



D9.1

BUSINESS MODEL FOR MIRRI-ERIC



The project "Implementation & Sustainability of Microbial Resource Research Infrastructure for 21st Century" (IS_MIRRI21) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 871129. This document reflects only the author's view and the European Commission is not responsible for any use that may be made of the information it contains.

Project number:	871129
Project acronym:	IS_MIRRI21
Project title:	Implementation & Sustainability of Microbial Resource Research Infrastructure for XXI Century
Start date of the project:	1st February 2020
Duration:	36 Months
Programme:	H2020/Research and Innovation Actions INFRADEV-03-2019

Deliverable type:	Report
Deliverable reference number:	D9.1
Work package:	WP9
Due date:	January 2021 – M12
Actual submission date:	April 2021

Responsible organisation:	UVEG-CECT		
Editor:	Aurora Zuzuarregui		
Version:	Revised by:	Date:	Notes:
Draft D9.1 Business Model	Luís Soares	23-02-21	Editor sections 4.3, 4.4
Draft D9.1 Business Model	Lidia Rodrigo	23-02-21	Editor section 4.2
Draft D9.1 Business Model	Marleen Bosschaerts	23-02-21	Editor sections 2.4, 2.5
Draft D9.1 Business Model	Marwa Zaarour	23-02-21	Editor sections 2.6, 2.7, 2.8
Draft D9.1 Business Model	Rosa Aznar	23-02-21	Editor section 4.5
Draft D9.1 Business Model	Bassem Kheireddine	23-02-21	Editor sections 5, 6
D9.1 Business Model v1 20210224	WP9 participants	02-03-21	Revision
IS_MIRRI21 - D9.1_Business Model_20210306	Aurora Zuzuarregui Lidia Rodrigo	06-03-21	Formatting and final revision
IS_MIRRI21 - D9.1_Business Model_20210306	Luis Almeida, Francisco Rocha and Tedora Aibu	16-03-21	Revision
IS_MIRRI21 - D9.1_Business Model for MIRRI-ERIC 30.03.2021	Aurora Zuzuarregui	30-03-21	Final Version
v2.0	Nelson Lima	22-04-21	Submission

Abstract:	This business model describes which are the MIRRI target groups and the MIRRI value proposal to address their needs, how MIRRI will be governed and managed to deliver the services, and includes an analysis of the socio-economic impact and of future opportunities.
Keywords:	Business, stakeholders, pricing, impact, SWOT analysis, PESTLE analysis, value proposal

Dissemination level:	Public	<input checked="" type="checkbox"/>
	Confidential (for the Consortium and EU Commission Services only)	<input type="checkbox"/>

Abstract

This document constitutes the Deliverable 9.1 of the project IS_MIRRI21 and describes in detail the strategy that the Microbial Resource Research Infrastructure (MIRRI) will follow to deliver the value proposal to its stakeholders, based on the European Research Infrastructure Consortium (ERIC) legal framework. The main elements described thereunder will be used to create a one-page document, aimed at attracting the different stakeholder communities towards the construction of the ERIC.

The report has five chapters including:

- a brief introduction to MIRRI (mission, goals and values);
- an analysis of the different stakeholder categories grouped according to their needs;
- the value proposal, including the channels to reach out the users, the projected costs and sources of income and how to access the services;
- a characterization of the targeted markets, together with a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and description of the main challenges facing competition;
- a discussion about opportunities for expansion, in terms of membership/partnership and emerging markets.

Contents

1.	MIRRI at a Glance	1
2.	Target Groups	3
2.1.	Users of microbial resources	3
2.2.	Providers of microbial resources	4
2.3.	The European Commission and the Member countries of the RI	5
2.4.	Policy makers	5
2.5.	Citizens	5
2.6.	Science communication professionals/journalists	6
3.	From Microbial Collections to Real-Life Innovations	8
3.1.	MIRRI's offer: The Collaborative Work Environment (CWE).....	9
3.1.1.	Research Infrastructure Information Gate	10
3.1.2.	Microbial Resources, Data and Services Gate	11
3.1.3.	The Collaboration & Experts Gate	13
3.1.4.	The Training and Education Gate	14
3.2.	MIRRI channels to reach out to the users.....	15
3.3.	MIRRI expenses and sources of income	18
3.4.	Access to the services and pricing modalities.....	20
4.	Market Analysis	23
4.1.	Socio-economic impact.....	23
4.2.	Research strategy to meet the market needs	27
4.3.	Position of MIRRI in the European Research Area (ERA) and the ESFRI landscape	27
4.4.	Strengths Weaknesses Opportunities and Threads (SWOT) analysis	29
4.5.	Competitors	31
5.	Future opportunities	33
5.1.	Membership enlargement	33
5.2.	Strategic partnerships with other RIs to target new users	33
5.3.	Identifying new markets through environment scanning.....	34
	References	37

Abbreviations

ABS - Access and Benefit Sharing
CC - Culture Collection
CCU - Central Coordinating Unit
CORBEL - Coordinated Research Infrastructures Building Enduring Life-science services
Covid-19 - Coronavirus disease
CWE - Collaborative Working Environment
EC - European Commission
EMBRIC - European Marine Biological Research Infrastructure Cluster
EOSC - European Open Science Cloud
ERA - European Research Area
ERIC - European Research Infrastructure Consortium
ESFRI - European Strategy Forum on Research Infrastructures
FAIR - Findable Accessible Interoperable Reusable
H&F - Health and Food
IB - Industrial Biotechnology
IPR - Intellectual Property Rights
LS - Life Science
mBRC - Microbial Domain Biological Resource Centre
MIRRI - Microbial Resource Research Infrastructure
MIRRI-IS - MIRRI Information System
M&O - Members and Observers
NN - National Node
PESTLE - Political, Economic, Sociological, Technological, Legal, Environmental
RI - Research Infrastructure
RIS3 - Research and Innovation Strategies for Smart Specialisation
R&I - Research and Innovation
SPOC - Small Private Online Courses
SRIA 2020-2021 - MIRRI “Strategic Research & Innovation Agenda 2021-2030”
TNA - Transnational Access
T&E - Training and Education

Content of Figures

Figure 1. The four main types of services constituting the MIRRI offer to support users and providers of microbial resources and the most relevant outcomes	8
Figure 2. MIRRI CWE Gates and services	9
Figure 3. MIRRI target groups have a single point of Access to the MIRRI offer, the CWE, which facilitates the provision of services from the Partners. Orange arrows show the inflows/outflows between the target groups and the RI offer. Grey arrows indicate an indirect profit of the EC and RI Member countries by the benefits obtained from their communities (i.e. the society and the users and providers of microbial resources)	10
Figure 4. The MIRRI-IS integrated solution maximizing the use of data associated with microbial resources to create innovative ideas	11
Figure 5. MIRRI expert clusters' approach to promote excellence and innovation in research by using microbial resources in compliance with applicable laws	13
Figure 6. MIRRI-ERIC Training & Education offer	15
Figure 7. MIRRI-ERIC operating as a distributed RI	18
Figure 8. Open and restricted access to the different sections of the MIRRI CWE	21
Figure 9. Main strategic sectors addressed by MIRRI	24

Content of Tables

Table 1. Summary of the MIRRI services targeting each stakeholder's main needs	9
Table 2. MIRRI-ERIC prospective Countries and Partners	15
Table 3. Estimated expenses and income (€) for the first five years of operation of MIRRI-ERIC	19
Table 4. Agreed contribution (in €) from MIRRI-ERIC prospective M&O for the first five years	20
Table 5. SWOT analysis of MIRRI	30



1. MIRRI at a Glance

1. MIRRI at a Glance

The Microbial Resource Research Infrastructure (MIRRI) is a pan-European distributed Research Infrastructure (RI) for the preservation, systematic investigation, provision and valorisation of microbial resources and biodiversity.

The goal of MIRRI is to create and consolidate a single, unified infrastructure to solve/mitigate the bottlenecks that impede faster microbiological-related developments in Europe, where multinational collaboration is currently hampered by the fragmentation of policies, resources, and expertise. MIRRI strives to promote complementarity, reduce redundancy, and continuously improve the capacity of its partner microbial domain Biological Resource Centres (mBRCs) to preserve microbial materials, in a coordinated (non-fragmented), traceable and cost-effective way, contributing to the reproducibility, integrity and cumulative character of research.

MIRRI's mission is to serve the bioscience and the bioindustry communities by facilitating the access, through a unique high-performance platform, the Collaborative Working Environment (CWE), to the broadest range of high-quality microorganisms, their derivatives, associated data and services, with a special focus on the domains of Health & Food, Agro-Food, and Environment & Energy. By serving its stakeholders, offering access to human expertise, collaborating with other RIs and working with public authorities and policy makers, MIRRI contributes to the advancement of research and innovation (R&I) in Life Sciences (LS) and biotechnology, as well as for a competitive and resilient bioeconomy in Europe and beyond.

MIRRI operates following the values of Respecting Human Rights and Environmental Sustainability, Diversity and Inclusion, Ethical action and Integrity, Fostering Trust and Collaboration, Transparency and Openness, and Confidentiality.

Through its motto, *“microbial resources for a green, healthy and sustainable future”*, MIRRI envisions a bright future of greener, healthier and sustainable world, based on the preservation, study and valorisation of microbial resources and biodiversity.

The hope for a healthier future for Europe and other regions motivates MIRRI to employ a holistic approach that brings together partner countries, institutes and researchers to work on shared goals to increase collaboration, complementarity, responsiveness, exchange of experience, resources and data-sharing, trust-building, ethics, reliability, fairness, equality, non-discrimination and transparency, on a not-for-profit basis.



2. Target Groups

2. Target Groups

MIRRI main target groups are the users and providers of microbial resources. The bodies governing, supporting or regulating these groups (e.g., the European Commission (EC) or the Policy makers) will also benefit from the services delivered by MIRRI, indirectly by serving their user and provider communities and directly receiving expert advice on matters related with the use of microbial resources. Finally, MIRRI will target a broader audience in the society, aiming to bring microbiological science closer to the citizens. Therefore, we can divide MIRRI target groups in the following categories:

- Users of microbial resources
- Providers of microbial resources - Culture Collections (CCs) and microbial Biological Resource Centres (mBRCs)
- The EC and the Member countries of the RI
- Policy makers
- Citizens
- Science communication professionals/journalists

2.1. Users of microbial resources

Research institutions and biotechnological companies using microbial resources

High-quality, cost-effective and sustainable research is fundamental to reinforce Europe's position in a highly competitive global economy. A fundamental criterion of science is the ability to repeat experiments and obtain the same results as the original work, and the opposite has critical negative socioeconomic impacts. A 2014 study based on workshops and surveys targeting authors publishing in microbiology journals indicated that only a small portion of microbial strains that are cited in papers are available in public mBRCs (Stackebrandt, 2014). More recently, a MIRRI internal study, carried out between 2015-2017, about microbial strains cited in 1100 LS databases indicated that less than 10% of the strains were preserved in CCs. In addition, almost no links were found between the strain datasheets in the CCs catalogues and the LS databases, resulting in a complete fragmentation of the data relative to a particular resource. This connection is essential to facilitate the replication of results, avoid the duplication of efforts and boost R&I in microbiology and biotechnology.

