BIOPOLIS

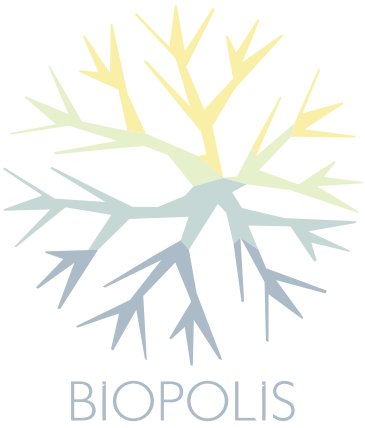
WP4

Strategic Research Plan

Deliverable 4.1

cibio

Porto Business School



Strategic Research Plan

Deliverable 4.1

Lead beneficiary	BIOPOLIS
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Summary

This deliverable (D4.1) presents the Strategic Research Programme of BIOPOLIS, as defined in Task 4.1 (Strategic Research Programme) of WP 4 (Operationalisation of the Research Programme). The main objective of the Deliverable is to update and refine the research strategy of BIOPOLIS already provided in the Teaming proposal, but it introduces some adjustments motivated by the new challenges and opportunities faced by BIOPOLIS, and by the need to integrate the best aspects of the previous CIBIO structure and the increased ambition and expansion of BIOPOLIS research. Section 1 sets the stage for the Programme, while Section 2 present the conceptual framework and justification of the research structure. Section 3 makes a detailed appraisal of the challenges and opportunities that will be addressed by BIOPOLIS, with particular attention given to developments occurring after the Teaming project submission in 2018 (e.g., European Green Deal, EU Biodiversity Strategy for 2030, Farm to Fork Strategy, New EU Forest Strategy for 2030, Nature Restoration Law), and the research priorities and funding programmes emerging from the COVID pandemic, Horizon Europe Missions, and Work Programmes, among others. Section 4 describes the organisational and thematic background associated with the last decade of research at CIBIO, which represents the structure upon which the research organisation of BIOPOLIS is built. Section 5 describes the three main Strategic Pillars that will be dealt with by the BIOPOLIS Teaming project: (i) Ecological Assessment and Monitoring; (2) Ecosystem Function, Services and Restoration; and (3) Agrobiodiversity and Sustainable Food Systems. For each of these themes, we provide two research lines and several research activities, as well as a timeline and an outline of its relevance to address societal challenge. In Section 6, we describe the organisational structure that is being implemented at BIOPOLIS, including the main statutory bodies, the thematic lines and research groups, and the composition, objectives and responsibilities of the bodies established at different organisational levels. Particular care is taken to show how the previous structure of CIBIO will be adjusted and updated to integrate the ambitious work programme of the BIOPOLIS Teaming project. In Section 7, we provide an outline of the implementation of the Programme. As this implementation is conditional on several components already covered in other deliverables (e.g., Data Management, Infrastructures and Equipment, Internationalisation, among others), here we focus on components that are more specific and/or particularly important for this Programme. Specifically, we outline the recruitment strategy (including priority areas of recruitment), the strategy to attract and retain talent, the promotion of successful application to funding, the engagement of stakeholders in problem-solving research, and the promotion of internationalisation and networking. Finally, in Section 8, we present aspects related to monitoring, evaluation, and revision, where we provide the key performance indicators to cover the different dimensions of the research program. The Programme will be adjusted, if necessary, during its implementation, while major revisions are scheduled for July 2025 (Deliverable 4.2; revised deadline agreed with the PO) and at the end of the project in September 2027 (Deliverable 4.3).

1. Introduction

The BIOPOLIS Teaming project, funded by the EC, aims to upgrade CIBIO – Research Centre in Biodiversity and Genetic Resources, to a Centre of Excellence in the fields of Environmental Biology, Ecosystem Research and Agrobiodiversity. Previously hosted by the proponent institution (ICETA), CIBIO will undergo a comprehensive transformation through extensive Teaming activities in collaboration with the University of Montpellier (UM; France), serving as the advanced partner organization, and with the Porto Business School (PBS), the business partner. One of the initial steps of the BIOPOLIS project involved establishing a new Non-Profit Scientific institution called the Association BIOPOLIS. Subsequently, ICETA transferred all assets and liabilities of CIBIO to this new association, including human resources, equipment, and scientific and technical capabilities. These initial steps have laid the foundation for the development of strategic plans and the initiation of urgent activities crucial to achieving the Association's Vision and Mission within the specified timeline of the Teaming project.

According to the Grant Agreement (GA) of the Teaming project, the Vision of the Association BIOPOLIS is to become "*one of the best international Centres of Excellence in Environmental Biology, Ecosystem Research and AgroBiodiversity, with the capacity for spreading excellence towards innovation in the areas of Environment, Biodiversity and Agriculture, and thereby contributing to socioeconomic development at the regional and national levels*". Building on this overarching vision, the Mission of the association is "*to advance biological understanding from genes to ecosystems, and to use this knowledge to address pressing societal challenges in the areas of environment, biodiversity and agriculture through the development of world-leading research, the establishment of long-term strategic partnerships, the engagement of stakeholders, and the transfer and exploitation of research outputs*". Aligned with its Vision and Mission, the Association has outlined several strategic objectives, organized in three primary axes: I. Excellence Towards Innovation; II. Empower Economy and Sustainability for a Better Society; and III. Internationalisation in Research and Training.

To achieve these strategic objectives, the Teaming project incorporates a dedicated Work Package (WP4) focused on operationalising the Research Programme. The overall goal of this WP is "*To implement and monitor the BIOPOLIS Research Programme in close collaboration with UM, thereby ensuring the development of excellent research towards innovation, the alignment of research with the objectives of the CoE, and the necessary links with the PhD and Post-doctoral training Programmes, the network of stakeholders and business partners, and the wider society at large*". As outlined in the Grant Agreement's Work Plan, there is a specific task (4.1) centred around the Strategic Research Programme. The purpose of this task is to refine the strategy outlined in the Business Plan and create the conditions for its successful execution and thus steer the development of excellent research towards innovation. This task was scheduled to be carried out from month nine until the end of the project, with leadership provided by ICETA-CIBIO in collaboration with UM. As per the work plan, following the approval and signing of the amendment to the Grant Agreement on April 26th, 2022, the BIOPOLIS Association has officially assumed all roles and responsibilities formerly held by ICETA-CIBIO.

One of the initial activities in Task 4.1 entails the development of a Strategic Research Programme, to be submitted to the European Commission as Deliverable 4.1. The Grant Agreement describes the contents of this deliverable as follows: "This deliverable is an update of the research strategy developed in the Business Plan, preparing a roadmap to steer the development of excellent research towards innovation. It will set up the Research Units (RU) and will create the conditions for implementing the research strategy". As per the Grant Agreement, the original deadline for producing this deliverable was Month 12 (September 2021). However, due to constraints related to the COVID pandemic, it was submitted later, in Month 21 (June 6th, 2021). On December 9th, 2021, the Project Officer (PO) provided feedback on D4.1, requesting a revision. This was due to the fact that the Associate Director for Research and Innovation had only been appointed in September 2021, after the submission of D4.1. The feedback further emphasized that "*The content of the deliverable should be further elaborated including a refinement of the strategy, a description of the Research Units put in place (e.g. RU leaders appointed and global planning of staff (FTE's) for the RA's). The indication 'short-term < 2 years' used in tables in the document should be clarified. Does this mean < 2 years since the start of the Teaming project 2019.10.01? Joint preparation with RU leaders is recommended*". Consequently, a revised and updated version of the Research Strategy was developed and submitted to the EC on June 26th, 2022.

Feedback on the new revised version of D4.1 was received on March 30th, 2023, with additional comments provided on March 31st, 2023, in the Review Report of the second Reporting Period (from January 1st, 2021, to September 30th, 2022) of the BIOPOLIS Teaming project. Briefly, the Deliverable was rejected, with key comments indicating that the revised Strategic Research Programmed deviated significantly "*from the BIOPOLIS business plan and from the current DoA*", and that the "*experiences and the rationale*" for the proposed deviations were "*not sufficiently explained in the RP2 report nor in D4.1*". Subsequently, members of the Board of Directors (BoD) of BIOPOLIS had meetings with the PO of the Teaming project on April 26th and 27th, 2023, to discuss the comments to D4.1, as well as other aspects of the Review Report. After these meetings, and following the suggestions of the PO, BIOPOLIS prepared and submitted to the EC on May 9th, 2023, a very detailed response to each and every comment and recommendation of the Review Report. Particular care was taken to address the comments regarding the Strategic Research Programme (D4.1), to which we provided arguments supporting the view that eventual deviations were well within the flexibility allowed by the DoA, as well as detailing the justifications for the changes proposed. These topics were revisited on the new meeting with the PO, on June 1st, 2023, where it was agreed that BIOPOLIS should submit a new version of D4.1 until the end of July 2023. This revision was submitted for feedback on 19/06/2023, by mail sent to the PO, incorporating all clarifications and justifications discussed during the meetings and presented in the response to the Review Report. Following this submission, we were informed that a new ad hoc review meeting would be held, especially in view of D4.1 (mail from the PO on 31/07/2023). Following a request of the PO on 19/09/2023, a new version of D4.1 was submitted on the participant's portal on 06/10/2023.

The revised research strategy presented in D4.1 was discussed at length during the ad hoc meeting at BIOPOLIS premises in Vairão, on 14/11/2024. The results of the ad hoc review were communicated to BIOPOLIS on 07/02/2024 (Ref. Ares(2024)932963). The corresponding review report addressed in detail the Strategic Research Programme of BIOPOLIS, indicating that "*To this end, D4.1 - Strategic Research Programme - is accepted*". However, on 02/07/2024 BIOPOLIS received the notification that D4.1 had been rejected, requiring updating regarding the revision of BIOPOLIS by-laws, the description of the Science Council and the Coordinating Committee of the SC, and the election of the speakers of Thematic Lines. Accordingly, a revised and updated version of the Strategic Research Programme of BIOPOLIS has been produced and is now provided in the present document. In addition, the document is updated regarding on the composition and leadership of the research groups, which was carried out in the scope of the evaluation of the research units by the Portuguese Science and Technology Foundation (FCT). In the following sections, we describe the Programme, including the conceptual framework and justification for the research structure adopted (Section 2), the challenges and opportunities underpinning the research priorities (Section 3), the organisational and thematic background associated with the last decade of research at CIBIO (Section 4), the Strategic Pillars, Research Lines and Research Activities of the BIOPOLIS Teaming project (Section 5), the organisational structure of BIOPOLIS research (Section 6), the implementation strategy (Section 7), and the monitoring, evaluation, and revision (Section 8). The research programme builds also on other components of BIOPOLIS activity, including governance and organization aspects, administration and finances, human resources, communication, dissemination, and exploitation, among others, which are dealt with in separate deliverables, and so will only be briefly mentioned in here.

2. Conceptual framework and justification of the research structure

2.1. General concepts

According to the DoA, the research structure of BIOPOLIS will involve six Research Units, each aligned with one of its Research Lines (described in Section 5). The main objective of the RUs is to further organise the research at BIOPOLIS, and particularly to promote the implementation of its research strategy. Furthermore, the DoA indicates that "*Each RU will be led by a Senior Researcher with adequate qualifications and experience, and it will include at least 2 Principal and 3 Assistant Researchers, who will be transferred from ICETA-CIBIO (Task 2.4) and/or hired following procedures described in T2.4*". However, the DoA also provides significant flexibility to this structure, indicating that "*The number and organization of RUs can be expanded and adjusted during project implementation to face new challenges and opportunities"*. Therefore, BIOPOLIS has proposed some adjustments to the research structure (Section 6), though maintaining the same scientific focus in terms of Strategic Pillars and priority Research Lines (Section 5) and remaining within the flexibility allowed by the DoA (T4.1). These changes were designed considering the new challenges and opportunities faced by BIOPOLIS (Section 3), as well as the need to promote a more virtuous integration of the best elements of previous CIBIO research structure (Section 4) with the new ambition and upscaling of research emerging from BIOPOLIS (Section 5).

Briefly, the adjustment of BIOPOLIS research structure has involved a reduction from six to three "Research Units", each matching one of the three broad Thematic Lines adopted at CIBIO since 2018 (Section 4). This was considered a satisfactory solution for adequately covering the breadth of research themes addressed by BIOPOLIS-CIBIO, and to reflect the interests and research questions addressed by its researchers. However, to guarantee that the Strategic Pillars of BIOPOLIS Teaming project are adequately covered under this structure, each priority Research Line envisaged in the Teaming project has been duly allocated to Thematic Lines (Section 6). The adjustments have also involved the replacement of the name "Research Units" by "Thematic Lines", though the concept in terms of organisational structure remains largely unchanged. This was necessary because the use of "Research Units" in the context of BIOPOLIS has proven to be a source of misunderstanding, as the same name is used by FCT to designate research centres (i.e., BIOPOLIS-CIBIO is in itself a Research Unit). Moreover, recent evaluations of performance by FCT have asked specifically for organising the Research Groups (RGs) in Thematic Lines, so it was found preferable to use an organisational structure that matched the requirements of both the BIOPOLIS Teaming project and FCT. Finally, to help streamlining the implementation of BIOPOLIS research strategy and enhance the communication between RGs (see below) and the governing bodies of BIOPOLIS, two Senior Researchers (Group Leaders) were elected as speakers of each Thematic Line. Details of the Thematic Lines and how they crosscut the Teaming priority Research Lines are given in Section 6.4.

Another significant improvement to the research structure described in the DoA is the prominence given to Research Groups in the organisational structure. Indeed, RGs are seen as the basic structural units of BIOPOLIS-CIBIO research organisation, following the practice of CIBIO, and reflecting the

strong commitment to privilege bottom-up approaches and to support the intellectual freedom of researchers. Each Research Group is allocated to a Thematic Line, but its activity crosscuts different Strategic Pillars and priority Research Lines of the Teaming project, thereby promoting transdisciplinarity and cross-fertilization across research fields. Details of the RGs and their roles are provided in Section 6.5.

2.2. Justifications

We believe the adjustments proposed to the research structure of BIOPOLIS are well aligned with the DoA of the Teaming project, and they will contribute to a more efficient implementation of the research programme, and ultimately to the successful upgrade of CIBIO to a CoE. Specifically, we provide below the rationale justifying adjustments proposed:

1) First, it is important to note that the scientific content proposed in the Strategic Research Programme remains the same as that in the Biopolis Teaming proposal, maintaining without changes the same Strategic Pillars and Research Lines described in the amended Grant agreement (Section 1.3.4, pp. 14-17, of Annex 1 of the DoA – part B). For each Research Line, the Programme lists a number of Key Research Activities, building primarily on the Research Programme produced in 2018 in the scope of the Teaming Phase 1 implementation. However, at this stage we have also introduced the necessary updates to keep up with major conceptual and technological progresses in the biological sciences (see below). Therefore, the Programme updates as required the Research Strategy developed in the Business Plan, though strictly maintaining the research focus and priorities defined in the DoA.

2) Since the Teaming proposal was submitted in 2018, following a long process of development which started in 2016, there have been major advances in the biological sciences, involving new emerging and hot topics, as well as new concepts, tools and technologies, making this one of the most dynamic and fast-changing areas in the whole body of science. To tackle these ongoing changes, our organisational research structure should be light and flexible, to rapidly track the ever changing research landscape and harness the power of the fast conceptual and technological advances. In this context, we believe that the structure in six RUs initially envisaged for BIOPOLIS was becoming too rigid and inefficient, hindering BIOPOLIS capacity “to face new challenges and opportunities”.

3) Also emphasising the need to move away from a rigid organisational structure, the societal demands for research coming from the biological sciences, and particularly from the fields of Environmental Biology, Ecosystem Research and Biodiversity, has greatly expanded and diversified since the submission of the Teaming proposal in 2018. This has been very evident at the European level, with the approval and implementation of a range of new and forthcoming policies, strategies and laws closely related to the research topics of BIOPOLIS, including for instance the European Green Deal, the EU Biodiversity Strategy for 2030 and the Farm to Fork Strategy, the Nature Restoration Law, and the Deforestation and Forest Degradation Law (details in Section 3). Combined, these policies and regulations are having major consequences on research priorities and funding programmes, including the Horizon Europe Missions, and Work Programmes, among others. Again, this strongly supports the

view that the organisational structure adopted by BIOPOLIS-CIBIO should be flexible to quickly adapt to these and forthcoming research opportunities.

4) Together with the fast advances in the biological sciences and the expanding societal demands, during the past years there has been an increasing focus on the adoption of more interdisciplinary and even transdisciplinary approaches, which challenge the traditional distribution of research and researchers in rigid and largely self-contained units. For instance, research calls on Cluster 9 of Horizon Europe often demand the adoption of multi-actor approaches, and the incorporation of the Social Sciences and Humanities (SSH) in research projects focusing on the areas of food, bioeconomy, natural resources, agriculture and environment. All these trends call for a lighter and more flexible structure, with loose boundaries between organisational units, thereby facilitating communication and collaboration. This is becoming increasingly obvious in the case of BIOPOLIS-CIBIO research, with the establishment of intellectual links and collaborations across research groups and disciplines leading to particularly innovative, disruptive and impactful research. Within it, we have, for instance, research linking the social sciences, economy and ecology; ecology and genomics; archaeology, history and genomics; biodiversity and corporate management; architecture, landscape architecture and biodiversity; behaviour and artificial intelligence; electronic engineering and marine biology; and many others. Given this highly productive dynamics, locking research and researchers in very tight and disciplinarily oriented units, would be counterproductive and run against the global tendency to promote innovation through organisations with a grid or a matrix structure, rather than setting traditional hierarchies with well-defined and rigid units. The proposal in this Programme follows this idea for a matrix-type structure, as detailed in Section 6 (Tables 7 and 8). Within this approach we intend to promote creativity and collaborations across disciplines by involving each RG in several Research Lines of BIOPOLIS, rather than tightly assigning each group to a single and rigid unit with a strict disciplinary focus.

5) According to the DoA, the Mission of BIOPOLIS involves the advancement of biological understanding, and the use of this knowledge to address pressing societal challenges in the areas of environment, biodiversity and agriculture through the development of world-leading research. To accomplish this Mission, BIOPOLIS set out the Strategic Pillars, Research Lines and Key Research Activities identified in the DoA and in this Programme (Section 5), which have been pursued since the beginning of the Teaming project. Yet, an important component of CIBIO's activities also involve more fundamental research, which addresses questions without immediate practical application, but that has greatly contributed to its scientific success and impact over the past decade. Maintaining and expanding this component along the more applied research priorities is not only fundamental to the pursuit of BIOPOLIS' Mission to "*advance biological understanding from genes to ecosystems*", but it is also a potential source of innovation to address societal challenges. In fact, the most disruptive innovations and the solutions to societal problems often emerge from ideas generated in more fundamental research, and not necessarily from research targeted more narrowly at solving specific problems. Therefore, locking CIBIO's research and researchers in rigid RUs strictly focusing on problem-solving research would likely be detrimental to the objectives of BIOPOLIS in the long run, potentially

hindering the achievement of its long term mission. Considering this potential problem, the Programme described here has tried to bring together and even embed in each other the more fundamental and more applied components of BIOPOLIS researchers, thereby creating an intellectual environment with higher potential for producing innovation and disruptive ideas. Therefore, the research organisation proposed was designed to promote a culture that embraces intellectual curiosity to address both basic questions in the biological sciences, from genes to ecosystems, and problem-solving questions aligned with societal challenges.

6) The Strategic Research Programme proposed here has also incorporated some of the basic principles previously adopted by CIBIO, and that we believe are key for the success and sustainability of BIOPOLIS. Specifically, the Research Structure was designed to foster scientific freedom of all its researchers, and to promote a largely bottom-up approach in the definition of fields of enquiry, both of which are considered critical to stimulate scientific creativity, effectively addressing societal challenges, and promote innovation. This justifies the importance given in the Programme to RGs, which are intended to be small, flexible and dynamic, thereby increasing the capacity of the organisation to adjust to ever changing scientific, social, and economic realities, which is particularly important to deal with the underfunding, instability, and unpredictability of the Portuguese scientific system. Moreover, these RGs are expected to work across the Strategic Pillars and the Research Lines, promoting collaborations and cross-fertilisation, and thus contributing to develop new and disruptive ideas and innovation. This is clearly expressed in Table 8 of Section 6, where most groups are assigned to multiple Research Lines.

Although we believe that this new structure is the best at this stage of BIOPOLIS implementation to meet its Vision and Mission, we recognise that its performance should be duly tested, evaluated, and then further improved if needed. The mechanisms to undertake such revision are foreseen in the DoA, with T4.1 indicating that “The review process will include a formal SWOT analysis, and will consider the performance of the CoE, new scientific and technological demands, the demands of the industry and the society at large for new services and products, and the impact of research on sustainable development and the contribution to public policies. The review and update process will be carried out in collaboration with experienced researchers from UM, who will be invited to participate in this process”. In addition, and following the recommendations of the outside experts during the review meeting of the second reporting period, the revised strategy will also be submitted for appreciation of the International Advisory Board. Such reviews will be documented on Month 70 (revised deadline agreed with the PO), through Deliverable 4.2, and on Month 96, through Deliverable D4.3.

3. Context: challenges and opportunities

The Strategic Research Programme of BIOPOLIS for the next decade was designed to harness and enhance its scientific and innovation competences and skills, and its ability to engage the region and the country in a strategic growth path pointing to long-term opportunities for economic development while addressing multiple societal challenges. This programme builds heavily on the outline presented in the Teaming proposal, benefiting from inputs by a wide range of partners and stakeholders, from both the private (e.g., business corporations, NGOs) and public sectors (e.g., central regional and local entities of the public administration, State Laboratories, Universities). The Programme was also conceived considering how the current and forthcoming competences and skills can be used in the context of goals and priorities set out in international and national plans, strategies, and agendas; thereby maximising the impact of its research to address **scientific, sanitary, social, environmental, and economic challenges**. Moreover, the programme took the modern stance that each of these challenges cannot be taken in isolation. For instance, **environmental challenges** cannot be addressed if their social and economic underpinning are disregarded, while the **economic and social challenges** cannot be taken in isolation from **environmental challenges**. This is clearly demonstrated by the recent COVID pandemic, in which **environmental and sanitary challenges have been closely interconnected**, with both of which affecting and being affected by **economic and social challenges**, all driving **scientific challenges** that require fully integrated perspectives and approaches. Therefore, the Programme took an integrated and complementary perspective on these different but complementary challenges, rooted in outstanding topics that reflect priorities from global, through national, regional and local scales. Specifically, the strategy was developed considering the following outstanding topics:

i. At the global level, the Strategy was designed to maximise the impact on the **Sustainable Development Goals** of the United Nations[1]. To do this, the design considered the recommendations of the EU paper "The Role of Science, Technology and Innovation Policies to Foster the Implementation of the Sustainable Development Goals"[2], where the importance of biodiversity, ecosystems, and nature-based solutions in the context of STI policies is clearly recognised. Given its core competences, **the focus of BIOPOLIS will be primarily on SDGs more related to the Biosphere, which provides the critical underpinning that supports all other SDGs more related to Society and the Economy**[3]. Specifically, research at BIOPOLIS will strongly contribute to SDG 6 (Clean Water and Sanitation; mainly targets 6.5 and 6.6), SDG 13 (Climate Action; mainly targets 13.1, 13.2 and 13B), SDG 14 (Life under Water; mainly 14.1 to 14.5, and 14A and C) and SDG 15 (Life on Land; all targets).

ii. At the European level, the Strategy was designed considering multiple Strategies, Directives, and initiatives. First and foremost, the Strategy is highly aligned with the **European Green Deal**, and ensuing strategies such as the **EU 2030 Biodiversity Strategy** and the **Farm to Fork Strategy,** which will become cornerstones of economic development during the decade to 2030. These

[1] The Sustainable Development Agenda – United Nations Sustainable Development
[2] The role of science, technology and innovation policies to foster the implementation of the sustainable development goals (SDGs)
[3] Vertical Integration of UN SDG

strategies represent huge opportunities for BIOPOLIS's research and development, with the **potential for developing new tools, processes, services, and products strongly contributing to public policies**. This is clearly demonstrated by the estimates of annual spending at the EU level of €20 billion a year related to the implementation of the EU Biodiversity Strategy alone. Likewise, **the Farm to Fork strategy will create huge research and innovation opportunities**, related to the need to reduce dependency on pesticides and antimicrobials, reduce excess fertilisation, increase organic farming, improve animal health and welfare, increase food safety and security, and reverse biodiversity loss. In this context, BIOPOLIS is expected to have a drag effect in the economy and generate positive externalities, by contributing to create a cluster of innovative research centres, business partners, and skilled human resources that will be increasingly sought after during the next decade.

iii. The Strategy developed by BIOPOLIS considered the strategies and plans for **EU-Africa cooperation in science, technology and innovation**, as well as the historical links and external policy priorities of Portugal regarding Portuguese-speaking African countries. Africa and the EU share common objectives regarding the contributions of scientific and technological research and innovation to social and economic growth, which has led to the emergence of a High-Level Policy Dialogue (HLPD) on Science, Technology and Innovation (STI) in 2010, within the framework of the Joint Africa-EU Strategy (JAES). As a consequence, there have been growing efforts to promote joint research initiatives between the EU and Africa, as highlighted in the Commission's paper "Investing in European Success: EU-Africa cooperation in science, technology and innovation"[4], in the "Roadmap towards a jointly funded EU-Africa Research & Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture[5], and in the **prominence given to cooperation with Africa in the European Green Deal**[6]. These initiatives are very important at the national level, as shown for instance by the **priority given to Africa by the Portuguese presidency of the EU**[7]. BIOPOLIS is in a privileged position to strongly contribute to these initiatives, given the **network of TwinLabs with institutions from African countries and the award of the UNESCO Chair Life on Land** established by CIBIO. Therefore, BIOPOLIS will facilitate the engagement of researchers and other stakeholders in Portugal with collaborative research towards sustainable development in Africa, particularly in Portuguese-speaking countries. This cooperation will involve the **development of innovations that can contribute to reducing poverty, the empowerment of women, and the fixation and generational renewal of populations through creative and more sustainable use of natural resources, and more efficient, productive, and profitable food production systems**. This will involve local (African) capacity building, including the advanced training of researchers, which will be engaged in the advanced training programmes organized by BIOPOLIS.

[4] Investing in European success - EU-Africa cooperation in science, technology and innovation | Horizon 2020
[5] Roadmap towards a jointly funded EU-Africa Research & Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture
[6] European Green Deal Call: €1 billion investment to boost the green and digital transition
[7] África será prioridade da presidência portuguesa da União Europeia

iv. The recent sanitary and economic crisis caused by COVID-19 pandemic further highlighted the responsibility of scientific institutions to address issues related to a fast and steady **recovery and consolidation of the Portuguese economy**. Therefore, the Strategy was delineated considering the guidelines and priorities set out in the "**Visão Estratégica para o Plano de Recuperação Económica de Portugal 2020-2030**"[8], and the "**Plano de Recuperação e Resiliência de Portugal**"[9] submitted by the Portuguese Government to the European Commission (PRR). This is particularly relevant because the Strategic Vision gives strong relevance to themes that are at the core of BIOPOLIS's competences, with biodiversity and ecosystems, in particular the marine, forest and agricultural ecosystems, being considered critical for the resilience of the economic systems, and a source of opportunities of economic development. For instance, it is recognised that one of the critical pillars of the Recovery Plan is the energetic transition and the decarbonisation of the economy, and the alignment with the **Green Deal for Europe**, The National Plan for Energy and Climate 2030, the Roadmap for Carbon Neutrality 2050, and the **National Strategy for the Conservation of Nature and Biodiversity 2030**. Moreover, the objectives set out by the Strategic Vision include the **qualification of the population** and the **digital transition** (Objective 2), the promotion of territorial cohesion through **programs oriented to the preservation of biodiversity, the valorisation of the natural capital, and the transformation of the landscape** (Objective 8), which are at the core of BIOPOLIS's activities. Likewise, the research planned at BIOPOLIS will greatly contribute to Objective 9, particularly regarding the **development of more green and sustainable cities**. These objectives have in turn a direct relation with the dimensions of PRR regarding **Resilience,** namely the components of **Forests** (8) and **Water management** (9), and **Climate Transition**, namely the **Sea** (10) and **Sustainable Bioeconomy** (12), but also contributing to several other components across dimensions.

v. The Strategy was designed to guarantee **alignment and synergy with the Portuguese smart specialization strategies, at National (ENEI) and Regional levels (RIS3)**. The Strategy is particularly aligned with ENEI, which specifically focuses on strategies that promote economic growth based on knowledge and innovation, without disregarding sustainability comprising the development of a green economy, which responds to the issue of climatic changes. The Strategy specifically addresses three thematic axes of ENEI and many of its established subdomains and Priority themes (PDs). At the national level, the Strategy has a particularly relevant contribution for Thematic Axis IV (**Natural Resources and Environment**) and will impact positively on all 3 out of 4 of its PDs: **Agro-Food, Forests, and Water and Environment**. It will also contribute with research topics regarding sustainability and environmental (bio)monitoring under the Thematic Axis I – Transversal technologies and their Applications, and Thematic Axis II – Industries and Technologies of Production, as well as Thematic Axis V – Health, Well-being and Territory, with regard to its contribution to the Tourism and Habitats PDs. Regarding RIS3, research was aligned with the convergence region "Norte", where the BIOPOLIS headquarters is located. The Strategic

[8] Visão Estratégica para o Plano de Recuperação Económica de Portugal 2020-2030
[9] Plano de Recuperação e Resiliência de Portugal

Plan addresses the RIS3 of this region, being strongly aligned with Axis I – **Research, technological development, and innovation**, and is suited to answer 2 of its 8 Specialization Domains (SDs): most strongly **Food and Agro-Environmental Systems**, but also the SD for **Advanced Production Systems**.

vi. Finally, the Research Strategy of BIOPOLIS is aligned and can contribute strongly for a number of strategies and agendas recently established at national level, with implications for a wide range of **scientific, sanitary, social, environmental and economic challenges**. These strategies and agendas are transversal to multiple sectors of society that can benefit from research at BIOPOLIS, of which we highlight the following:

   a. **National Plan of Science and Technology and its Thematic Agendas of Research and Innovation**[10]. Research at BIOPOLIS is strongly aligned with the Agendas for research and innovation produced by FCT. In particular, the **Agenda on Agrifood, Forests and Biodiversity** is at the core of BIOPOLIS research and innovation, with some of its researchers having contributed to the preparation of the Agenda. Research at BIOPOLIS is relevant to address most priority axis of this Agenda, not only regarding the biodiversity component, but also contributing strongly to the Agrifood and Forests components. BIOPOLIS research strategy also addresses themes related to other Thematic Agendas, namely **Climatic Change**, **Urban Science and Cities for the Future**, and the **Sea**.

   b. **National Strategy for the Conservation of Nature and Biodiversity 2030**[11]**.** This strategy is at the core of BIOPOLIS's research, contributing strongly to its three main pillars: **improve the conservation status of the natural heritage**; **promote recognition of the value of the natural heritage**; **and promote the appropriation of the natural heritage and biodiversity by society**. These pillars are connected to all thematic lines of BIOPOLIS, contributing for instance, to enhance the knowledge of our natural heritage, ecosystems and biodiversity; contribute to understand the value of ecosystem services and promote their ecological intensification; provide innovative solutions to recover endangered species and restore ecosystems; develop new and more cost-effective systems of monitoring; develop tools and approaches for the management of protected areas and sites of the Natura 2000 network; among multiple other aspects. The alignment with the priorities set in the strategy is facilitated by a protocol of collaboration between BIOPOLIS and ICNF established in 2014, by multiple joint initiatives linking BIOPOLIS, ICNF and other regional and local partners, and by a strong collaborative network with research institutions at national and international levels.

   c. **Strategy of Territorial Cohesion**[12]. A number of BIOPOLIS's research lines and activities are relevant for this Strategy, contributing markedly to the **valorisation of endogenous resources** and **increase the knowledge and scientific capacity of hinterland territories**. This

[10] FCT | Thematic Agendas of Research and Innovation
[11] Resolução do Conselho de Ministros 55/2018, 2018-05-07
[12] Estratégia para a Coesão Territorial - XXII Governo

includes research targeted at increasing the competitiveness and sustainability of farming systems, the harnessing of agrobiodiversity to create new products, the management of forest landscapes to reduce fire hazard, and the management of wildlife and ecosystems to enhance ecotourism, among others. Moreover, BIOPOLIS already has and it will reinforce a range of **partnerships with institutions from hinterland territories** (e.g., local government agents and NGOs), promoting the development of joint projects and knowledge transfer. Flagship projects include, for instance, the recently created **Biological Station of Mértola**[13,14], a partnership involving a range of local and regional actors and already funded by CCDR-Alentejo with over 2 M€, and the **establishment of a long term research site in the Sabor valley**[15], in collaboration with UTAD and IPB.

d. **Technological and Business Innovation Strategy 2018-2030[16].** BIOPOLIS is closely aligned with this strategy designed by Agência de Inovação (ANI), which is the main reference for innovation policy for the next decade in Portugal. Specifically, the design of BIOPOLIS's research strategy is aligned with its crucial assumptions, namely concerning strategic vectors as the **increase in entrepreneurship rates**; v**alorisation and transfer of technology**; **internationalization**; boosting the **application of European structural and investment funds**; reinforcement of **interface sectors**; and **promotion of innovation**. This is illustrated by the close partnerships and collaborative projects involving a range of both large companies and SMEs, the outstanding capacity to attract funding from H2020, and the high visibility and high networking capacity of BIOPOLIS at the international level.

e. **Agenda for the Innovation of Agriculture 2020-2030**[17]. BIOPOLIS's strategy is relevant for a number of axis defined in the Agenda, with **a particular emphasis on Axis I.2 (Promotion of animal and plant health)**, **Axis II.1 (Combating climate change)**, **Axis II.2 (Valorization and sustainable management of natural and genetic resources)**, and **Axis IV.1 (Dynamization of the national network of research in agriculture).** This is achieved through a number of research lines and activities targeted at enhancing the sustainability of food production systems, mainly, but not only, through those planned under Strategic Pillar 3. Research by BIOPOLIS contributes to evaluate **impacts and dependencies in relation to biodiversity and ecosystem services** (including, e.g., natural pest control, soil fertility), and by contributing to **develop farming systems more resilient to climate change and other natural hazards**. Moreover, research will contribute to develop new products and to improve quality and production, particularly by using less explored autochthonous animal and plant resources. The tapping of the local agrobiodiversity holds a strong potential to diversify food production, promote environment friendly agricultural processes that will underpin the economic development of rural areas. This will perfectly match the just-approved **Farm to**

[13] CIBIO-BIOPOLIS lidera projeto pioneiro em Mértola
[14] Mértola dá a conhecer Estação Biológica – Canal Alentejo
[15] Baixo Sabor LTER - Portugal
[16] Resolução do Conselho de Ministros 25/2018, 2018-03-08
[17] Resolução do Conselho de Ministros n.º 86/2020

Fork strategy that combines social, economic, and environmental approaches for the achievement of a sustainable agriculture in the EU. The contribution of BIOPOLIS to this Agenda is supported by a network of collaborations with a number of national and international partners, with a particularly close relationship with INIAV, given the proximity of its reference laboratories in Vairão.

f. **Action Plan for Digital Transition[18].** The scientific expertise and technical competences of BIOPOLIS can contribute to this Plan, which is facilitated by its coordination of the e-Infrastructure PORBIOTA[19]. The contribution of BIOPOLIS is particularly relevant for the **digital transition in the planning and management of natural resources, biodiversity and ecosystem (including urban, agricultural and forest production systems)**. This area of research is important to harness the opportunities created by technological advances to increase **information flows from field monitoring to end users** (e.g., public administration, business corporations, citizens), and to **develop tools and processes for streamlining the use of this information to take planning and management decisions** by the private sector and the public administration. In this way, BIOPOLIS has the potential to contribute to all pillars of this Action Plan, from the capacitation and digital inclusion of people (Pillar I), through the digital transformation of the business fabric (Pillar 2), to the digitalization of the public administration (Pillar 3).

[18] Resolução do Conselho de Ministros n.º 30/2020
[19] PORBIOTA: Home

4. Background: Research organisation at CIBIO

The research organisation inherited from CIBIO is a key factor that has been accounted for when planning the organisational structure of research at BIOPOLIS. The research organisation at CIBIO was devised to promote a culture that embraces intellectual curiosity to address both basic questions in the biological sciences, from genes to ecosystems, and problem-solving questions aligned with societal challenges. The organisation has evolved over the years to accommodate the increasing number of researchers and the expanding breath of their scientific interests. However, it has always maintained some basic principles, including the (i) scientific freedom of all its researchers, (ii) a largely bottom-up approach in the definition of fields on enquiry, (iii) a wide scientific scope, to stimulate interdisciplinarity and cross-fertilisation between fields that are traditionally disconnected, and (iv) a light structure designed to avoid excessive administrative and organisational burdens to researchers and to stimulate scientific creativity. More recently, the structure has evolved to privilege small Research Groups (RG) led by a Principal Group Leader (GL), often a relatively young but promising researcher, which are the basic organisational units of the institution. These RGs are intended to be flexible and dynamic, increasing the capacity of the organisation to adjust to ever changing scientific, social, and economic realities, which is particularly important to deal with the underfunding, instability, and unpredictability of the Portuguese scientific system.

In its latest format before the beginning of the Teaming project, the research organisation of CIBIO was described in the 2017-2018 evaluation of research units by an external international panel commissioned by the Portuguese Science and Technology Foundation, obtaining an overall quality grade of Excellent and a score of 15 out of 15. Briefly, the research strategy was established by its Directive Board (DB), with the assistance of the Executive Council (EC) and consultation with the Scientific Council (SC). The implementation of this strategy has been coordinated by the Principal Investigator (PI) of each Thematic Line (TL) in close collaboration with the GLs of all RGs. To streamline this implementation model, CIBIO established three TLs, which together provide a comprehensive coverage of its scientific scope and objectives: (i) Evolution, Genetics & Genomics; (ii) Biodiversity, Ecology & Conservation; and (iii) Sustainability, Ecosystems & the Environment. Altogether, these three TLs were composed by 34 RGs, each headed by a Group Leader (GL) with considerable scientific autonomy. In coordination with the PIs of the TLs, the GL assure the alignment and promote the implementation of research and outreach activities by group members. In particular, the GLs are responsible to coordinate with the group members new project applications, selection and supervision of MSc and PhD students, the organisation of journal clubs and internal seminars, networking with international collaborators, and collaboration with other RGs, while promoting the participation in the general activities and initiatives of CIBIO. In the following sections we describe the rationale, objectives, and research groups of each Thematic Line.

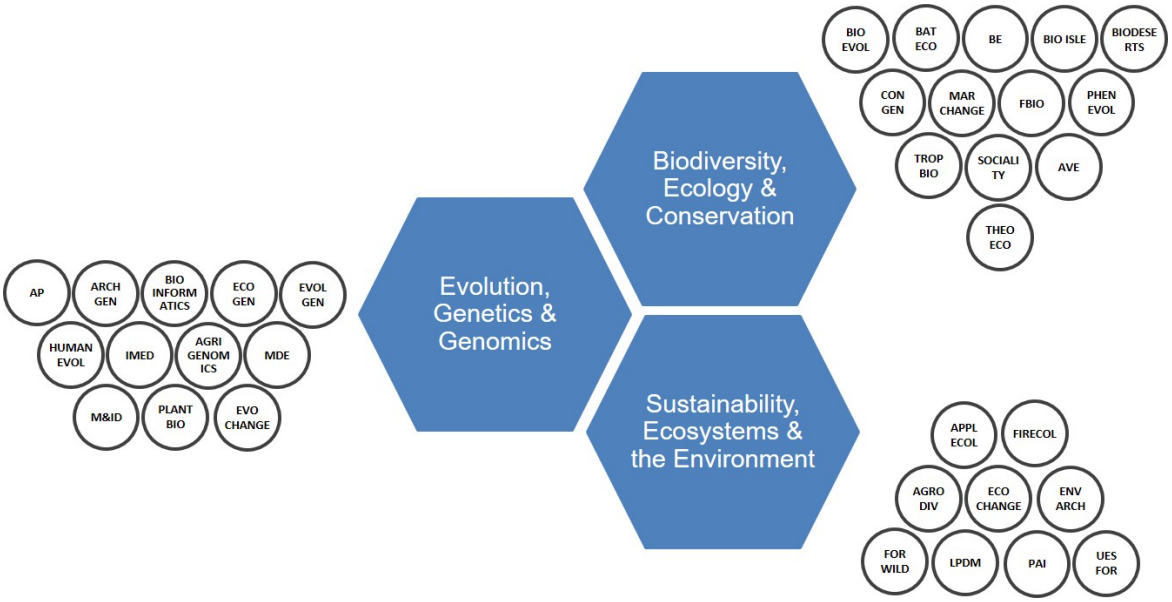

Figure 1. Organisation in three Thematic Lines and 34 Research Groups adopted by CIBIO in 2018.

4.1. Thematic Line 1 – Evolution, Genetics and Genomics

Rationale: Evolutionary processes are on the basis of the generation of the immense biological diversity, establishing a tight relationship between genetic variation, species and the interaction between organisms. Evolution underlies biogeographic patterns, the formation of new species and hybridization, adaptation, domestication, and co-evolution, and determines the adaptive potential of natural populations facing habitat change, and the basis of traits driven by artificial selection. We address these topics in a wide range of model systems, including our own species and a multitude of animals, plants, and microbes, using information from genes to whole genomes, historical to modern DNA, morphology to physiology, and applying cutting-edge analytical tools, with emphasis on bioinformatics, population genetics and genomics, phylogenetics, and statistical modelling.

Objectives:

i. *Diversity* – Describing and inferring evolutionary processes generating patterns of genetic diversity, as structure, migration and demographic fluctuations; inferring phylogenetic relationships among species; map cultural and biological traits on the evolutionary history.

ii. *Speciation and hybridization* - Understanding the genomics of speciation, and the role of neutral and selective processes on hybridization from natural and human-mediated processes.

iii. *Adaptation* – Studying the genomic basis of population uniqueness and local adaptation, the evolution of adaptive phenotypes, and the evolutionary potential facing rapid habitat change.

iv. *Domestication* – Infer the historical, demographic and selective processes underlying domestication, and the genomic basis of selected traits.

v. *Host and Parasite Evolution* – Studying evolution of hosts, microbes and their co-evolution, and the genetic basis of resistance to diseases with impacts on natural and domestic populations.

vi. *Bioinformatics* – Developing tools to analyse large DNA sequence dataset, in particular from next-generation sequencing.

Research groups contributing to the Thematic Line:

1. Applied Phylogenetics (AP)
2. Archaeogenetics (ARCHGEN)
3. Bioinformatics (BIOINFORMATICS)
4. Ecological Genomics (ECOGEN)
5. Evolutionary Genetics and Genomics (EVOLGEN)
6. Genomics of Evolutionary Change (EVOCHANGE)
7. Human Evolutionary Genetics (HUMANEVOL)
8. Immunogenetics, microbes and infectious diseases (IMID)
9. Livestock Genomics and Diversity (AGRIGENOMICS)
10. Microbiology and Infectious Diseases (M&ID)
11. Microbial Diversity and Evolution (MDE)
12. Phenotypic Evolution (PhenEvol)
13. Plant Biology (PLANTBIO)

4.2. Thematic Line 2 - Biodiversity, Ecology & Conservation

Rationale: Over 500 years after the discoveries of the 15th century started acquainting Europeans with the astounding diversity of the living world, describing and understanding the diversity of life on Earth remain key challenges in the life sciences. Addressing such challenges is currently more important than ever, as biodiversity is being eroded at a rate only comparable to the mass extinctions in geological time, while steep declines in population abundances is hindering the functional role of many species. We tackle these topics in a wide range of geographical and ecological settings, using a combination of observational, experimental, and modelling approaches to document and model spatial and temporal biodiversity patterns, to assess mechanisms driving species persistence and diversity from local communities to the global scale, and to inform biodiversity conservation strategies.

Objectives:

i. *Biodiversity exploration and discovery* – To document biodiversity patterns in least explored regions and taxonomic groups, focusing strongly in islands, deserts and arid regions of the Sahara-Sahel, and tropical regions, with a particular interest in Portuguese-speaking African countries in the context of CIBIO's TwinLab initiative.

ii. *Behavioural diversity* – To document and understand behaviour as a key component of biodiversity that affects species responses to environmental change, and to investigate how behaviour contributes for the long term species persistence in the face of such changes.

iii. *Movement ecology* – To document, understand and model how animals move, and what are the consequence of such movements for species persistence in the marine and terrestrial realms, particularly under human exploitation and global environmental change.

iv. *Population monitoring and management* – To develop new tools for population monitoring based on advances in genetics, genomics and non-invasive sampling, and contributing to understand the drivers of population fluctuations and persistence towards their sustainable management.

v. *Functional biodiversity* – To understand the functional role of the elements composing biodiversity (from genes to landscapes), in particular the importance of genetic and species diversity for ecosystem function and services.

vi. *Conservation biogeography* – To use biogeographical approaches to address problems related to biodiversity conservation, namely for the prioritization of conservation areas, design of ecological corridors, and definition of conservation strategies in relation to global climate and land use changes.

vii. *Knowledge and technology transfer* - fostering for instance the commercial development of new biosensors, the provision of services related to non-invasive population monitoring, and the application of new information in biodiversity conservation.

Research groups contributing to the Thematic Line:

1. Avian Ecology (AVE)
2. Bat Ecology (BatEco)
3. Behavioural Ecology (BE)
4. Biodiversity of Deserts and Arid Regions (BIODESERTS)
5. Biodiversity and Islands (BIOISLE)
6. Conservation genetics (CONGEN)

7. Ecology and Evolution of Aquatic Organisms (AGE)
8. Functional Biodiversity (FBIO)
9. Systematics, Biogeography and Conservation of Madagascar herpetofauna (SBC)
10. Animal Sociality (SOCIALITY)
11. Theoretical Ecology and Biodiversity Modelling (THEOECO)
12. Tropical Biology (TROPBIO)

4.3. Thematic Line 3 - Sustainability, Ecosystems & Environment

Rationale: Earth's life support systems are under increasing pressure due to the fast-growing human population and the mounting consumption of resources. Human actions have become the main driver of global environmental change, with many recognizing a new era in the history of the Planet since the Industrial Revolution, the Anthropocene. This era has witnessed environmental contamination, the overconsumption of natural resources, climate change, loss of biodiversity, and the degradation of ecosystems and their services. To face these challenges, researchers need to better understand how human actions interact with natural processes to affect ecosystems and the environment at large, and to find practical solutions to promote the sustainable use of the natural world and natural resources. We take a socio-ecological perspective promoting tight interaction between natural and social scientists, and use approaches spanning from history and archaeology, to remote sensing and metagenomics.

Objectives:

i. *Environmental history* – To understand the long history of human interactions with the environment, how they shaped the economic, social, cultural and biological diversity of our ancestors, and what have been their consequences to the current state of ecological systems.

ii. *Biological invasions* – To understand the mechanisms of species invasions, from trade networks to species traits, and the effects of invaders on biodiversity and ecosystems, thus contributing to prevent invasions and optimizing the management of novel ecosystems.

iii. *Management of production ecosystems* - To understand the interplay of socioeconomic and ecological processes in agricultural and forest production systems, developing new policies and management strategies to improve their sustainability and resilience to stressors such as climate change and wildfires.

iv. *Ecosystem services* – To develop cost-effective tools for measuring, mapping and valuing ecosystem services, to understand the role of biodiversity for ecosystem service delivery, including plant-animal interactions, and to develop guidelines for enhancing ecosystem services in natural, rural and urban landscapes.

v. *Impact assessment and mitigation* – To develop new approaches to improve the assessment of impacts and enhance the cost-effectiveness of mitigation actions, particularly related to the building and operation of large infrastructures such as roads, railways, power lines and dams.

vi. *Landscape planning and management* – To develop new approaches and tools for enhancing the contribution of natural and cultural landscapes to improve human lives and livelihoods, while preserving biodiversity and ecosystem services.

vii. *Knowledge transfer* – The problem solving research of this TL involves collaborations with a range of stakeholders, from NGOs and municipalities, to public organisms and private corporations.

Research groups contributing to the Thematic Line:

1. Applied Population and Community Ecology (ApplEcol)
2. Biodiversity in Agricultural and Forest Ecosystems (AGRODIV)
3. Environmental Archaeology (ENVARCH)
4. Fire Ecology (FirEcol)
5. Forest and Wildlife Ecology and Management (ForWild)
6. Landscape Planning, Design and Management (LPDM)
7. Plant-animal interactions (PAI)
8. Predicting and Managing Ecological Change (ECOCHANGE)
9. Urban ecology and social forestry (UESFOR)

5. Strategic Pillars of BIOPOLIS

Three strategic pillars have been defined in the Teaming proposal and incorporated in the Grant Agreement (Section 1.3.4; Pages 14-17; revised Annex 1 – Description of Action [Part B]). They were designed to meet the Vision, Mission, and Objectives of BIOPOLIS, considering the scientific and technical skills and capacities of CIBIO at the time of proposal's preparation (Section 3), but also accounting for extant and future challenges and opportunities, and the growth potential leveraged by the resources obtained through the Teaming project. Therefore, the BIOPOLIS Strategic Research Programme was structured in three Strategic Pillars, each of which developed through two main research lines (Fig. 2). These lines were selected considering the results of a SWOT analysis, the expertise and competence of the partner institutions, the inputs of stakeholders, the EU and national strategic documents, the opportunities and potential impacts of research and innovation results, and the overarching goal of supporting the public administration and other end users to address scientific, sanitary, social, environmental and economic challenges.

Figure 1: Summary organization and content of the Strategic Research Programme of BIOPOLIS presented in the Teaming proposal.

5.1. Strategic Pillar 1 - Ecological Assessment & Monitoring

Where we are

One of the key limitations regarding the effectiveness of EU and national policies for the conservation and sustainable use of biodiversity and ecosystems is the lack of cost-effective tools and methods for ecological assessment and monitoring, which are essential to evaluate the current health of the systems, to measure the impacts of anthropogenic activities (including climate change and land use changes), to understand the effectiveness of public policies and management actions at multiple spatial and temporal scales, and to predict future changes under different socioeconomic scenarios. This is particularly troublesome given the responsibilities of Portugal to conserve its rich and unique natural heritage, as clearly demonstrated by the large proportion of the country protected under the Natura 2000 network (22% in continental Portugal). Moreover, there are fast transformations in the Portuguese territory that require close monitoring of changes in natural and production systems. In the one hand, there is a strong trend for the intensification of agricultural and forest production in some regions (e.g., expansion of intensive and super-intensive olive orchards, intensification of horticultural production, eucalyptus plantation), including in protected areas, which requires a continuous assessment to help designing solutions to mitigate impacts on the environment. On the other hand, vast parts of the Portuguese territory are suffering the consequences of the rural exodus and land abandonment occurring since the last decades of the 20th century, particularly in more mountainous areas. This is causing the recovery of native forests and the expansion of shrublands, with potential positive consequences on biodiversity through rewilding[20], but which at the same time are important drivers of the tragic wildfires occurring during the last decade. In such a context, the gathering of accurate data, with enough temporal and spatial resolutions, is essential to public authorities and decision makers, to design new environmental management programmes or redefine new policies and regulations. Besides this, innovative tools are also essential to provide guidance to a vast number of SMEs and few large corporations, which develop their economic activities in close connection with the territory (e.g., forest and agrifood sectors, (Eco)tourism, energy and transport infrastructures). Its success depends on their fast adaptation to the new and changing EU policies on biodiversity and the environment.

Where we go

Most of the methods and tools widely used in ecological assessment and monitoring do not take full advantage of recent technological developments. More, some of the concepts and approaches do not account for the possibility of obtaining detailed and, sometimes, near real time data, that just a decade ago were impossible to consider. Important technological developments that can be mainstreamed into ecological assessment and monitoring include, for instance, non-invasive molecular methods for species and individual level identification of endangered, exploited and invasive species, eDNA-based

[20] Rewilding Europe | Greater Côa Valley

techniques couple with next-generation sequencing for the ecological monitoring of ecosystems and large scale biodiversity assessments, bio-logging to collect data on animal behaviour and their surrounding environment, and new generation of satellites proving ever more detailed platforms of ecosystem observation from space, artificial intelligence to recover biodiversity data from photography and internet sources, drones equipped with a wide range of sensors, among many others. BIOPOLIS possesses all the capacities to cover this technological lagging and incorporate new engineering and technological solutions that reduce the cost and increase the effectiveness of strategies, tools and methodologies, for the study of biodiversity on all levels, from genes to ecosystems, the assessment and monitoring of species and ecosystems, minimisation of environmental impacts, and management of biological populations for conservation and sustainable use. By doing this, BIOPOLIS will contribute, in the medium-long term, to territorial cohesion, to better planned and managed natural and production landscapes, and a more sustainable use of natural resources. This in turn can create business opportunities by SMEs providing cutting edge technologies for ecological assessment and monitoring, to increase the sustainability and thus the added value of agricultural and forest products, to reduce the conflicts between nature protection and local communities, to provide real time information on the state of ecosystems to evaluate and reduce fire hazard, and overall to the increased capacities of public authorities to develop a science-based administration of the Portuguese territory. This will also contribute to the increasing awareness by the society on biodiversity and environment, and it will promote the mobilization of the society to be active data collectors and monitors of environmental changes. Ultimately, this will lead to a substantial increase of well-being and quality of life of the populations.

Research Lines and activities

Research Line 1: Developing new methods and tools for assessing and monitoring biological diversity at multiple levels in terrestrial and aquatic ecosystems.

Key Research Activities (RA)

RA1.1. **Developing cost-effective tools for monitoring biodiversity, based on non-invasive approaches - environmental DNA, non-invasive sampling, machine-based real-time sample collectors** - capable of performing in all different environments – air, soil, water.

RA1.2. **Using 2D and 3D imaging acquisition for vegetation and habitat mapping** using unmanned aerial systems (drones) photogrammetry and remote sensing, including image acquisition and automatic processing using Artificial Intelligence approaches.

RA1.3. **Combining engineering and technological solutions to mitigate the impact of energy and transportation infrastructures** such as roads, railways, airports, wind farms, hydroelectric dams, and power lines, including visual and acoustic deterrents, bird and bat collision mitigation devices, fish ladders and elevators, wildlife passages, among others.

RA1.4. **Developing of bio-logging technologies to take measurements from free-ranging animals**, thereby **enhancing the quality and cost-effectiveness of data acquisition** on animal position,

movements, physiology, and behaviour, based on the strengthening and expansion of ongoing initiatives such as MoveTech Telemetry[21]. This will contribute both to increase basic knowledge on animal ecology and the assessment of anthropogenic impacts on species ecology and behaviour.

RA1.5. **Developing new approaches to promote community-based environmental monitoring and information systems**, building for instance on innovative and novel Earth observation applications embedded in portable or mobile personal devices, thereby **engaging citizens in the collection and analysis of data**, and **enhancing their scientific literacy**.

RA1.6. **Developing cost-effective techniques and approaches for monitoring population trends of threatened species, trends in area and conservation status of habitats listed in EU conservation directives, and trends on drivers of biodiversity loss,** to monitor and evaluate the impact of biodiversity conservation policies at European and national levels.

RA1.7. **Developing cost-effective omics-based techniques and approaches for monitoring the soil ecosystems** and to develop new measuring models to quantify the role of the soil as an ecosystem service, such as **waste decomposition, water filtration system, and degradation environmental contaminants**.

Research Line 2: Promote fundamental research on biological diversity in terrestrial and aquatic ecosystems, at multiple levels, and the impact of global climate change and anthropogenic disturbances.

Key Research Activities (RA)

RA2.1. **Developing new approaches to mobilize, organize and disseminate biodiversity data** at the level of genes, species, and ecosystems, providing a **critical baseline for innovation in environment, ecosystem**, **and landscape research**.

RA2.2. **Developing computational methods for the modelling and simulation of ecological and socio-ecological systems**, including for instance species range dynamics, population and metapopulation dynamics, animal movements, landscape dynamics, ecosystem metabolism, and socio-ecological interactions and dynamics.

RA2.3. **Developing Virtual Research Environments** (Virtual Laboratories & Decision-support Applications), where specific issues related with **biodiversity and ecosystem preservation and sustainable use are addressed in-silico**, combining big data resources from multiple research projects, governmental agencies, private corporations, and non-governmental associations.

RA2.4. **Characterize and understand the evolutionary processes underlying current distributions of biodiversity,** resulting from both long-term natural geo-climatic cycles and rapid anthropogenic change, to guide conservation strategies and policies.

[21] MoveTech Telemetry

RA2.5. **Use functional genomics approaches to identify the genetic basis of selected traits in locally adapted natural populations,** building a basic understanding of biodiversity richness and resilience to environmental change, and promoting conservation of genetic uniqueness and local ecosystem services.

RA2.6. Understand the **resilience of natural populations to diseases affecting their conservation and sustainable use,** by characterizing and boosting natural resistance mechanisms.

RA2.7. Understand how **anthropogenic impacts affect wildlife diseases and the spread of diseases from wildlife to humans and domestic animals.**

RA2.8. Improve the current understanding on the biological diversity of the poorly known **soil ecosystems and understanding on the interactions between living and non-living matter, and its role in natural ecological cycles** (carbon, nitrogen, oxygen, water, and nutrients), that have been used by human societies since the beginning of agriculture**.**

Timeline

The Research Activities in this Strategic Pillar will be developed largely in parallel and throughout the entire period considered in the present proposal. However, it is expected that peaks in outputs and achievements will vary depending on the levels of maturity and scientific and technological readiness, according to the timeline indicated in Table 1.

Table 1. Summary of the timeline for developing the main Research Activities (RAs) foreseen under BIOPOLIS Strategic pillar 1 - Ecological Assessment and Monitoring**.** For each RA, the Table indicates the planned start of research projects and the production of outputs, following the beginning of the BIOPOLIS project (September 2019).

Research Activity (RA)	Short-term (< 2022)	Medium-term (2023-2025)	Long-term (2025-2030)
RA1.1	•		
RA1.2	•		
RA1.3		•	
RA1.4		•	
RA1.5	•		
RA1.6	•		
RA1.7		•	
RA2.1	•		
RA2.2		•	

Research Activity (RA)	Short-term (< 2022)	Medium-term (2023-2025)	Long-term (2025-2030)
RA2.3			●
RA2.4		●	
RA2.5		●	
RA2.6		●	
RA2.7		●	
RA2.8		●	

Responses to societal challenges

Research Activities in this strategic pillar contribute to address a number of scientific, sanitary, social, environmental and economic challenges, by for instance promoting the application of cutting-edge techniques and technologies to tackle scientific frontier areas, improve the early detection of emerging pathogens of plants, animals and humans, enhance the cost-effectiveness of environmental monitoring, contribute to the creation of highly qualified employment, and provide tools and approaches for increasing the environmental sustainability of economic activities. A summary of the links between key research activities and societal challenges is provided in Table 2.

Table 2. Summary of the main societal challenges addressed by each Research Activity (RA) foreseen under BIOPOLIS Strategic pillar 1 - Ecological Assessment and Monitoring**.**

Research Activity (RA)	Scientific	Sanitary	Social	Environmental	Economic
RA1.1	●	●	●	●	●
RA1.2	●			●	●
RA1.3	●		●	●	●
RA1.4	●			●	
RA1.5	●	●	●	●	
RA1.6	●			●	
RA1.7	●			●	●
RA2.1	●		●	●	●
RA2.2	●			●	
RA2.3	●			●	
RA2.4	●			●	
RA2.5	●	●		●	●
RA2.6	●	●	●	●	●
RA2.7	●	●	●	●	●
RA2.8	●			●	●

5.2. Strategic pillar 2 – Ecosystem Function, Services & Restoration

Where we are

Ecosystems are net providers of a broad variety of commodities (products and services) that have been used by human societies since the dawn of its existence. Thus, a correct identification of the diversity and distribution patterns of the species commonly harvested by humans, and the management of the natural landscape are important for the endless regeneration of the ecosystems and its valorisation. Forests within the agricultural systems are known to be essential providers of multiple ecosystems services throughout Europe. Annually, the Portuguese forests and meadows provide high-quality food resources that need to be sustainably used and valued. For instance, Non-Wood Forest Products (NWFPs) such as mushrooms, honey, chestnuts, cork, pine nuts and berries are important from an economic and social perspective, but the impact of this harvest for the natural species, respective ecosystems and local economy is poorly known. Portugal also possesses a peculiar forest that is mainly constituted by cork oaks (*Quercus suber*) which covers approximately 8% of the total area and constitutes 28% of its forests, and grows best in central and southern parts of the country, creating a very singular landscape. This forest produces approximately half the cork harvested annually in the world and exports over recent years have accounted for about 62.9% of world trade. But oak forests of southern Portugal (*a.k.a*. montado) offer much more than the cork. They offer an active barrier to prevent desertification and form a unique habitat in the Iberian Peninsula that is the refuge of many endangered and emblematic species and, the oak acorns are used to feed the famous Iberian black pigs that are used to produce a similarly famous type of ham (pata-negra). Finally, Portugal offers very favourable conditions for agro- and eco-tourism: considerable biodiversity, contrasting landscapes, plentiful historical sites and mild weather all year long. While tourism represents a tremendous opportunity, the sustainability of the touristic activities depends on a good management of the landscape and its interplay with the agroforestry activities and coastal environments. There is a tremendous lack of information on the forest harvested species and of the impact of harvesting on the ecosystem's health and resilience. Also, the correct management of the oak forest ecosystem is a pressing issue that urges to be addressed, particularly, when global climate changing poses a real threat to the Portuguese autochthonous forests with the increase of water scarcity and the arrival of new pathogens.

Where we go

In the scope of this strategic pillar, BIOPOLIS will contribute to understand and manage complex socio-ecological systems, using comprehensive and systemic approaches to sustain and potentially intensify the delivery of ecosystem services in natural and human-dominated landscapes. We propose to develop innovative approaches which consider both urban and rural landscapes, to conceive and implement, in conjunction with stakeholders, nature-based solutions which combine nature conservation goals with the goals of innovation for the sustainable economic growth of the forest and agricultural sectors. Given its importance in the European Green Deal and the EU Biodiversity Strategy

for 2030, a particular attention will be given to **nature-based solutions**[22] that can be turned into business opportunities[23] for adapting to and mitigating climate change, reducing environmental risks (e.g., floods, landslides, soil degradation and erosion), greening cities, and managing coastal zones and water resources, among other applications[24]. The approaches taken in this Strategic pillar will combine genomic and functional data with landscape and socio-ecological information, to assess the health and impact on the genetic diversity and distribution of the harvested species. This will contribute to obtain a better management of the resources and set traceability tests to protect and regulate the economic activities based on the ecosystem services. Finally, the gathered biological information on soil, forest species and landscapes will also be used to build or transform urban green zones in more natural and biodiverse areas that replicate the native ecosystems and offer solutions for problems such insulation of city arteries, noise control and reduce recurrent flooding areas. This strategic pillar will thus greatly contribute to addressing societal challenges such as climate change, the reduction of wildfire risks and the greening of cities, while contributing to align the goals of biodiversity and ecosystem service conservation with the goals of innovation for growth and job creation.

Research Lines and activities

Research Line 3: Ecosystem services and nature-based solutions to address environmental challenges and enhance the conservation and sustainable use of ecosystems and their services.

Key Research Activities

RA3.1. Developing new strategies, tools and techniques for ecosystem restoration using nature-based solutions, in articulation with stakeholders, thereby **improving the resilience of ecosystems,** enabling them **to deliver vital services** and to meet other societal challenges**,** including **reductions in the risk of sanitary emergencies caused by the outbreak of both unknown and known zoonotic agents**.

RA3.2. Developing new strategies, tools and techniques for **climate change adaptation and mitigation using nature-based solutions** that can provide more resilient responses and enhance carbon sequestration and reduce carbon emissions associated with wildfires.

RA3.3. Developing nature-based solutions for **improving risk management and resilience, and increasing the insurance value of ecosystems**, exploring their potential to deliver greater benefits than conventional methods and **offering synergies in reducing multiple risks** such as floods, landslides, coastal erosion, wildfires, and desertification.

RA3.4. Developing nature-based solutions for **multi-functional watershed management and the sustainable use of water resources**, including water provisioning and purification, regulation of water flows, enhance biodiversity, improve the ecological status of freshwater systems.

[22] Nature-based solutions
[23] Financing and Business Models
[24] CEM work on nature-based solutions

RA3.5. Developing **nature-based solutions for the sustainable use of the soil**, including restoration, management, and monitoring of the soil biodiversity dynamics, to improve fertility and prevent desertification and erosion.

RA3.6. Developing **cost-effective genomic tests for population diversity monitoring of the regularly harvested natural populations of wildlife species**, microbiological characterization/monitoring of the soils, and simultaneously help protecting and regulating the market of nature harvested products.

RA3.7. Developing techniques to foster **green infrastructure in cities, through nature-based solutions** that can **stimulate economic growth as well as improving the environment, human well-being, and urban biodiversity**.

RA3.8. Developing **database and visualization approaches for species interactions**, from mutualistic (e.g., pollination, symbiosis) to antagonistic (e.g., predation parasitism), establishing a streamlined pipeline of information from conventional field studies and DNA metabarcoding analysis to the research community and the general public.

Research Line 4: Promote fundamental and holistic research on natural and production ecosystems and their restoration.

RA4.1. Strengthening basic research on the role of the microbiome on ecosystem function and services, such as respiration of soil microorganism to C sources in micro-scale and leguminous rhizobia to nitrification, measurement and cataloguing of the microbiome diversity across ecosystems, and importance to ecosystem restoration and resilience.

RA4.2. Application of Remote Sensing and GIS to investigate the structure and function of ecosystems over a range of spatial scales**, and to model and predict their capacity to sustain biodiversity and deliver ecosystem services**.

RA4.3. Develop uniform standards **of valuing ecosystem services to enhance credibility of evaluation.**

RA4.4. Establishing long-term orientation research of ecosystems to provide a scientific basis for sustainable management of forest ecosystem services and the establishment of a GDP accounting system (Green GDP) in Portugal.

Timeline

The Research Activities in this strategic pillar will be developed largely in parallel and throughout the entire period considered in the present proposal. However, it is expected that peaks in outputs and achievements will vary depending on the levels of maturity and scientific and technological readiness, according to the timeline indicated in Table 3.

Table 3. Summary of the timeline for developing the main Research Activities (RAs) foreseen under BIOPOLIS Strategic pillar 2 - Ecosystem Function, Services & Restoration**.** For each RA, the Table indicates the planned start of research projects and the production of outputs, following the beginning of the BIOPOLIS project.

Research Activity (RA)	Short-term (< 2022)	Medium-term (2023-2025)	Long-term (2025-2030)
RA3.1	●		
RA3.2	●		
RA3.3	●		
RA3.4		●	
RA3.4		●	
RA3.6		●	
RA3.7			●
RA3.8	●		●
RA4.1	●		
RA4.2	●		
RA4.3		●	
RA4.4		●	

Responses to key societal challenges

Research Activities in this strategic pillar contribute to address key scientific, sanitary, social, environmental and economic challenges, by for instance increasing the scientific understanding on the mechanisms driving ecosystem structure, function and services, improving the techniques for ecosystem restoration, designing realistic solutions to create rural landscapes resilient to fire, developing nature-based solutions to mitigate climate change, promoting green cities with higher biodiversity and quality of life, among other aspects. A summary of the links between key research activities and societal challenges is provided in Table 4.

Table 4. Summary of the main societal challenges addressed by each Research Activity (RA) foreseen under BIOPOLIS Strategic pillar 1 – Ecosystem Function, Services and Restoration**.**

Research Activity (RA)	Scientific	Sanitary	Social	Environmental	Economic
RA3.1	●	●	●	●	●
RA3.2	●		●	●	●
RA3.3	●		●	●	●
RA3.4	●		●	●	●
RA3.5	●		●	●	●
RA3.6	●			●	●
RA3.7	●		●	●	●
RA3.8	●			●	
RA4.1	●			●	●
RA4.2	●			●	
RA4.3	●		●	●	●
RA4.4	●			●	●

5.3. Strategic pillar 3 - Agrobiodiversity and Sustainable Food Systems

Where we are

Over the past two decades, agriculture has had a steady loss of importance in the country's economy. Despite the favourable edafo-climatic conditions for agriculture offered by a significant portion of the territory, the sector faces major socio-economic challenges. For instance, Portugal is heavily exposed to the impacts of climate change, which are enlarging the time periods without rain, increasing average temperature, increasing the probability of climatic extremes, and making inappropriate many of the agricultural varieties and practices still widely used. At the same time, there have been large scale transformations in agricultural land uses, with the loss of farming systems that were more environmentally sustainable but also less productive and requiring more human power, and the expansion in some areas of more productive systems that require low human power and have strongly negative ecological impacts (e.g., highly intensive monocultures of olive, exotic fruits, vegetables, berries). These changes, together with the low attractiveness of the new generations to rural regions, have precluded the fixation and generational renewal necessary for the territory cohesion and economic development. Nonetheless, recent years have witnessed an upward trend in the food sector, mostly propelled by the excellent organoleptic qualities of the agricultural product and competitive prices, which are creating new opportunities to renew the sector. The wine, traditional types of olive oil, tomato, berries, almonds, and pears are now starting to contribute to agricultural exportations. Indeed, Portugal possesses a vast number of local varieties (e.g., grapes, almonds, pears, olives) of celebrated quality, which allied to a favouring climate and soils dictates its uniqueness in the world markets (e.g., tomato, almonds, aromatic herbs). Also the livestock products are among the most exported, particularly lamb, pork, ham and charcuterie, and milk and cheese. Yet, Portugal needs innovative solutions, not only to boost agricultural production, without losing its agrobiodiversity and the typicity of its agrosystems, but also to fixate the young and better educated generations in the hinterland. A good indicator that the Portuguese agriculture sector lacks innovation, comes from the fact that most of its agricultural exports result from highly intensive production systems (e.g., olive trees, greenhouse vegetables and berries) that are not based on locally adapted varieties, sustainable at mid- to long-term, do not require skilled human-resources, and ultimately will result in the significant degradation of the soil and water systems. A significant lack of knowledge about the advantages of the autochthonous agricultural varieties that are well adapted to local environments, provides no alternative other than to invest in a few highly selected and resource-demanding varieties that increases the vulnerability to unpredictable climate conditions, and pests and pathogens (e.g., *Xylella fastidiosa*). In summary, the Portuguese agriculture needs young and skilled human resources and innovation profiting from the new Agron-Omics scientific field, to move towards more effective and sustainable food production systems, which can be tailored to meet the needs of stakeholders and the new challenges of the EU **Farm to Fork Strategy**.

Where we go

BIOPOLIS will use "omics" information to guide the agri-food sector stakeholders to tap on the potential of local agrobiodiversity in a way to foster sustainable and resilient production systems in changing environments. This includes information on the biodiversity underpinning ecological services on farmland (e.g., soil fertility, pollination, pest control), which can be used to promote more sustainable food production systems, and the design and implementation of policies such as the Common Agricultural Policy and the Farm to Fork Strategy of the European Union. The collection of genomic and functional information from local adapted agricultural varieties and microbiomes of the traditional fermented agricultural products (e.g., wine, cheese, honey, butter, bread, regional charcuterie) will be the basis of a new strategy to protect traditional high-quality agricultural products (PDO and PGI labels)[25], and to improve traditional crop varieties without losing resilience and thus help to create new business opportunities in rural regions. The combination of new methodologies and technological advances will permit to identify genomic regions responsible for productive and resilience traits, that will guide the breeding programmes in wine grape, olives, and tomato varieties. Genomic information will also be used to identify genomic regions responsible for economic important traits and resilience of local livestock breeds, namely regarding climate change. An innovative breeding programme will use genomic breeding values to improve Portuguese livestock species – cattle, sheep, goat, pig - without losing their resilience and the organoleptic characteristics of their meat and dairy products. Also, cost-effective monitoring methods and tools based on omics will be developed to guide the sustainable management of soil and water resources, thereby preventing soil erosion, and water pollution and waste. By doing this, BIOPOLIS will provide a range of outputs to the agri-food sector, and thus actively contribute for a more innovative and competitive agricultural sector, that certainly will contribute to its revival. The positive impacts on the agricultural sector will be fostered through a strong engagement with the largest State Laboratory in agriculture (INIAV), farmer and producers' associations, and business corporations, among others.

Research Lines and activities

Research Line 5: Agroecology and Food Production Sustainability. Understanding ecological and socio-ecological processes in agricultural ecosystems to protect biodiversity and ecosystem services, and to enhance the sustainability of food production systems.

Key Research Activities

RA5.1. Characterizing the **soil microbiome biodiversity and its role in the improvement of sustainable production**, soil restoration and resilience.

[25] European policy for quality agricultural products - Publications Office of the EU

RA5.2. Adapting and validating novel strategies, tools and technologies to **assess, protect and restore soil biodiversity to improve fertility and sustainable production**, aiming to minimise the use of chemical fertilizers and reducing environmental impacts of farming,

RA5.3. Understanding and mainstreaming the use of local beneficial microorganisms (yeast, fungi, bacteria) which are responsible **for the organoleptic characteristics of process food** (cheese, honey, yogurt, olive oil, vinegar) and drinks (wine, beer, milk beverages, fruit juices) and **are high prized by the biotechnological and pharmaceutical industry**.

RA5.4. Improve the understanding of links between management and biodiversity patterns and processes using for instance novel developments in metabarcoding, metagenomics and transcriptomics.

RA5.5. Developing cost-effective techniques and approaches for evaluating the effectiveness of agricultural policies in protecting biodiversity, including the changes brought about by changes in the Common Agricultural Policy, and their mechanisms such as Greening, Agri-environment and Climate schemes.

Research Line 6: Agron-Omics. Promote the use of omics-based technologies to assess the architecture of domestication, incorporate genomic data to foster diversity and resilience of plant and livestock varieties, and enhance the added-value of regional varieties and the traceability of agricultural products.

Key Research Activities

RA6.1. Understanding the genomic process of domestication, and identifying the genetic basis of selected functional traits, in particular those involved in the resilience of populations to a changing environment**.**

RA6.2. Gathering of genome-wide information of local genetic resources to identify variants (SNPs) related with environmental resilience and productivity and incorporate this information in breeding programs.

RA6.3. Applying and mainstreaming of **genomic tools and technologies to improve the breeding of domesticated species** for improved resilience and efficiency, with a particular focus to **assessing and exploiting the potential of underutilized genetic resources** (e.g., traditional landraces).

RA6.4. Developing new –omics approaches to **improve the prevention, early detection, and control of plant and animal pathogens**, particularly those involving vector-borne diseases with strong environmental drivers and transmission pathways between wild and domestic species.

RA6.5. Gathering of genomic and functional information on microorganisms (yeast, fungi, bacteria) which are responsible **for the organoleptic characteristics of processed food** (cheese, honey, yogurt, olive oil, vinegar) and drinks (wine, beer, milk beverages, fruit juices), and soils.

RA6.6. Developing DNA tailor-made tests to implement a bidirectional "Farm to Fork to Farm" traceability system, to assure the consumers and protect labelled protected food products can be traced back to the animal, plant, or the farm in which it has grown.

Timeline

The Research Activities in this strategic pillar will be developed largely in parallel and throughout the entire period considered in the present proposal. However, it is expected that peaks in outputs and achievements will vary depending on the levels of maturity and scientific and technological readiness, according to the timeline indicated in Table 5.

Table 5. Summary of the timeline for developing the main Research Activities (RAs) foreseen under BIOPOLIS Strategic pillar 3 - Agrobiodiversity and Sustainable Food Systems**.** For each RA, the Table indicates the planned start of research projects and the production of outputs, following the beginning of the BIOPOLIS project (September 2019).

Research Activity (RA)	Short-term (< 2022)	Medium-term (2023-2025)	Long-term (2025-2030)
RA5.1	●		
RA5.2	●		
RA5.3	●		
RA5.4		●	
RA5.5		●	
RA6.1	●		
RA6.2	●		
RA6.3		●	
RA6.4		●	
RA6.5		●	
RA6.6			●

Responses to key societal challenges

Research Activities in this strategic pillar contribute to address key societal challenges, by for instance enhancing our understanding of the relations between soil productivity, ecosystem health and agricultural productivity, improve the design, implementation and monitoring of agricultural policies promoting the sustainability of farming systems, enhance the traceability of agricultural products from farm to fork (to farm), improve the detection and prevention of plant and animal pathogens, harness the power of agrobiodiversity to enhance economic competitiveness of extensive farming systems, among other aspects. A summary of the links between key research activities and societal challenges is provided in Table 6.

Table 6. Summary of the main societal challenges addressed by each Research Activity (RA) foreseen under BIOPOLIS Strategic pillar 3 - Agrobiodiversity and Sustainable Food Systems**.**

Research Activity (RA)	Scientific	Sanitary	Social	Environmental	Economic
RA5.1	●			●	●
RA5.2	●			●	●
RA5.3	●				●
RA5.4	●			●	
RA5.5	●		●	●	
RA6.1	●				●
RA6.2	●				●
RA6.3	●				●
RA6.4	●	●	●	●	●
RA6.5	●				●
RA6.6	●	●	●	●	●

6. Organizational Structure of BIOPOLIS Research

The statutory governing bodies involved in the organisational structure of BIOPOLIS research, and their competences, objectives, and responsibilities, are legally defined by the by-laws of the BIOPOLIS Association. The current version of the by-laws was approved in the General Assembly (GA) of BIOPOLIS, on May 17th, 2024. These by-laws and regulations largely integrate the organisational structure of BIOPOLIS research provided in the Description of Action of the Teaming project, with modifications previously discussed with the PO, and that were required to align them with Portuguse law, namely minimum requirements established under Article 23.º a) of DL no. 63/2019, of 16th May. The organisation model also builds on the new challenges and opportunities faced by BIOPOLIS, on the experience of CIBIO's research during the past decade, and the inputs from researchers and stakeholders, as detailed in Section 2. Below, we describe the main bodies involved in the governance and operation of BIOPOLIS research activities.

6.1. Board of Directors and Executive Committee

The Board of Directors (BoD) is established by the by-laws of the Association as the top management body, and is composed of three to five members, including the President of the BoD. One of the members of the BoD is responsible for the component of research and innovation. The Executive Committee is composed by a subset of the members of the BoD, which are in charge of overseeing the daily implementation of BIOPOLIS strategies and management. Regarding the component of research, these bodies have the ultimate responsibility to define the strategic orientations of the Association, and to decide on and oversee the implementation of staff recruitment, including researchers and support technicians, the construction and rehabilitation of infrastructures, the purchase of equipment, the close liaison with the University of Montpellier and its linked third parties, the promotion of institutional relations with other research organisations and stakeholders at national and international levels, the monitoring of scientific performance and quality control, among other duties and responsibilities. Overall, they are in charge of defining the general orientation of BIOPOLIS research, in close alignment with the Strategic Pillars and priority Research Lines of the Teaming project, and to create the conditions for researchers developing excellent research and innovation activities. These bodies are under the close scrutiny of the SB and ultimately the GA, and they work in close collaboration with the Science Council (6.2), the International Advisory Board (6.3), and the researchers (6.4 and 6.5).

6.2. Science Council and Coordinating Committee of the SC

According to revised by-laws (Articles 22 and 23), the Science Council (SC) is an advisory body of the Association, which is chaired by the President of the BoD. The SC is composed by all researchers holding a doctoral degree, including those employed directly by BIOPOLIS and those employed by other institutions but formally affiliated with CIBIO. Given the large number of SC members, the revised by-laws created a Coordinating Committee of the SC (CCSC). This Committee is also chaired by the

President of the BoD and includes as its members all group leaders from BIOPOLIS-CIBIO Research Groups. The mandate of the members of the CCSC is two years, renewable for equal periods. The competences of the CCSC includes a) Approving its internal regulations, as well as the internal regulations of the Scientific Council; b) Reviewing the budget, the plan, and the annual activity report of the Association, and assisting with related tasks whenever requested by the Board; c) Issuing any opinions requested by the Board or deemed appropriate by the Committee.

6.3. International Advisory Board

The revised by-laws establish the International Advisory Board (IAB) as a consultative body of the Association (Articles 24 and 25), composed of experts and individuals external to the Association, appointed by the President of the Board or the Executive Committee and designated by the Supervisory Board, taking into account their recognized scientific competence and suitability in the areas of activity of the Association. Whenever possible, the individuals designated will carry out their activities in foreign institutions, but the participation of individuals of recognized merit working in national institutions is not excluded. The term of office of the IAB is five years, and its members may be reappointed more than once.

The International Advisory Board is responsible for: a) Providing opinions on the scientific orientation and operation of the Association; b) Evaluating and issuing opinions on the quality of the Association's programs and research projects; c) Issuing opinions they deem appropriate, particularly regarding the activity plan and report; d) Providing opinions on other matters submitted to them by other bodies of the Association; e) Proposing to the General and Supervisory Council, the Board, the Executive Committee, or the Scientific Council the initiatives they consider appropriate; f) Electing its President; g) Exercising the competences attributed to them by law and the Board.

The IAB is composed of two commissions: the International Advisory Board - Science (IABS) and the International Advisory Board – Business (IABB). Each Board has five to ten members, one of which is the chair. At present the members of the IABS are Peggy Oti-Boateng, Maria Manuel Mota, Craig Moritz, Jeremy Searle, Scott Edwards and Luigi Boitani. The present members of the IABB are Tatiana Kourotchkina, Rosalia Vargas, Paul Symington, Claudia Azevedo, Rombout Swanborn, João Nuno Palma and Fernando Freire de Sousa.

6.4. Thematic Lines

The BIOPOLIS research structure involves three Thematic Lines (TLs), representing an adjustment and renaming of the six Research Units initially foreseen, but remaining well within the flexibility allowed by the DoA (details in Section 2). These TLs are similar to those adopted at CIBIO since 2018 (Section 4), covering adequately the breadth of research themes addressed by BIOPOLIS-CIBIO, and reflecting the interests and research questions addressed by its researchers. Moreover, the three TLs adequately cover, and actually crosscut, the Strategic Pillars and priority Research Lines defined in the Teaming project (Table 7).

Table 7. Allocation of the Research Lines (RL) of BIOPOLIS across the three thematic lines (TL) inherited from CIBIO's organisational structure. Each TL is linked with a primary RL (dark grey) and secondary (light grey) RLs.

		TL1. Evolution, Genetics & Genomics	TL2. Biodiversity, Ecology & Conservation	TL3. Sustainability, Ecosystems & the Environment
SP1. Ecological Assessment and Monitoring	RL1. Assessing and monitoring biological diversity.			
	RL2. Biological diversity and its conservation.			
SP2. Ecosystem Function, Services and Restoration	RL3. Ecosystem services and nature-based solutions.			
	RL4. Ecosystem research and restoration.			
SP3. Agrobiodiversity and Sustainable Food Systems	RL5. Agroecology and Food Production Sustainability.			
	RL6. Agron-Omics.			

Each TL will have two speakers, which will be elected for a period of three years. The election will be made within the Group Leaders (GL) of all Research Groups (RGs) of each TL. All GLs of a TL can be elected and can vote for the speakers of the corresponding TL. The election is made online through secret vote, in a process organised by the IT Unit in articulation with the BoD of BIOPOLIS. To be elected, a speaker needs to receive votes from the absolute majority of RGs from the corresponding TL. The election process will be repeated with the candidates receiving most votes, until the absolute majority of votes for the two candidates per TL is achieved. The first election process was conducted between 20/06/2024 and 04/07/2024, requiring one to three rounds of voting, depending on the TL, to achieve the absolute majority for all speakers. The speakers elected are the following: TL1 – Raquel Godinho and José Melo Ferreira; TL2 – José Carlos Brito and Nuno Queiroz; TL3 – Joana Vicente and Clara Grilo. The speakers will provide a link between the RGs and the BoD and other governing bodies of BIOPOLIS. They will also promote the implementation of the BIOPOLIS research priorities and working programme. They will foster scientific collaborations and other joint initiatives between RGs within the TL, but also across TLs, thereby improving cross-fertilisation and interdisciplinary work. Speakers will participate in the review meetings of BIOPOLIS, where they will report on the progress of research.

6.5. Research Groups

The Research Groups (RG) are the basic structural units of CIBIO-BIOPOLIS research organisation, following the practice of CIBIO, and reflecting the strong commitment to privilege bottom-up approaches and to support the intellectual freedom of researchers. Each RG is coordinated by a Group Leader (GL), often with the help of a deputy GL. Typically, the research groups are relatively small (5-

15 senior researchers and post-docs, plus PhD students), but they can be larger or smaller depending on their research objectives, fund raising capacity, among other factors. Individual researchers are free to join RGs that best match their main research interests, with each researcher being associated with a primary RG but having the possibility to collaborate and participate in the activities of other RGs.

The RGs have a strong level of autonomy. The activities of each RG are under the responsibility of the GL (and deputy GL, in larger groups), in close articulation with the other members. These can include the organisation of journal clubs and internal workshops, the definition of the internal research objectives and strategy, the application to external calls for funding, and the proposal of courses and workshops to be organised at BIOPOLIS level, among others. The RGs report annually on their activity to the BoD and the SC, and the information thus provided is used centrally to produce the annual research reports to funding agencies (e.g., the Portuguese Science and Technology Foundation, FCT).

At the outset of the BIOPOLIS Teaming project there were the 34 Research Groups listed in Section 3. Following the flexibility and dynamism of groups, as well as the need to progressively reinforce the alignment of research with the Strategic Pillars of BIOPOLIS, during the first two years there was the creation of some groups, and the splitting and merging of others, resulting at present in a total of 41 groups (Table 8). The groups are distributed across the three Thematic Lines, and together they adequately cover the six Research Lines of BIOPOLIS, as indicated in Table 8. Each group covers from two to five RLs, depending on their size, specialisation, interdisciplinarity and integration of research (e.g., groups interested in biodiversity monitoring conservation, often address also questions related to ecosystem restoration and sustainable food production systems).

Table 8. Research groups of CIBIO-BIOPOLIS and their relation to Thematic Lines and Research Lines of BIOPOLIS (https://cibio.up.pt/en/groups/).

Group Name	Group Leader	TL1	TL2	TL3	RL1	RL2	RL3	RL4	RL5	RL6
SOCIALITY - Animal Sociality	Rita Covas	1				X				
AP . Applied Phylogenetics	James Harris	1			X	X				
AquaGenPhy – Aquatic Genetics and Physiology	Ana Veríssimo	1				X				
AGRIGENOMICS - Domestic Species Genomics for Food Security and Sustainability	Albano Beja Pereira	1							X	X
COMPBIO – Computational Biology	Nuno Fonseca	1			X	X				X
ECOGEN – Ecological Genomics	Raquel Godinho	1			X	X				X
EVOLGEN - Evolutionary Genetics and Genomics	Miguel Carneiro	1				X				X
EVOCHANGE - Genomics of Evolutionary Change	José Melo Ferreira	1				X				X
HUMANEVOL - Evolutionary Perspectives on Human Genetic and Cultural Diversity	Anne Maria Feh	1			X					X

Group Name	Group Leader	TL1	TL2	TL3	RL1	RL2	RL3	RL4	RL5	RL6
IMED - Immunity and emerging diseases	Pedro Esteves	1			X	X				X
PLANTBIO - Plant Biology	Herlander Azevedo	1							X	X
PlantEvol - Plant Evolution	Raquel Tavares	1								
PlantN - Plant Nitrogen	Helena Carvalho	1							X	X
SEAGEN - Seascape Genomics & Speciation	Rui Faria	1			X	X				
AngBIO - Angolan Biology	Pedro Vaz Pinto		2		X	X	X	X		
BE - Behavioural Ecology	Paulo Gama Mota		2		X	X				
BEPE - Biogeography and Evolution of Plants and Ecosystems	Carlos Vila Viçosa		2		X	X	X	X		
BIOISLE - Biodiversity & