Nodes	Genome Canada , Ontario Institute for Cancer Research (collaboration via the ELIXIR Beacon project); various ongoing projects (e.g. EC-funded CINECA project ; EUCANCan project); Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures	
China	Formal/concrete collaboration(s)	ELIXIR UK, EMBL-EBI	Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures; project collaboration with BGI and GigaScience via the CUDEL (China-UK Data Dissemination in Metabolomics) project, with MetaboLights (EBI) and ISA tools (ELIXIR UK)	
Japan	Formal/concrete collaboration(s)	Hub, ELIXIR UK	Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures; National Bioscience Database Center (NBDC) and Database Center for Life Science (DBCLS) in the context of the Biohackathon series; dialogue with European offices of JSPS and AMED .	
India	Emerging dialogue	Hub	Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures	
Mexico	Emerging dialogue	Hub	Contact initiated with the Center of Genomic Sciences (National Autonomous University of Mexico)	
New Zealand	Formal/concrete collaboration(s)	Hub	Dialogue with Science attaché at New Zealand Embassy in Brussels ; engagement through the International Bioeconomy Forum	
Russia	Emerging dialogue	Hub	National University of Science and Technology via the Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures	
Singapore	Formal/concrete collaboration(s)	Hub	Collaboration via the ELIXIR Beacon project with Global Gene Corp	
South Africa	Formal/concrete collaboration(s), with potential interest in Membership	Hub, Training Platform, Galaxy Community	Human Heredity and Health in Africa (H3Africa) Initiative ; Pan African Bioinformatics Network for H3Africa (H3ABioNet); Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures	

Country	Status or aim of engagement	Focal point(s) in ELIXIR	Focal entity, project, initiative, at country-level	Main objective
South Korea	Emerging dialogue	Hub	Korea Basic Science Institute , National Research Facilities & Equipment Center	
USA	Formal/concrete collaboration(s)	Hub, Training Platform, Interoperability Platform, Compute Platform, Data Platform, ELIXIR UK, EMBL-EBI	Collaborations with the US include projects with the California Digital Library (collaboration on identifiers.org); Broad Institute (collaboration via the ELIXIR Beacon project); Country Delegation to G7's Group of Senior Officials on Global Research Infrastructures; projects with the US National Institutes of Health via the Office of Data Science Strategy (ODSS)	

Annex I: Actions to implement the Strategy (Table 8)

Table 8. Actions to implement the International Strategy.

Strategic objective	Implementation actions
1. Scale-up the international user base of ELIXIR's Services	Continue advertising specialist bioinformatics training to international participants through TeSS ¹ , including courses run in non-European countries. Build on, and expand, joint training events with international partners with the appropriate fund/grant schema.
	Continue facilitating and sponsoring the attendance of "international" collaborators to key ELIXIR events (e.g. All Hands, BioHackathon, etc) via a dedicated Travel Scheme ² . Continue facilitating international participation to ELIXIR-run events.
	Continue ensuring that ELIXIR is visible at international specialist conferences ³ (e.g. "special sessions" and workshops led/convened by ELIXIR, event sponsorship, posters and oral presentations by ELIXIR participants).
	Develop approaches to assess the international user base of ELIXIR Services (for example, for ELIXIR Core Data Resources, ELIXIR training, AAI), ideally using spatio-temporal trends in user numbers.
	Explore and develop outreach channels with regional bioinformatics associations and projects ⁴ .
2a. Improve bioinformatics services and promote global standards through collaborations with international bioinformatics-related initiatives	Develop new, and implement existing, agreements (e.g. Collaboration Strategies) to formalise collaborations between ELIXIR and key international bioinformatics or data initiatives ⁵ .
	Develop a comprehensive presence for international collaboration on the ELIXIR website.
	Continue working within the Global Biodata Coalition to establish an international scheme for long-term equitable funding and life-cycle management of key biological data resources.
	Implement the Strategic Partnership between ELIXIR and the Global Alliance for Genomics and Health (Ga4GH).

1 TeSS is an online portal that gathers life science training materials and training courses. <https://tess.elixir-europe.org/>
2 "Travel scheme for experts external to ELIXIR, to attend key ELIXIR events". In 2019, delegates from Australia, the USA and South Africa attended the ELIXIR All Hands meeting
3 E.g. ISMB <https://www.iscb.org/about-ismb> (<https://elixir-europe.org/events/ismbeccb-20192>), Bioinformatics Education Summit <https://h3abionet.org/categories/training/bioinformatics-education-summit>
4 E.g. linked to ISCB (International Society for Computational Biology), or via projects such as CABANA <https://www.cabana.online/>
5 E.g. with the Australian BioCommons or the US National Institutes of Health

Strategic objective	Implementation actions
<p>2b. Improve bioinformatics services by promoting global standards, data-sharing and data annotation through collaborations with national-level bioinformatics infrastructures</p>	<p>Encourage the exchange of best practices by extending the existing ELIXIR Staff Exchange Programme⁶ to allow ELIXIR Node staff to be hosted by service providers located beyond Europe, and conversely, allow international participants to be hosted by an ELIXIR Node if there is clear benefit to ELIXIR. Support applications to the Research and Innovation Staff Exchange⁷ (RISE) scheme under the Marie Skłodowska-Curie Actions⁸.</p> <p>Encourage/facilitate international interaction in the growing portfolio of ELIXIR Communities.</p> <p>Promote the participation of countries outside of the European Union in research projects of relevance to ELIXIR, funded by the European Union's Framework Programmes⁹.</p> <p>Support key international collaborators in "lighting" a Beacon¹⁰ and expand ELIXIR's activities on the interoperable federation of access controlled data beyond Europe.</p> <p>Promote the uptake, by countries beyond Europe, of standards which ELIXIR helped develop or is strongly invested in.</p>
<p>3. Expand international Membership in, and collaborations with, ELIXIR</p>	<p>Harness the visibility of ELIXIR's inclusion on the G7 GSO roadmap of Global Research Infrastructures to initiate or continue discussions with scientific leaders and government officials in countries considered for ELIXIR Membership. Hold joint high-level events in these countries and host visits of delegations of officials and scientists from those countries¹¹.</p> <p>Ensure ELIXIR presence at relevant international policy events such as the bi-yearly International Conference on Research Infrastructures (ICRI)¹².</p>
<p>4. Reinforce recognition of ELIXIR as an infrastructure of global significance, and a trusted partner</p>	<p>Ensure that ELIXIR is visible in major intergovernmental events and processes (incl. technical bodies) related to research infrastructure, health, food security, and the environment.</p> <p>Identify ELIXIR's unique niche in current intergovernmental processes in the fields of research infrastructure, health (e.g. World Health Organization's Programme of Work), food security (e.g. Food and Agriculture Organization of the United Nations: Commission on Genetic Resources for Food and Agriculture¹³), and environment (e.g. United Nations: Convention on Biological Diversity and the Nagoya Protocol¹⁴, ongoing international negotiations on the conservation and sustainable use of Biodiversity in areas Beyond National Jurisdiction¹⁵), and the overarching United Nations Sustainable Development Goals¹⁶.</p>

6 <https://www.elixir-europe.org/news/elixir-launches-staff-exchange-programme>

7 https://ec.europa.eu/research/mariecurieactions/actions/staff-exchange_en

8 E.g. REFRAC project <https://cordis.europa.eu/project/rcn/219178/factsheet/es>

9 E.g. a number of international countries are able to take part in research projects under Horizon 2020: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/international-cooperation_en.htm#support-non-eu-countries

10 Beacon is a 'genetic mutation sharing platform', used to share genetic data. <https://beacon-network.org/#>

11 In 2019, ELIXIR hosted three study visits by Australian delegates, and one in 2018.

12 <https://www.icri2018.at/>

13 <http://www.fao.org/nr/cgrfa/cgrfa-about/cgrfa-history/en/>

14 <https://www.cbd.int/abs/about/>; Ad Hoc Technical Expert Group (AHTEG) on Digital Sequence Information on Genetic Resources <https://www.cbd.int/abs/dsi-gr/ahteg.shtml>

15 <https://www.un.org/bbnj/>

16 In particular: Goal 2 Zero Hunger; Goal 3 Good Health and Wellbeing; Goal 9 Industry, Innovation and Infrastructure, Goals 14 Life Below Water and 15 Life On Land

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