Users of microbial resources claim that the current offer of microbial resources, associated data and related services including expert advice, does not satisfy their needs (Van Hauwenhuysse, 2014a, 2014b). They have difficulties in finding (1) resources cited in papers, (2) certain microbial taxa, especially fastidious microorganisms, (3) specialised services, and (4) extended datasets associated to the resources. Besides, they would find very useful (1) the delivery of innovative, specialised services and (2) the creation of expert topic-driven platforms. Furthermore, there is a

lack of awareness about regulations related with the use of microbial resources (e.g. Access and Benefit Sharing (ABS), Biosecurity, Transportation) in the user community, urging the need to facilitate access to expert guidance and training on these matters.

The difficulty to obtain certain strains from qualified providers (i.e. CCs and mBRCs), drives users to share strains lacking the corresponding quality controls among colleagues, constituting a source of flaws and increasing the socioeconomic burden due to irreproducible research.

Besides these handicaps associated with the microbiological research in a broad sense, biotechnological companies in the areas of Health & Food, Agro-Food and Environment & Energy have difficulties accessing microbial strains suited for their processes. Moreover, finding counselling on how to cultivate, characterise and preserve microbial strains, and legal advice regarding their use (e.g. Intellectual Property Rights (IPR) or ABS issues), tends to present a challenge.

Currently, no single country offers complete coverage of microbial diversity and associated services and expertise and therefore an overarching European organisation of the nationally distributed infrastructures is required to make the best use of current capacity, bridge gaps and address the needs of biotechnology and bioindustry today.

2.2. Providers of microbial resources

Institutions (public or private) preserving and sharing microbial resources. They can be CCs (repositories of microbial resources with limited quality control procedures) and mBRCs (advanced culture collections, providing microbial resources as well as databases with molecular, physiological and structural information relevant to these resources, and other services associated with the characterization of microorganisms, all this following advanced Quality Management Systems)

Most European CCs / mBRCs' financial models are based on institutional and/or governmental support, research grants and income from supply of strains and provision of services. Government funding, when provided, is usually balanced against the income received for the various services and products offered by the collection, with additional income above plan being returned. This leaves very little for investment, to enable the collections to improve their coverage and incorporate new and advanced technologies. Harnessing the power of collections working together is therefore essential to evolve for an efficient provision of services and microbial resources to the scientific community.

2.3. The European Commission and the Member countries of the RI

The EC launched in 2000 the European Research Area (ERA), with the ambition to create a single, borderless market for research, innovation and technology across the European Union. One pillar of this ERA is the European Strategy Forum on Research Infrastructures (ESFRI), supporting the establishment of pan-European RIs to provide Europe and the Members of the RIs (Member States, associated countries, third countries other than associated countries and intergovernmental organizations) with the most up-to-date research capacities

The recently published White Paper (EC, 2020a) concludes that RIs are essential pillars of the ERA. RIs form the basis of the European R&I competitiveness, and are the major promoters of Open Science providing high-quality FAIR (Findable, Accessible, Interoperable and Reusable) data, needed to support the success of the European Open Science Cloud (EOSC).

For these reasons, RIs need to be reinforced and considered as strategic investments to address complex societal challenges. Therefore, the Members of the RIs (countries and intergovernmental organizations) need to coordinate their resources and services for the benefit of their scientific community, such as:

- cost-effective CCs and research centres;
- high-quality Training & Education (T&E) programmes;
- reliable research materials with significant scientific value for universities and industries;
- services with added value to already existing facilities in their territories;
- adhering to the national and regional Circular Economy and Bioeconomy roadmaps;
- adhering to environmental and scientific research ethical regulations.

2.4. Policy makers

Policy makers regulate and implement legislation in various areas of specialisation such as LS, economics and political sciences

The Policy makers need (1) guidance based on reliable scientific results, (2) support raising awareness about the legal framework associated with the use of microbial resources, (3) assistance avoiding misinformation and (4) easier access to scientific experts.

2.5. Citizens

Citizens comprise a heterogeneous group of individuals that would benefit from a facilitated access to simple, interesting, educational and relevant materials on the importance, applications and risks associated to the diverse world of microorganisms, as well as access to science-based public activities and events

Within the group of citizens, teachers and students may need special attention, as they play pivotal roles in the foundations of a well-informed society, immune to fake news. For this, teachers from all levels of education (primary and secondary schools, technical degrees, university) need

training and outreach material, scientifically relevant, and adapted to the different formative stages. Building knowledge about the different domains in microbiology is also crucial to attract future scientists and professionals to the field.

2.6. Science communication professionals/journalists

Most science communication professionals and journalists have, in the best scenario, only a broad knowledge of different scientific topics, so they need support to communicate trustable information, especially on sensitive issues

Science communication (and communication in general) is facing some challenges in the era of internet and social networks. Nowadays, information spreads quickly and widely, in most cases before being filtered by experts, contributing to the reduction of the quality of the communication and the diffusion of messages that have not been corroborated or that are not correctly interpreted. Indeed, the EC has recognized this problem and has developed an “Action Plan against Disinformation” (EC, 2018a), in which one of the pillars is the need of raising awareness and improving societal resilience to fake news, where independent researchers play a key role mitigating the negative impact of disinformation. Therefore, science communication professionals need fast access to accurate and reliable information, validated by experts and in a format that is easy to understand.



3. From Microbial Collections to Real-Life Innovations

3. From Microbial Collections to Real-Life Innovations

MIRRI will remove walls that obstruct the view on a global offer of microbial biodiversity data and beyond linking data and expertise from e.g. ecology, climate, human, animal and plant health. For this, MIRRI will offer its stakeholders the Collaborative Work Environment (CWE). This platform is designed to be a unique entry point to the broadest offer of resources and data, options to T&E, links to legal advice, assistance through experts, aid in data analysis, hence providing the users of microbial resources with options of additional information that enrich the original query (**Erro! A origem da referência não foi encontrada.**). Besides, the CWE informs broad audiences about the importance of microorganisms in our daily life and serves as a unique point of access to experts in transversal aspects related with microbiology, facilitating the collaboration not only with researchers but also with the society, policy makers, etc.

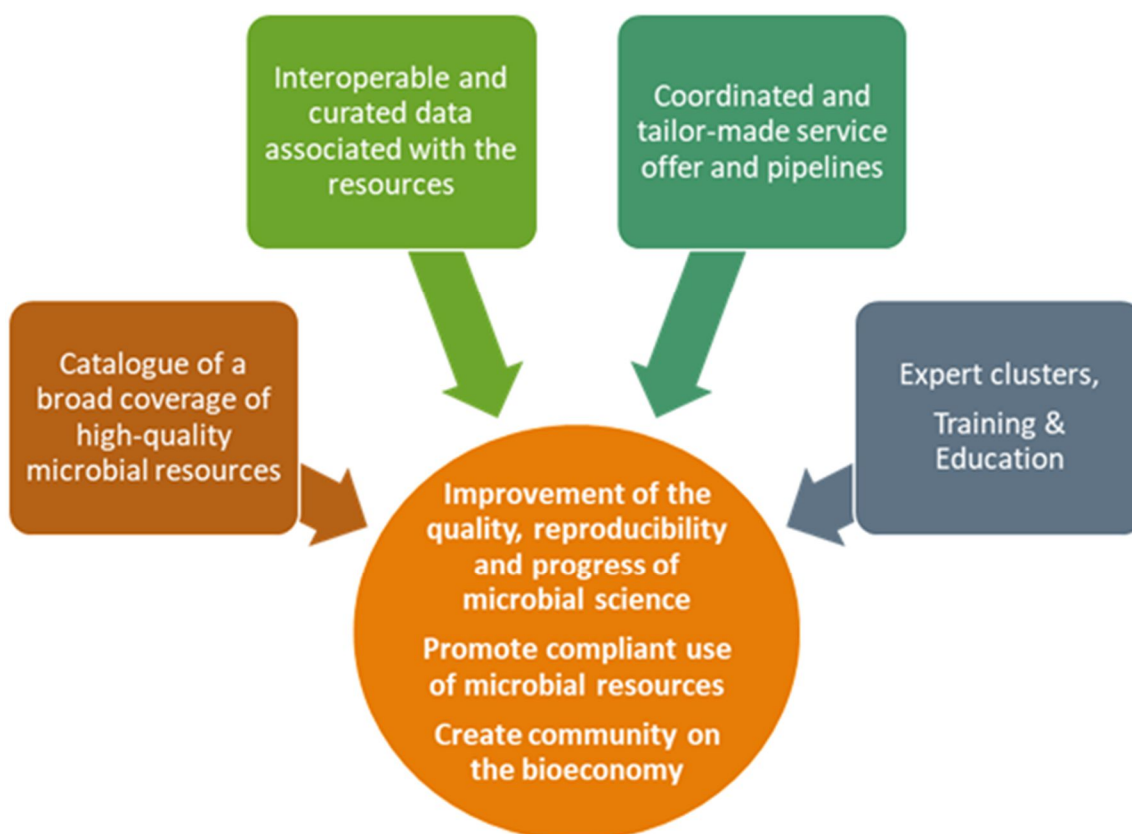


Figure 1. The four main types of services constituting the MIRRI offer to support users and providers of microbial resources and the most relevant outcomes

3.1. MIRRI's offer: The Collaborative Work Environment (CWE)

The CWE is a virtual platform serving as the main communication channel between MIRRI and all its target groups. The platform is thematically organised in four gates (**Erro! A origem da referência não foi encontrada.**), providing different types of services:

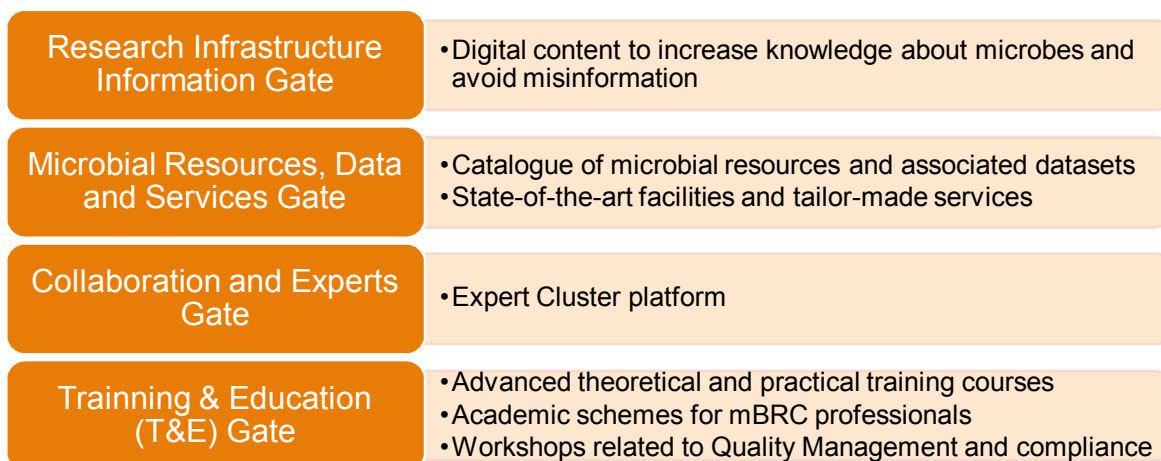


Figure 2. MIRRI CWE Gates and services

MIRRI target groups benefit from these services according to their main needs (**Erro! A origem da referência não foi encontrada.**).

Table 1. Summary of the MIRRI services targeting each stakeholder's main needs

		MIRRI PRODUCTS AND SERVICES						
		Digital content to increase knowledge about microbes and avoid misinformation	Catalogue of microbial resources and associated datasets	State-of-the-art facilities and tailor-made services	Expert Cluster platform	Advanced theoretical and practical training courses	Academic schemes for mBRC professionals	Workshops related to Quality Management and compliance
MIRRI TARGET GROUPS	Users of microbial resources		●	●	●	●		
	Microbial CCs and mBRCs				●		●	●
	The EC and the RI Member countries	●	●	●	●	●	●	●
	Policy makers	●			●			
	Citizens	●						
	Science communication professionals/journalists	●						

The EC and the MIRRI Member countries benefit from all services directly receiving expert advice related to policies involving the use of microbial resources and indirectly through their stakeholder communities (the society and the users and providers of microbial resources). The society receives accurate information related to the microbial world through the public website. Finally, the main stakeholders benefiting from all the services are the users and providers of microbial resources, which take advantage from the whole offer. All these relationships are outlined in **Erro! A origem da referência não foi encontrada.** A detailed description of the four CWE gates is provided hereunder.

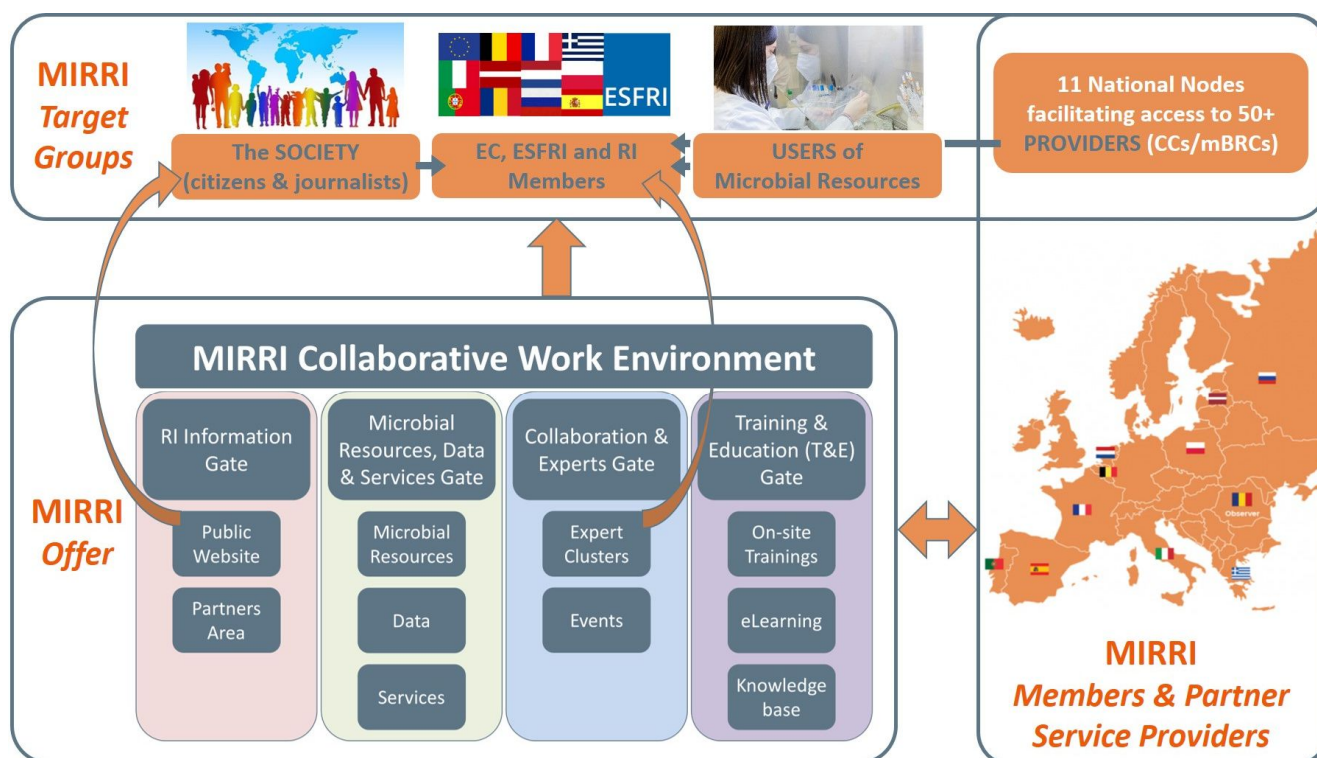


Figure 3. MIRRI target groups have a single point of Access to the MIRRI offer, the CWE, which facilitates the provision of services from the Partners. Orange arrows show the inflows/outflows between the target groups and the RI offer. Grey arrows indicate an indirect profit of the EC and RI Member countries by the benefits obtained from their communities (i.e. the society and the users and providers of microbial resources)

3.1.1. Research Infrastructure Information Gate

This gate will provide open access to **digital content to increase knowledge about microbes and avoid misinformation** in the society, adapted to different audiences (schools, policy makers, broad range of audiences).

By providing scientifically validated (digital) information, in an accessible way, MIRRI will contribute to correct the still existing negative perception of microorganisms (human, animal and plant pathogens), showing the positive impact that microorganisms have in our daily lives. Other

relevant topics for the community that are usually hotspots of misinformation, such as vaccines, will also be addressed by MIRRI in simple informative materials.

3.1.2. Microbial Resources, Data and Services Gate

Online, open and centralised access to the broadest **catalogue of microbial resources**, associated with largest **datasets of information**, embedded in the EOSC and following FAIR principles. **Erro! A origem da referência não foi encontrada.** summarizes the complete offer of microbial resources, data and data analysis tools.

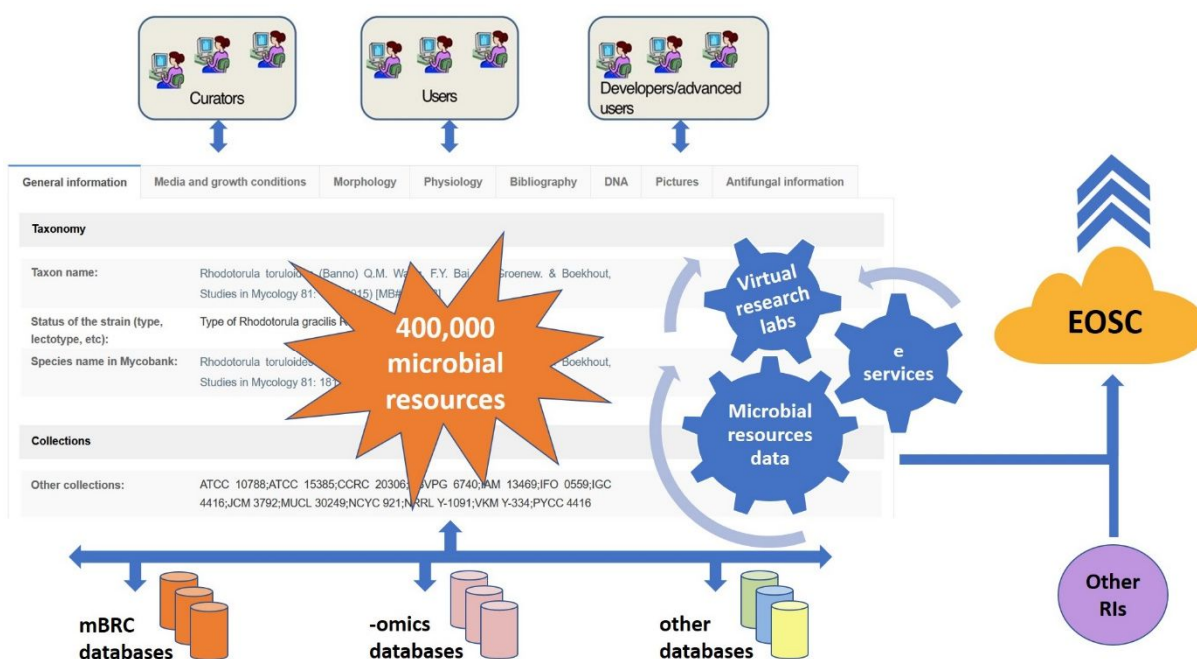


Figure 4. The MIRRI-IS integrated solution maximizing the use of data associated with microbial resources to create innovative ideas

MIRRI offers users and providers of microbial resources a single point of access to more than 400,000 high-quality microbial resources, covering all types of microorganisms, such as bacteria (and their cognate bacteriophages), archaea, fungi (including yeasts), eukaryotic viruses, microalgae and other microbiological material such as cell lines, natural or constructs carrying plasmids, DNA libraries, and genomic DNA. New and potentially valuable strains covering gaps in the existing offer will be incorporated into the catalogues to be made available through a coordinated approach towards isolation and deposit of microorganisms in partner mBRCs (MIRRI Accession Policy and MIRRI Partner Charter).

From strains producing antimicrobials or other bioactive compounds for the pharmaceutical industry, to others that can be used in the production of healthier food products, in the biological management of agricultural soils and crops, in the bioremediation of polluted sites or contaminated effluents, or in the production of renewable fuels, to mention a few examples, MIRRI

is very likely to hold microbial resources matching every demand from researchers and bioindustries in the sectors of Health & Food, Agro-food, and Environment & Energy.

The microbial resources database (MIRRI Information System, MIRRI-IS) hosting the catalogue is an integrated, high-quality, automatically validated, manually annotated, semantic-rich, non-redundant microbiological resource database which provides all relevant information and associated contextual data (metadata) about a particular microbial resource – e.g. taxonomy, ecology, pathogenicity, morphology, physiology, chemical characterisation, DNA barcoding or genomics. It is not merely a database of microbial resources as it provides tools for advanced analyses and include them in many scientific workflow scenarios such as polyphasic identifications, metabarcoding, metagenomics or microbiome research. Active links to key biological databases (PubMed, EMBL-EBI, etc.) add knowledge to the resources, and connection with the EOSC (through active participation in the EOSC-Life project), ensures the FAIR availability of the data, as well as integration with cross-disciplinary information, driving the innovation needs of the European bioeconomy.

Remote or Physical **access to state-of-the-art facilities and tailor-made services** and pipelines, going from bioprospection to validation of functional properties. Based on its partners' state-of-the-art facilities and top-level expertise, MIRRI makes available a vast and diverse portfolio of high-quality services covering the value chain from bioprospection to preservation, identification and valorisation of microbial resources. The different types of services are divided into the following categories:

- Deposit
- Microorganism isolation, preservation and cultivation
- Molecular identification
- Phenotypic characterisation
- Molecular characterisation, molecular typing and phylogenetic analysis
- NGS related services
- Screening, tests and bioassays
- Taxonomic database tools
- Consultancy, Training and Contract Research

The broad range catalogue of services can be applied to different fields of research (e.g. Human and animal health, Agro-food, Environment & Energy) and can be combined into pipelines of integrated, product-oriented services made available as tailor-made, turnkey solutions. To mention a few examples, MIRRI can provide solutions for the diagnosis of human, animal and plant pathogens, for the development of bio-pharmaceuticals, biofertilizers, biocontrol agents and bioplastics, for environmental bioremediation, production of bioenergy and the production of food or food-additives. A detailed description of the targeted market sectors and the current available

services for each purpose is available in the MIRRI “Strategic Research & Innovation Agenda 2021-2030” (SRIA 2021-2030, MIRRI, 2021).

The range of services provided will be enlarged as soon as MIRRI generate outputs from the research strategy, aimed at delivering new capacities in emerging fields such as culturomics and preservation of microbial communities.

3.1.3. The Collaboration & Experts Gate

The offer of technical and analytical services (Gate 2) is to be complemented with the access to a wide selection of experts in different topics related with the use of microbial resources through the **Expert Cluster platform**, an integrated set of online tools providing a unique environment for researchers in LS and policy makers to exchange knowledge (**Erro! A origem da referência não foi encontrada.**).

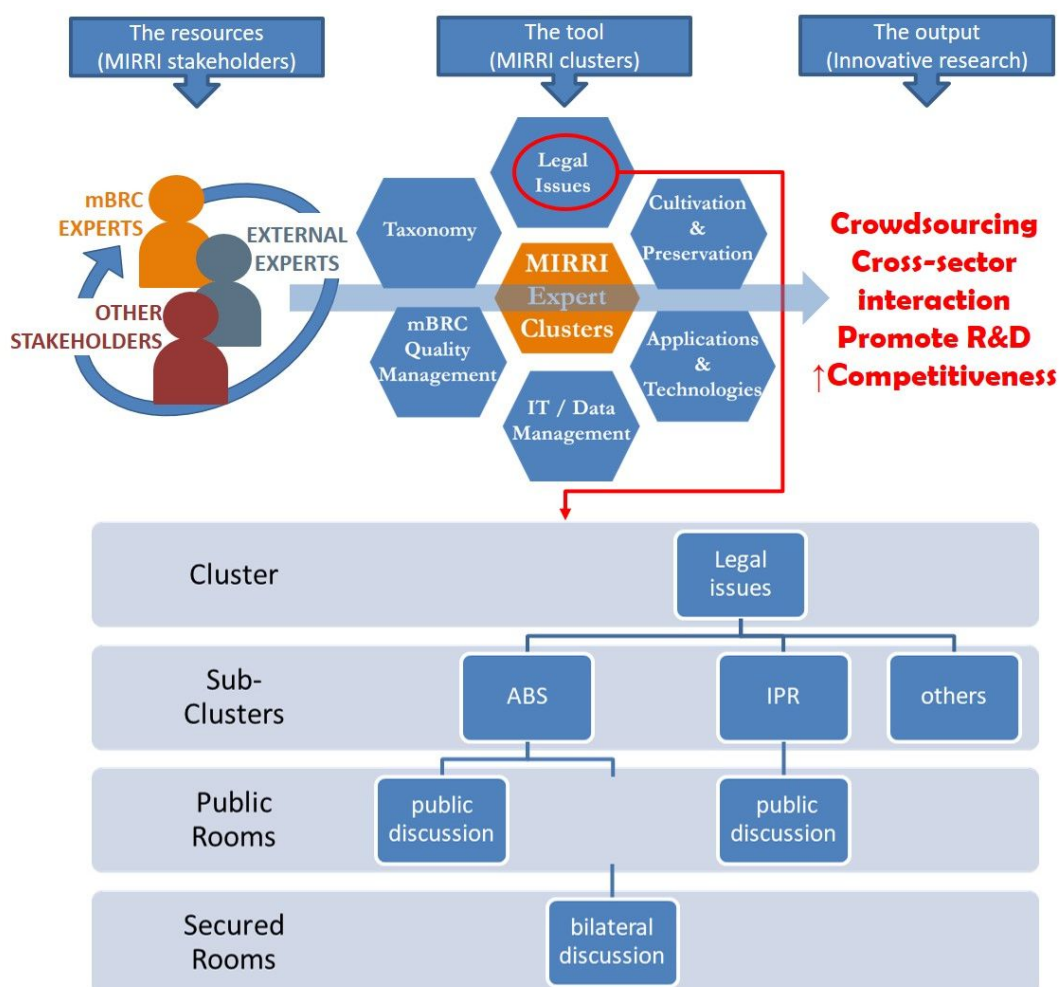


Figure 5. MIRRI expert clusters' approach to promote excellence and innovation in research by using microbial resources in compliance with applicable laws

The “MIRRI Expert Clusters” will be organised around the key-topics of mBRCs’ activities to support R&I processes at the demand of the stakeholders. Initially, six thematic clusters [Microbial Taxonomy, Cultivation & Preservation, Applications & Technologies, Legal issues, IT / Data management and mBRC Quality Management] will be provided to the community, but the specific content of each one will follow the stakeholders’ needs and new areas could be opened on demand.

Besides the expertise available in MIRRI, leading experts in different fields (e.g. biosecurity, IPR, ABS) will be invited to join the MIRRI expert cluster community with the purpose of enriching and sharing knowledge between the MIRRI partners, academia and industry. The clusters are intended to provide consultancy, to develop operational best practices, to promote technology enhancement, to improve efficiency and effectiveness and to design and evaluate MIRRI’s T&E offer, among others. Different tools available through the CWE will facilitate the activities of the Expert Clusters:

- public rooms where all experts can participate and share ideas;
- secured rooms for bilateral confidential consultancy;
- tutorials; and
- webinars, symposia and workshops.

3.1.4. The Training and Education Gate

The T&E Gate of the CWE gives access to the MIRRI training programmes towards different user categories (e.g., scientists, entrepreneurs/industrials, young professionals, partners), contributing to the capacity building within the scientific community as well as industrial users (**Erro! A origem da referência não foi encontrada.**).

On one side, MIRRI offers **advanced theoretical and practical training courses**, Small Private Online Courses (SPOC) and webinars targeting the needs of users of microbial resources.

Besides, MIRRI promotes official **academic schemes to train mBRC and CC professionals**, like the European Specialization Course on mBRCs at UMinho-MUM, in collaboration with other MIRRI partners and higher education institutions. The target audiences for these courses are Master students, PhDs, Postdocs and professionals who want to acquire high-level, international and research-oriented education in identification, preservation and valorisation of microbial diversity; integrate scientific competences and necessary skills to manage the mBRCs under quality control standards and complying with national and international regulations.

Finally, curators and managers of mBRCs have access to **workshops related to Quality Management and compliance**, specially ABS and biosecurity, which are essential elements for mBRCs to meet the requirements of the MIRRI Partner Charter.

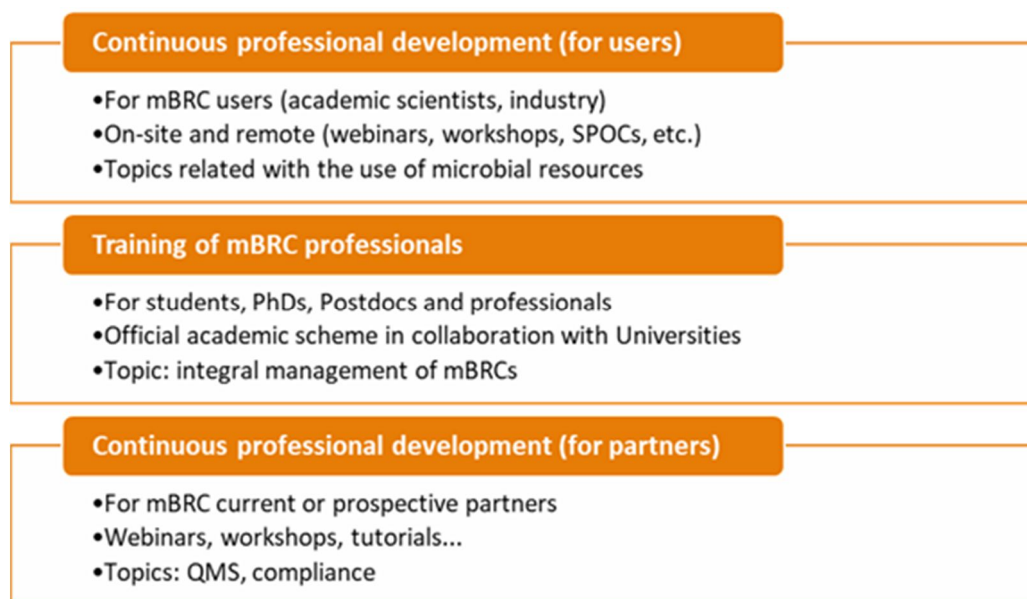


Figure 6. MIRRI-ERIC Training & Education offer

3.2. MIRRI channels to reach out to the users

To operate, MIRRI will be constituted as a European Research Infrastructure Consortium (ERIC), a specific legal form adapted to the business concept for not-for-profit RIs in the European Union, and governed by the Member and Observer (M&O) countries following the provisions on the MIRRI-ERIC Statutes. At the time of writing this report, a total of ten European countries (Belgium-BE, Spain-ES, France-FR, Greece-GR, Italy-IT, Latvia-LV, Netherlands-NL, Poland-PL, Portugal-PT and Romania-RO) and one third country (Russian Federation-RU) have signed the MIRRI Memorandum of Understanding, committing to work towards the constitution of the MIRRI-ERIC (**Erro! A origem da referência não foi encontrada.**). For this, countries are finalizing their national procedures in order to submit their request to the EC to be funding MIRRI-ERIC M&O. The submission will include the MIRRI-ERIC Statutes and the Scientific and Technical Description, which need the final approval of the EC to establish the ERIC.

Table 2. MIRRI-ERIC prospective Countries and Partners

Country	Partner (acronym)	Partner (full name)
BE	BCCM	Coordination cell - Belgian Science Policy
	BCCM/DCG	Diatoms Collection
	BCCM/GeneCorner	GeneCorner Plasmid Collection
	BCCM/IHEM	Fungi Collection: Human and Animal Health
	BCCM/ITM	Mycobacteria Collection
	BCCM/LMG	Bacteria Collection
	BCCM/MUCL	Agro-food and Environmental Fungi Collection
	BCCM/ULC	Cyanobacteria Collection
ES	CECT	Spanish Type Culture Collection

	BEA	Spanish Bank of Algae
FR	CIRM-CFBP	International Centre for Microbial Resources - Plant associated bacteria collection
	CIRM-BIA	International Centre for Microbial Resources - Food associated bacteria collection
	CIRM-BP	International Centre for Microbial Resources - Pathogenic bacteria collection
	CIRM-CF	International Centre for Microbial Resources - Filamentous fungi collection
	CIRM-Levures	International Centre for Microbial Resources - Yeasts collection
	CRBIP-CNCM	National Collection of Cultures of Microorganisms
	CRBIP-CVIP	Collection of Viruses of the Institut Pasteur
	CRBIP-CIP	Collection of bacteria of the Institut Pasteur
GR	CCUoA-NKUA	Culture collections of the National and Kapodistrian University of Athens
	ACA-DC	Agricultural College of Athens - Dairy Collection
	BPIC	Benaki Phytopathological Institute Collection
IT	TUCC (UNITO)	Turin University Culture Collections
	DBVPG	Industrial Yeasts Collection
	UMCC	University of Modena and Reggio Emilia Microbial Culture Collection
	CNR-PLAVIT	National Research Council-Plant Viruses Italy
	CNR-ITEM	National Research Council-Agro-Food Microbial Culture Collection
	USMI	University Hospital (Ospedale Policlinico) San Martino
LV	MSCL	Microbial Strain Collection of Latvia
NL	CBS	Collection of yeasts and filamentous fungi
	NCCB	Netherlands Culture Collection of Bacteria
PL	IAFB	Collection of Industrial Microbial cultures of the Prof. Waclaw Dąbrowski Institute of Agricultural and Food Biotechnology
	KPD	Collection of Plasmids and Microorganisms of the University of Gdansk
	PCM	Polish Collection of Microorganisms
PT	MUM	Micoteca da Universidade do Minho, Centro de Engenharia Biológica
	PYCC	Portuguese Yeast Culture Collection, Unidade de Ciências Biomoleculares Aplicadas, Universidade Nova de Lisboa
	ACOI	Algoteca de Coimbra, Universidade de Coimbra
	LEGE	Blue Biotechnology and Ecotoxicology Culture Collection, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto
	UCCCB	Coleção de Culturas de Bactérias da Universidade de Coimbra, Universidade de Coimbra
	CIMOCC	Mountain Research Centre Culture Collection, Centro de Investigação de Montanha, Instituto Politécnico de Bragança
	VFMCC-INIAV	Agronomic, Veterinary and Food Microbial Culture Collections - Instituto Nacional de Investigação Agrária e Veterinária
	Biotropical Resources	Global Health and Tropical Medicine, Institute of Hygiene e Tropical Medicine, Universidade Nova de Lisboa
	CDB	Coleção do Departamento de Biologia, Centro de Biologia Molecular e Ambiental, Universidade do Minho
	IVDP	Instituto dos Vinhos do Douro e Porto, I.P.

	LRV/DRAg	Laboratório Regional de Veterinária dos Açores, Direção Regional da Agricultura
RU	VKM	All-Russian Collection of Microorganisms
	IEGM	Regional Specialised Collection of Alkanotrophic Microorganisms
	UNIQEM	The Collection of Unique and Extremophilic Microorganisms
	VKPM	Russian National Collection of Industrial Microorganisms
RO (Observer)	IBB	Institute of Biology Bucharest
	MCUB	Microbial Collection of University of Bucharest
	CMII-ICCF	Culture Collection of Industrial Importance Microorganisms-National Institute for Chemical Pharmaceutical Research and Development
	MIUG-DJUG	Industrial Microorganisms Collection of “Dunărea de Jos” University of Galati
	CNBC-IC	Cantacuzino National Institute for Research in Microbiology and Immunology

According to the proposed Statutes, MIRRI-ERIC will be a distributed, but centrally coordinated, pan-European RI with three main organisational levels (**Erro! A origem da referência não foi encontrada.**):

- (1) Strategic Decision-making: with the assistance of Advisory and Ethical Boards, the Assembly of Members, constituted by the Members with voting rights and Observers without voting rights, is the body by which the Members take collective decisions on matters relating to MIRRI-ERIC.
- (2) Executive level: those decisions shall then be managed and implemented by the Executive Director, as the legal representative of MIRRI-ERIC, together with the staff of the Central Coordinating Unit (CCU). The MIRRI-ERIC CCU consists of two distributed sections, the Statutory Seat situated in Braga (Portugal) and the CWE Hub located in Paterna (Spain).
- (3) Operational level: the CCU shall be the operational secretariat of the MIRRI-ERIC, responsible for the general management and administration, organisation of meetings and outreach activities, and control of common services through the CWE. It serves also as the main point of communication with the stakeholders, through the Access Officer. Each Member will designate a National Node (NN) and a national coordinator overseeing the MIRRI activities of the Partners on its territory in alignment with MIRRI-ERIC. Bound to their NN by signing the MIRRI-ERIC Partner Charter, partners will be mBRCs, persons or institutions providing resources, services and/or expertise. Prospective partners are listed in **Erro! A origem da referência não foi encontrada.**

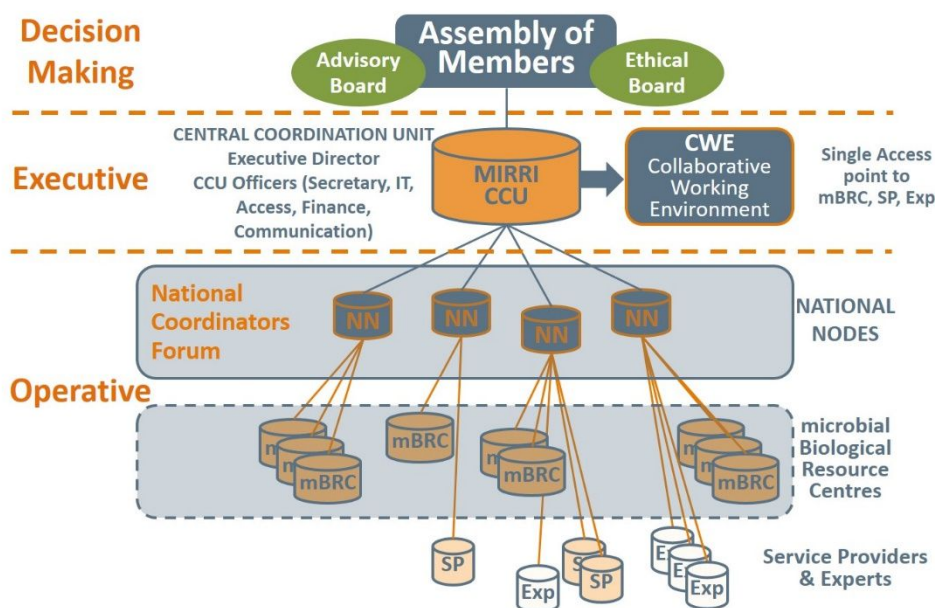


Figure 7. MIRRI-ERIC operating as a distributed RI

MIRRI marketing plan is being implemented in several media. Inspired by its logo and motto “Microbial resources for a green, healthy and sustainable future”, MIRRI is running promotional campaigns to strength its brand identity in social and public media, such as the MIRRI LinkedIn company page, the twitter account @MIRRI_live and the Facebook account @mirri.esfri. MIRRI targets companies offering microbial solutions and adding value to the health, food and agricultural sectors, among others, and serving educational/research institutes and individuals through its CWE, access programmes and T&E courses.

3.3. MIRRI expenses and sources of income

To provide services to the community, MIRRI needs to establish the CCU, serving as a central office, and to implement the CWE.

Once constituted as an ERIC, the CCU office will be run by an Executive Director, a Financial Officer, a Secretary and an Access Officer, based in Portugal, and an IT Manager, based in Spain. In the fourth year of constitution, a Communication and Outreach officer will be hired to join the team in Portugal. Besides the running costs of the offices (rent, electricity, etc.), some budget will also be needed to cover travel costs of the CCU personnel and organisation of meetings (General Assembly, National Coordinators Forum (NCF) meetings, workshops, etc.).

Regarding the CWE and provision of services, the software providing online access to the different gates of the platform (catalogues, expert platforms, T&E, provision of services, etc.) has to be developed by internal programmers or subcontracted. The construction of the MIRRI-IS is already on-going with the contribution from the partners, a donation from BioAware (the owner of the BioloMICS software for CCs management) and the in-kind contribution from LifeWatch ERIC Common Facility in Spain, which will complement the IT services offered, allowing data analysis

and modelling through Virtual Research Environments. Additionally, some budget is foreseen to provide some Transnational Access (TNA) based on selection through academic excellence and free for the users, as well as to subcontract some experts that could fill in gaps or strengthen the consultancy assistance provided via the expert clusters.

shows the costs and income foreseen for the first five years of implementation of MIRRI-ERIC, where the Infrastructure's services will be deployed and consolidated. To cover these costs, the main source of income for MIRRI will be the contributions of its M&O, calculated according to the provisions of the MIRRI-ERIC Statutes (**Erro! A origem da referência não foi encontrada.**). In return, the M&O stakeholder communities are granted with prime access and reduced fees to the CWE services (see section 3.4). Budget from the project IS_MIRRI21 "Implementation and Sustainability of Microbial Resource Research Infrastructure for 21st Century" (GA n° 871129) will also support the implementation of the RI until January 2023.

Table 3. Estimated expenses and income (€) for the first five years of operation of MIRRI-ERIC

EXPENSES	2021	2022	2023	2024	2025	TOTAL
Central Office rent	17.000	17.000	17.000	17.000	17.000	85.000
Consumables and communication	10.000	10.000	10.000	10.000	10.000	50.000
Stakeholder meetings' costs	50.000	50.000	50.000	50.000	50.000	250.000
Salaries (w/overheads)	243.000	243.000	243.000	278.000	278.000	1.285.000
Auditing and consulting	13.000	13.000	13.000	13.000	13.000	65.000
IT services (catalogue and expert, TNA and T&E platforms)	40.000	45.000	45.000	45.000	45.000	220.000
IT infrastructure (Life-Watch ES)	567.088	145.838	145.838	145.838	145.400	1.150.000
TNA	40.000	60.000	80.000	80.000	100.000	360.000
Subtotal (operational costs)	980.088	583.838	603.838	638.838	658.400	3.465.000
Activities derived from EC funded projects	1.600.000	1.600.000	250.000	250.000	250.000	750.000
Total expenses	2.580.088	2.183.838	853.838	888.838	908.400	4.215.000
INCOME	2021	2022	2023	2024	2025	TOTAL
Total host contribution	729.088	313.837	314.838	319.837	321.400	1.999.000
Member + Observer fees (excluding hosts)	251.000	274.000	283.000	301.000	308.000	1.417.000
Subtotal (Member contributions)	980.088	587.837	597.838	620.837	629.400	3.416.000
Grants	1.600.000	1.600.000	250.000	250.000	250.000	750.000
Revenues from services	0	0	10.000	20.000	30.000	60.000
Sponsorship and advertising	0	0	5.000	5.000	10.000	20.000
Total income	2.580.088	2.187.837	862.838	895.837	919.400	4.246.000
BALANCE	0	4.000	9.000	7.000	11.000	31.000

Table 4. Agreed contribution (in €) from MIRRI-ERIC prospective M&O for the first five years

	Country	2021	2022	2023	2024	2025	TOTAL
MEMBERS	Belgium	35.000	39.000	41.000	44.000	45.000	204.000
	France	43.000	48.000	49.000	52.000	53.000	245.000
	Greece	17.000	20.000	20.000	22.000	23.000	102.000
	Italy	41.000	44.000	46.000	48.000	49.000	228.000
	Latvia	15.000	16.000	17.000	18.000	18.000	84.000
	Netherlands	37.000	42.000	44.000	48.000	49.000	220.000
	Poland	25.000	26.000	27.000	28.000	29.000	135.000
	Portugal	148.750	151.750	151.750	153.750	154.750	760.750
	Russia	34.000	35.000	35.000	36.000	37.000	177.000
	Spain	580.338	162.087	163.088	166.087	166.650	1.238.250
OBSERVER	Romania	4.000	4.000	4.000	5.000	5.000	22.000
	TOTAL	980.088	587.837	597.838	620.837	629.400	3.416.000

The fees shown in **Erro! A origem da referência não foi encontrada.** include the agreed 1,875 K € in-kind contribution from the hosts (Portugal and Spain).

Other funding sources are third party grants to MIRRI (e.g. participation in European RIs funding programmes such as Research and Innovation Actions or Coordination and Support Actions, projects under national calls, e-infrastructures calls to fund IT services) and the European Regional Development Funds. In the period November 2012 to February 2023, MIRRI partners have received about 10M € from European H2020 and FP7 funds dedicated to support the development of RIs.

Gradually, MIRRI will start receiving income from services provided through the CWE (see section 3.4 “Access to the services and pricing modalities”) and from sponsorship and advertising associated with the organisation of events (workshops, courses, congresses, etc.).

shows the estimated income for the first five years of implementation for all sources of revenues.

3.4. Access to the services and pricing modalities

MIRRI is engaged to provide as much open and free access as financially possible, especially for M&O (**Erro! A origem da referência não foi encontrada.**). However, for sustainability reasons, free-open access will not always be implemented, in which case fees may apply, especially for users from countries that are not contributing members or for applied/industrial research projects. MIRRI will seek funding mechanisms to reduce the cost of access for users, for example, through research collaborations or TNA supported by EC-funded projects.

The stakeholders request the services through the CWE or contacting the MIRRI Access officer, who will find the best solution and coordinate internally the provision of the service(s). Services

are delivered by the Partners, which commit to targeted accession into their catalogues of new valuable resources, the provision of TNA or the participation in clusters of expertise, following appropriate quality standards.

Microbial resources, technological services and courses can be provided on-site or remotely and will follow the “European Charter for Access to RIs”, which includes three modes of access: Excellence-driven, Market-driven and Technical need-driven. For the last two modes of access, a contract will be established between the requester and MIRRI, which will define the obligations and responsibilities of each party, confidentiality, and IPR where necessary. These types of access will contribute to strengthening the innovation chain and the user has to cover the cost of the service or enter into a collaborative agreement with MIRRI, where both parties benefit from the collaboration. The excellence-driven mode of access will be provided through open calls, where users need to fill in an application that will be evaluated based on scientific merit, type of institution (profit/non-profit) and membership (MIRRI-ERIC M&O countries). Free or partially-free access will be provided to the best rated proposals.

On-site trainings and scientific events organized by MIRRI, as well as the virtual tools offered through the CWE, i.e. advanced data analysis, expert clusters forum, consultancy, webinars and tutorials, will require registration and, in some cases, payment of a fee. Advantageous conditions will be granted to institutions from M&O and non-profit organisations (**Erro! A origem da referência não foi encontrada.**).

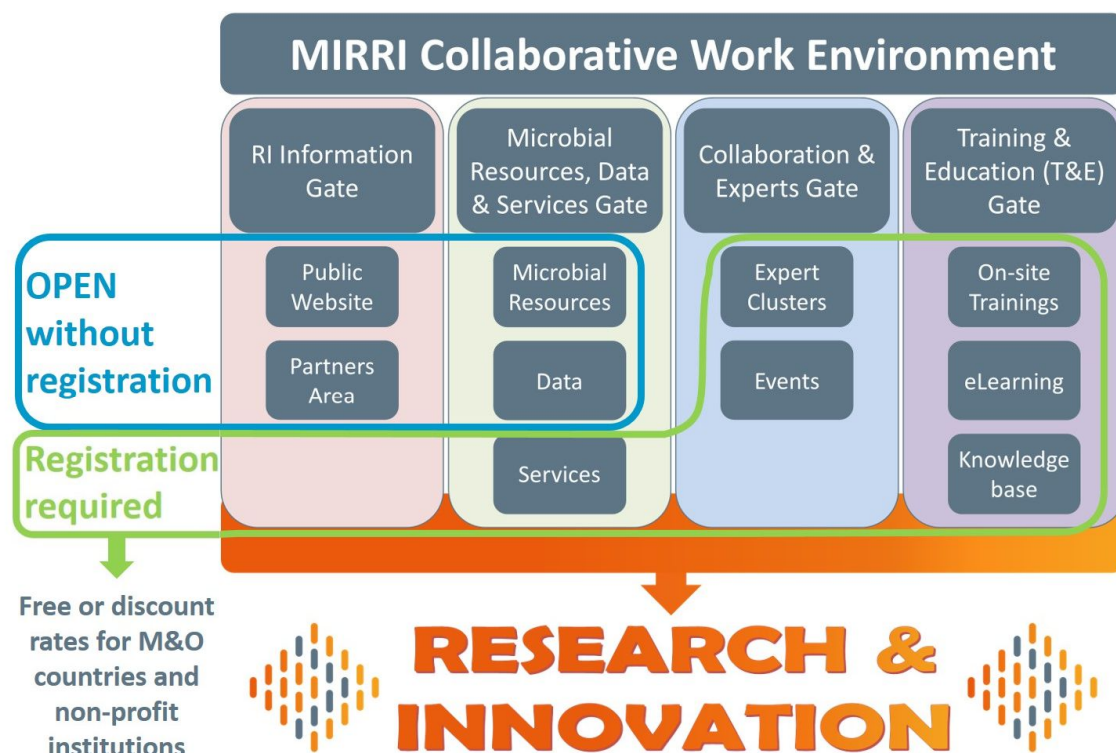


Figure 8. Open and restricted access to the different sections of the MIRRI CWE



4. Market Analysis

4. Market Analysis

4.1. Socio-economic impact

High-quality bioscience research and innovative bioindustries are key contributors to tackle global societal challenges, today and in the future, towards a green, healthy and sustainable world.

However, there are studies of biomedical and other sciences indicating that a considerable fraction of published peer-reviewed scientific literature has significant flaws, causing a huge waste of public money. In 2015, a ground-breaking economic study claimed that about US\$28 billion a year was spent largely fruitlessly on preclinical research in the USA (Freedman et. al., 2015). Improper biological reagents and reference materials cause a whopping 36% of this irreproducibility. In other words, US\$10 billion per year are lost because of misidentified cell lines, contaminated microbial strains, or “borrowed” biological materials. For years, CCs have proven capacity building in microorganism’s management and preservation through their very specialised staff. However, there is still a lack of visibility, fragmentation of the offer and insufficient capacity of individual partners to deliver harmonised, reliable, high quality and integrated microbial-related scientific services throughout Europe.

The global market for microbes and microbial related products was estimated at 150B € in 2015 and up to 2023 has an expected annual growth rate of >10%. The EC estimates that the bioeconomy generated 2.3T € of turnover value and created 18 million full-time jobs in 2015 (Ronzon et al., 2018), reaching 1,460.6B € of value-added, which is 11% of the Gross Domestic Product in the European Union-28 (Kuosmanen et al. 2020). In 2013, the fraction of turnover value corresponding only to the industrial biotechnology (IB, a sector relying on the use of enzymes and microorganisms to produce bio-based products in diverse sectors), was 31.5B €, from which 8.4B € was generated in terms of value-added (EuropaBio Report, 2016). Furthermore, half a million jobs are associated with the IB in Europe and this number is expected to double by 2030. The economic impact generated by these sectors will certainly increase, as the EC calls to strengthen the sustainable bioeconomy valuing natural resources and diminishing environmental pressures, as well as increasing the use of sustainable renewable products, restoring and enhancing ecosystems’ functions and biodiversity (Bioeconomy strategy, EC, 2018b). In this line, the EC has recently published the Biodiversity strategy (EC, 2020b), an ambitious agenda to protect and restore nature.

Harvesting the full value in microorganisms is fundamental to approach these challenges, as they impact different sectors, and MIRRI will contribute to address them following the MIRRI SRIA 2021-2030 (MIRRI, 2021) towards the main areas summarized in **Erro! A origem da referência não foi encontrada..**

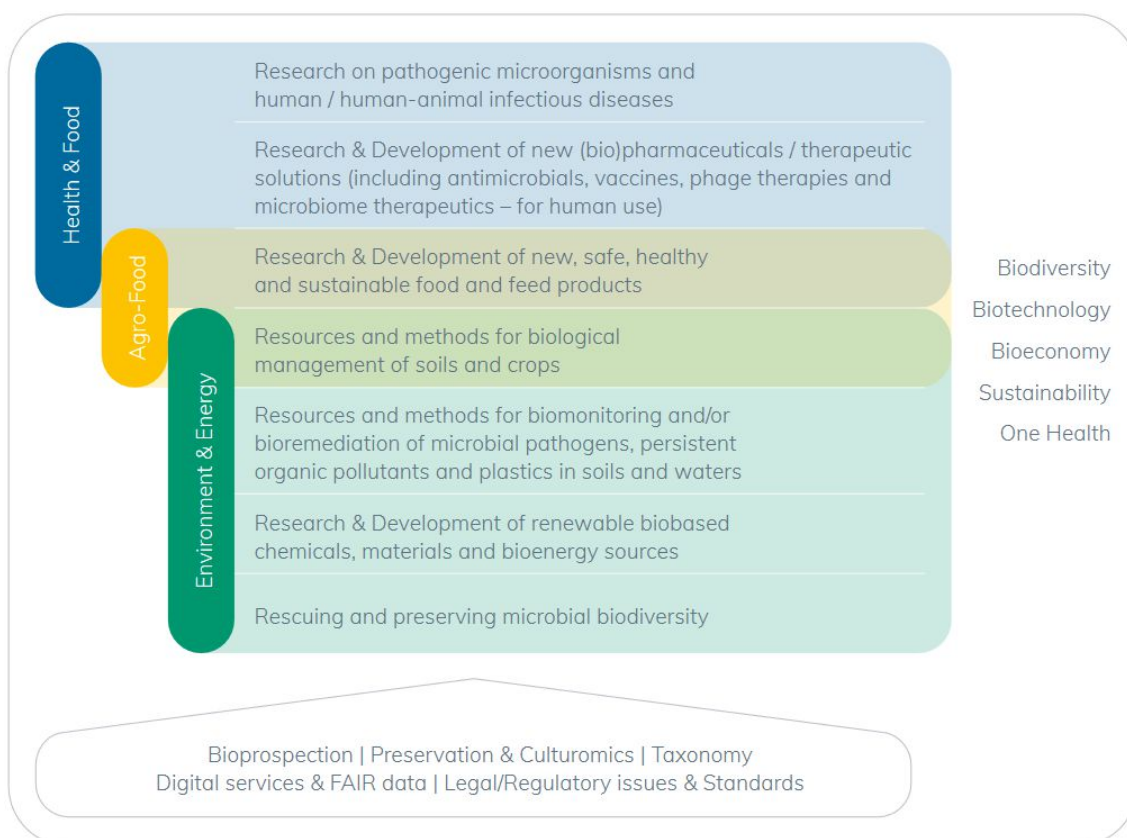


Figure 9. Main strategic sectors addressed by MIRRI

A non-exhaustive analysis of the socio-economic impact of some of the main areas where MIRRI plays a role is summarized hereunder. A deeper analysis can be consulted in the MIRRI SRIA 2021-2030 (MIRRI, 2021).

Infectious diseases and the growing concern for human and animal health

The World Health Organization estimated that 420,000 people die every year after eating contaminated food, resulting in the loss of 33 million healthy life years. Other threat related with public health are water-related infectious diseases and animal pathogens, since it is estimated that approximately 60% of human infections are associated to zoonoses. Recently, the world was hit by the novel coronavirus disease (Covid-19) pandemic that impacted the global economy through the costly use of medical care materials, low productivity, and forced lockdown in different countries. Implementation of prevention and mitigation measures is required to avert global health and economic crises. Besides the global emerging infectious diseases, there are the neglected infectious diseases affecting around 1 billion people in the world's poorest countries.

New (bio)pharmaceuticals / therapeutic solutions

Oncology, autoimmune and inflammatory diseases, diabetes and metabolic disorders, (neglected) infectious diseases, neurological and cardiovascular diseases, are currently the focus of an intensive R&I effort to deliver new therapeutic solutions, such as monoclonal antibodies,

recombinant growth factors, purified proteins, recombinant proteins, enzymes or hormones, cell and gene therapies, vaccines, immunomodulators, phage therapies, microbiome therapeutics, and many other product types. The global biopharmaceuticals market is highly competitive and is projected to grow by 9% through to 2025, reaching as much as 360-440B €. Alongside with this scenario, the pharmaceutical industry, together with academia, start-ups, and supported by governments, non-governmental organisations and charities have been developing new drugs and therapeutic solutions, to operate in financially less attractive markets. Several initiatives and programmes to illustrate what is ongoing are: (1) the Special Programme for Research and Training in Tropical Diseases (<http://www.who.int/tdr/en/>), (2) the Medicines for Malaria Venture (<https://www.mmv.org>), (3) the Global Alliance for Tuberculosis Drug Development (<https://www.tballiance.org>) or, (4) Drugs for Neglected Diseases Initiative (<https://www.dndi.org>).

Future of food innovation in balance with a resilient food system

Innovation in the food sector is oriented towards consumers that are more inclined to a healthy lifestyle and disease prevention. In fact, there is a growing demand for organic and healthy diets, including more nutritious and low-calorie food, customised food products, or food with health-promoting effects. Functional food is an emerging solution representing a huge market of 147B € (2021) that is expected to grow to 225B € in 2027, and 65% of this type of foods are elaborated with the help of microbes (i.e., bakery, dairy, novel vegetal fermentations). In addition, food and feed products need to meet the safety regulations and there is a great concern to ensure the food system sustainability, which are reflected in the Farm to Fork Strategy and the Food 2030 policy of the European Commission, both aligned with the Green Deal priorities. The agro-food chain generates about 700 million tons of waste each year in Europe. They are secondary raw materials which, in line with the transition towards a circular economy, can be exploited as carbon and nitrogen sources for microbial fermentation. Therefore, challenges such as agro-industrial by-products management and valorisation or foodborne-pathogen mitigation can also be addressed with the aid of microbes.

Healthy soil - healthy microbial ecosystem

The EC's Joint Research Centre has estimated that approximately 60-70% of soils in the European Union are unhealthy. Soil is an ecosystem containing large numbers of bacteria, fungi and other microbes; these contribute to 80-90% of the soil's biological activity and play a critical role in maintaining soil's health, ecosystem functions and crop production. Soil microorganisms can also affect human health, either directly via infection or by acting as reservoirs of antibiotic and antifungal genes than can be acquired by pathogens - for example, resistance to antifungal azoles administered to humans for treating aspergillosis has been linked with azoles used in agriculture. Healthy soils are required to fulfil the European Green Deal, the Common Agricultural Policy, the Water Framework Directive, the Habitats Directive, the Circular Economy Action Plan and the Soil Thematic Strategy.

Plant-microbe interactions for plant health and crop management

Plant-microbe interactions have dramatic effects on crop yield and economic viability. Microbes are important in nutrient transfer, nitrogen fixation, soil litter decomposition, solubilisation of inorganic minerals, stimulation of plant growth through phytohormones, antagonism towards pathogenic microorganisms, and mitigation of salt stress. Chemical fertilizers increase the cost of agricultural production and deteriorate soil quality of soil. Use of beneficial microbes has a low cost and can reduce a crop's requirement of nitrogen by 50–70% and increase its yield by up to 20%. It is estimated that employing beneficial microbes could potentially reduce the usage of chemical fertilizers by half.

Biocontrol is the use of microbes or secondary metabolites produced by microbes to control pathogens; these can cause large reductions in pathogen numbers or pathogen virulence and thus reduce the dependence of farmers on harmful pesticides.

The potential of microbes to reduce the reliance on pesticides and fertilizers, as well as their ability to remediate contaminated soils means that they can have a major role in the development of sustainable farming systems and can thus play a major role in achieving the United Nations Sustainable Development Goals such as Zero Hunger.

Global environmental issues require immediate action

Pollution is one of the main causes of soil and water degradation and loss of ecosystem services: the accumulation of persistent pollutants from agriculture (agro-chemicals), industry (hydrocarbons, plastics, dyes), and civil society (pharmaceuticals, personal care products) led to negative consequences on climate change, alteration of water cycle, soil quality, and biodiversity with a strong impact on human health. The European Environment Agency estimates more than 2.5 million potentially contaminated sites; 340,000 sites are already identified and require remediation intervention. Managing contaminated land in Europe costs an estimated 6.5B € per year. Therefore, to reduce the European ecological deficit there is a pressing need to invest in new sustainable products and processes and to restore the ecological functions of lands, surface waters and oceans.

Attempts at remediating contaminated environments continue to be managed using conventional chemical-physical and often costly approaches. These methods are time consuming, invasive, disruptive to natural habitats and usually result in a rearrangement of the problems. Moreover, they are not applicable to tackle the problem of diffuse pollution of micropollutants (including microplastics) in soil and water. The environmentally safe and relatively inexpensive biotechnological methods of pollution control involving microorganisms (bioremediation) allow facing such issues in a sustainable way keeping into consideration the high number of sites that have to be treated.

Urgent need for renewable energy to afford climate change

Among the motivations behind the development of technologies to utilise renewable sources for the production of bioenergy are energy security and the drive to reduce national and global greenhouse gas production, as well as supporting the efficient utilisation of agricultural and forestry resources as part of a circular bioeconomy.

The natural resources, can serve as replacements to chemicals and fuels derived from fossil fuel reserves, as well as in the production of bioalcohol (current bioethanol for automobiles and future longer chain alcohols for jet aircraft, for example), biochar and syngas. Specifically developed bacterial consortia, simultaneous and selective-degrading filamentous fungi, highly sugar-specific fermentative yeast strains, microalgae and more recently, co-cultivation methodologies have been developed to systematically remove high value components of the biomass for transformation into green chemistry precursors. These high value components find their application in the pharmaceutical, food and specialised chemicals industry.

4.2. Research strategy to meet the market needs

MIRRI makes microorganisms and their potential available to society. The microbial resources, top-level researchers, services and facilities in more than 50 repositories in 11 European countries (**Table 2**) are a source of solutions to address some of the society's most pressing challenges: climate change, loss of soil fertility, air, water and soil pollution, renewable energies, protection of biodiversity, elimination of hunger and malnutrition, fight against emerging pathogens, search for new drugs and therapies. But they, also, generate new products for companies in an increasingly competitive market: new materials, ingredients, biodegradable products, improvements in process performance, health-promoting foods, etc. MIRRI offers science and industry solutions aligned with global and European strategic agendas, such as the UN Sustainable Development Goals and the EC Horizon Europe, besides the ESFRI Strategy Report and Landscape Analysis, and national/regional Research and Innovation Strategies for Smart Specialisation (RIS3).

MIRRI and its partner organisations are, therefore, on a privileged position to collaborate with the bioscience and the bioindustry communities and other RIs, on delivering the maximum value and impact from their projects, technologies and products, most remarkably in the strategic domains of Health & Food, Agro-food, and Environment & Energy, and the strategic areas shown in **Erro! A origem da referência não foi encontrada.** The contribution of MIRRI to these sectors can be consulted in the MIRRI SRIA 2021-2030 (MIRRI, 2021).

4.3. Position of MIRRI in the European Research Area (ERA) and the ESFRI landscape

MIRRI occupies a unique position and plays a singular role in the ERA and, particularly, in the ESFRI landscape, since (i) it is the only pan-European RI focusing on the preservation, study, provision and valorisation of microbial resources, and (ii) the broadness of its catalogue of

microbial resources, associated data and services transversally crosses several highly-relevant R&I domains, including Health & Food, Agro-Food, Environment & Energy.

MIRRI continuously analyses the landscape and scans the horizon in these domains, in order to systematically anticipate gaps and opportunities, aiming at better addressing the effective needs of its user communities, and helping them deliver the maximum value and impacts from their projects, technologies and products. This means, among other things, that MIRRI is aligned and/or establishes potential links with relevant global, European and national/regional agendas, benchmarks and initiatives, i.e.:

STRATEGIC AGENDAS / FRAMEWORKS

- NATIONAL/REGIONAL RIS3
- HORIZON EUROPE CLUSTERS (Health / Digital, Industry and Space / Climate, Energy and Mobility / Food, Bioeconomy, Natural Resources, Agriculture and Environment)
- HORIZON EUROPE MISSIONS (A Climate Resilient Europe / Conquering cancer / 100 Climate-neutral Cities by 2030 / Mission Starfish 2030 / Caring for soil is caring for life)
- HORIZON EUROPE PARTNERSHIPS
 - Health (European Partnership for EU-Africa Global Health / European Partnership for Innovative Health (Initiative) / European Partnership for Chemicals Risk Assessment / European Partnership - ERA for Health Research / European Partnership for Personalised Medicine / European Partnership for One Health / Antimicrobial Resistance)
 - Climate, Energy and Mobility (European Partnership on Clean Hydrogen / European Partnership for Clean Energy Transition)
 - Food, Bioeconomy, Natural resources, Agriculture and Environment (European Partnership accelerating farming systems transition / European Partnership for Animal health / Agriculture of data / European Partnership for rescuing biodiversity to safeguard life on Earth / European Partnership for Safe and Sustainable Food Systems / European Partnership Water Security for the Planet)
 - Partnerships across themes (European Partnerships Innovative SMEs / EOSC Partnership / European Institute of Technology Climate-Knowledge and Innovation Community (EIT Climate-KIC) / EIT InnoEnergy-KIC / EIT Health-KIC / EIT Food-KIC / EIT Manufacturing-KIC / EIT Raw materials-KIC / EIT Urban Mobility-KIC)

ESFRI RIs

- Environment
 - DANUBIUS-RI. International Centre for Advanced Studies on River-Sea Systems
 - DiSSCo. Distributed System of Scientific Collections

- eLTER. Long-Term Ecosystem Research in Europe
- EMSO ERIC. European Multidisciplinary Seafloor and water-column Observatory
- LifeWatch ERIC. e-Infrastructure for Biodiversity and Ecosystem Research
- Health & Food
 - AnaEE. Infrastructure for Analysis and Experimentation on Ecosystems
 - EU-IBISBA. European Industrial Biotechnology Innovation and Synthetic Biology Accelerator
 - METROFOOD-RI. Infrastructure for Promoting Metrology in Food and Nutrition
 - BBMRI ERIC. Biobanking and BioMolecular Resources Research Infrastructure
 - EATRIS ERIC. European Advanced Translational Research Infrastructure in Medicine
 - ECRIN ERIC. European Clinical Research Infrastructure Network
 - ELIXIR. A distributed infrastructure for life-science information
 - EMBRC ERIC. European Marine Biological Resource Centre
 - ERINHA. European Research Infrastructure on Highly Pathogenic Agents
 - EU-OPENSREEN ERIC. European Infrastructure of Open Screening Platforms for Chemical Biology
 - Euro-BioImaging. European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences
 - INFRAFRONTIER. European Research Infrastructure for the generation, phenotyping, archiving and distribution of mouse disease models
 - INSTRUMENT ERIC. Integrated Structural Biology Infrastructure

The alignment between the MIRRI areas of research and the Strategic Agendas and ESFRI RIs listed above is described in the MIRRI SRIA 2021-2030 (MIRRI, 2021).

4.4. Strengths Weaknesses Opportunities and Threads (SWOT) analysis

Throughout its preparatory and implementation phases, MIRRI has been capable of accumulating a substantial number of relevant strengths, which set up the foundations for a competitive and sustainable RI in the long-term. Now fully entering the operation phase, some weaknesses remain, as they naturally occur in RIs with this level of maturity. It is important to highlight that these weaknesses have been properly diagnosed and monitored, and are on their way to being adequately solved/mitigated.

MIRRI's main strengths and weaknesses are listed, along with the context's opportunities and threats, on the SWOT analysis shown below (**Erro! A origem da referência não foi encontrada.**).

Table 5. SWOT analysis of MIRRI

Strengths	Weaknesses
<p>(1) Participation of 10 Member and 1 Observer countries mobilizing 50+ mBRCs, CCs and research institutes</p> <p>(2) Availability of the broadest range of 400,000+ high-quality microbial strains and associated data, as well as a comprehensive, diverse offer of relevant, high-quality services – important assets for researchers and bioindustries in e.g. Health & Food, Agro-food, and Environment & Energy</p> <p>(3) Top-level scientific expertise and leadership</p> <p>(4) Adoption of a unified, long-term R&I vision, through the MIRRI’s SRIA 2021-2030</p> <p>(5) Clear vision and available resources for full implementation and sustainability, through the Horizon 2020 project <i>IS_MIRRI21</i></p> <p>(6) Recognition by the global mBRCs community as a key player to bring cohesiveness to the current disparate collections and resources in different European countries (also expandable to non-European countries)</p> <p>(7) Growing engagement of partners and interactions with stakeholders</p> <p>(8) Established, highly-qualified, multidisciplinary CCU</p>	<p>(1) Still insufficient recognition of the MIRRI brand among (some) relevant stakeholders</p> <p>(2) Limited financial capacity</p> <p>(3) Reduced number of personnel in the CCU</p> <p>(4) Specifications for technical design, operational procedures, monitoring key performance indicators, and operations of e-infrastructure services still not fully defined or not yet implemented</p> <p>(5) Catalogue of integrated services (workflows, pipelines), including in collaboration with other RIs, still under construction</p> <p>(6) Proactive enlargement and business development activities still not in place</p>
Opportunities	Threats
<p>(1) Ever-increasing need for cohesiveness and unification between collections and resources across countries</p> <p>(2) Escalating demand for microbial resources, associated data and services from fast-growing scientific fields and market segments in the domains of Health & Food, Agro-Food, Environment & Energy</p> <p>(3) The high alignment of the MIRRI SRIA 2021-2030 with strategic agendas, such as Horizon Europe and national/regional RIS3, can bring new opportunities – e.g., on access to funding, on attracting new countries and organisations, and on the external demand for MIRRI resources and services</p> <p>(4) The unique position in the ESFRI landscape and the transversality of MIRRI, intersecting several research areas, creates multiple opportunities for collaboration with other RIs, not only within the Health & Food domain, but also with the Environment, and the Data, Computing and Digital domains</p> <p>(5) Establishment of MIRRI as ERIC can bring reputational gains and new opportunities – e.g., on access to funding, on the external demand for resources and services, etc</p> <p>(6) Increased interest from the policy-makers and general public on microbes triggered by the Covid-19 pandemic</p>	<p>(1) Lack of decision about MIRRI being recognised as ERIC</p> <p>(2) Lack of foreseeable financial commitments obtained from Member countries when the ERIC will be signed</p> <p>(3) Potential non-inclusion of MIRRI NNs on the respective national roadmaps of RIs</p> <p>(4) Competition from other organisations providing microbial resources and services</p> <p>(5) Uncertainty and competition on the access to public funds and grants</p>

4.5. Competitors

MIRRI aims to become a quality “trademark” to highlight the difference in the whole microbiological offer provided: biological material, services, data from microbial resources or T&E. It will be realized by the expertise of the consortium supporting and, managing the RI, as well as Standard Operational Procedures and best practices.

Individual CCs/mBRCs can be considered competitors since most of them basically offer the same kind of services as MIRRI, but a complete offer is not supplied by a single one of them. Main competitors are large European CCs/mBRCs outside MIRRI like the German Collection of Microorganisms and Cell Cultures GmbH (DSMZ, Leibniz Institute, Germany) and the Culture Collection University of Gothenburg (CCUG, Sweden). DSMZ holds 73,000 microbial resources, covering a wide diversity, and on-line tools and databases like BacDive with sequences from 82,892 strains (including those from Institute Pasteur and CCUG). CCUG assures to hold the highest number of clinically-relevant bacteria in the world.

Internal competition between the MIRRI partner providers could be given if prices for strains and services offered are not harmonized internally and the single access entry is not well implemented.

Regarding other ESFRIs as competitors, the most closely related are those including CCs that can provide microbial resources such as EMBRC-ERIC for marine resources, ERINHA for highly pathogenic agents or those providing services related to managing biological materials like BBMRI-ERIC for biobanking of human resources for biomedical research, or EU-IBISBA for industrial biotechnology innovation.



5. Future Opportunities

5. Future opportunities

5.1. Membership enlargement

MIRRI has the ambition to enlarge MIRRI's membership (M&O countries) and partnership (Institutions or persons from M&O countries delivering services), recruiting important mBRCs not (yet) partners of MIRRI and providing support to countries with important specialised collections for the implementation of quality standards needed to upgrade the CCs into mBRCs. Luxembourg is currently in the process to come on-board and two more countries (Slovakia and Finland) are following the development of MIRRI activities. MIRRI has also received signed expressions of interest from organisations in Chile and Brazil. New potential M&O shall issue a written request to be evaluated by the Assembly of Members and they must adhere to the MIRRI-ERIC Statutes to be accepted.

5.2. Strategic partnerships with other RIs to target new users

During its construction phase, MIRRI has already interacted with other ESFRI RIs, through the cluster projects CORBEL, EMBRIC, RI-VIS and EOSC-Life and the H2020 project RItrain.

In addition to these projects, MIRRI aims to cooperate with BBMRI-ERIC (human resources) and EMBRC-ERIC (marine resources), especially in legal matters related to the Nagoya Protocol, access to resources, public-private relationships, implementation of data-processing and analysis tools, etc.

Interaction with other Health & Food/LS RIs such as Instruct-ERIC, Euro-BiolImaging and EU-OpenScreen ERIC will give the opportunity to increase knowledge on MIRRI own resources and to develop workflows of high quality services integrating technologies of several RIs. Generating data on MIRRI own resources via high throughput screenings (e.g., metabolomics, imaging) will be invaluable in the increase of the attractiveness of the resources preserved by MIRRI. Creating a strong community of service providers will bring the highest quality and complementary services possible to the MIRRI users.

Since a key aspect of MIRRI rely on sequence data of the holdings and their analyses, MIRRI will also cooperate with ELIXIR, the infrastructure for life-sciences information and leader of the project EOSC-Life.

Close cooperation and synergies with LifeWatch-ERIC, the European e-Science distributed Infrastructure focused on how to measure the impact of Global Climate Change issues on Earth Biodiversity and Ecosystem Research, will take place. The connection will be established through LifeWatch-Spain, which will develop and deploy tools that will support MIRRI to accomplish its goals: (1) Construction of the MIRRI-IS to guarantee the interoperability among available data on the preserved resources; and (2) Complex analyses of data associated to the resources used in

the digital service offer of MIRRI. This mission will be achieved by providing access to a multitude of data sets, e-Services and e-Tools enabling the construction and operation of Virtual Research Environments, which provide the environments for integrating data, software and computation as developed in the pan European infrastructure cooperation. These developments are part of the in-kind contribution of Spain to MIRRI.

There is a relatively new project placed on the 2018 ESFRI roadmap, IBISBA, which will develop new technologies and strategies for public and private researchers involved in the field of IB. It will be a perfect partner of MIRRI by supporting the practical implementation of joint projects between MIRRI partner mBRCs and their public or private users, helping to strengthen the possible industrial applications generated as a result of the collaboration.

The recently published SRIA 2021-2030 (MIRRI, 2021) and the participation in the LS RI Strategy Group will facilitate the preparation of proposals for different Horizon Europe calls, including the development of common service workflows with other RIs.

5.3. Identifying new markets through environment scanning

In its quest for (new) markets, MIRRI as a pan-European RI could be influenced by a myriad of factors in its environment on several levels. MIRRI makes use of PESTLE (Political, Economic, Sociological, Technological, Legal, Environmental) analysis to identify the main factors as follows:

P – Political: The current and potential influences from political pressures

- ESFRI Roadmap
- National R&I strategies
- EC, which guides the constitution of the RI as an ERIC proposal
- MIRRI-ERIC Assembly of prospective members
- Policymakers and national vs. European regulations

E – Economic: The local, national and world economic impact

- Contributions from M&O countries
- Funding redirected for health research due to the Covid-19 Pandemic
- Availability of National and European Research funds
- Non-for-profit business approach towards sustainability of RI
- Inflation rate affecting direct costs (salaries)

S – Sociological: The ways in which changes in society affect the RI

- Population and language of communication of the main Member countries
- Covid-19 pandemic and its influence on MIRRI's plans, employees and society at large
- Ethical considerations

- Outreach capacities to meet the needs of citizens and society

T – Technological: How new and emerging technology affects the RI

- Digitalisation of databases from CCs
- Biolomics software to host MIRRI-IS
- LifeWatch ERIC Common Facility in Spain to provide e-Tools and Virtual Research Environments
- New emerging technologies that outdate the current systems and the need to improve service provision

L – Legal: How local, national and global legislation affects the RI

- Protection of personal data of involved users
- Nagoya Protocol
- Biosafety and Biosecurity regulations
- Access procedure adapted to the bioindustry needs (e.g. IPR, confidentiality)
- ISO certifications
- MIRRI-ERIC Statutes
- Changes in organisational or institutional protocols for the Partner organisations

E – Environmental: Local, national and global environmental issues

- Awareness about positive impact of microbes
- Pests and soil treatment with microbes
- Management of lab waste

References



References

- EC. Action Plan against Disinformation. 2018a
- EC. A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. 2018b.
- EC. Communication: EU Biodiversity Strategy for 2030 - Bringing nature back into our lives. 2020b.
- EC. Making Science Happen. A new ambition for Research Infrastructures in the European Research Area. ESFRI White paper 2020a.
- Europabio Report. Jobs and growth generated by industrial biotechnology in Europe. 2016.
- Freedman LP, Cockburn IM, Simcoe TS. The Economics of Reproducibility in Preclinical Research. PLoS Biol. 2015;13(6): e1002165. doi.org/10.1371/journal.pbio.1002165
- Kuosmanen T, Kuosmanen N, El-Meligli A, et al. How Big is the Bioeconomy? Reflections from an economic perspective. 2020. doi:10.2760/144526
- MIRRI “Strategic Research & Innovation Agenda 2021-2030”. 2021. www.mirri.org/repository/position-papers/
- Ronzon T, M'Barek R. Socioeconomic Indicators to Monitor the EU's Bioeconomy in Transition. Sustainability. 2018;10(6):1745. doi.org/10.3390/su10061745
- Stackebrandt E, Smith D, Casaregola S, et al. Deposit of microbial strains in public service collections as part of the publication process to underpin good practice in science. Springerplus. 2014;3:208. Published 2014 Apr 28. doi:10.1186/2193-1801-3-208
- Van Hauwenhuysse F, Hellemans A, Piessens V, et al. MIRRI Innovative User Survey. Zenodo. 2014a. doi:10.5281/zenodo.1119043
- Van Hauwenhuysse F, Hellemans A, Piessens V, et al. MIRRI User Survey Report. Zenodo. 2014b. doi: 10.5281/zenodo.1119041



MIRRI IS21

IMPLEMENTATION AND
SUSTAINABILITY FOR
THE 21ST CENTURY

MICROBIAL RESOURCE RESEARCH INFRASTRUCTURE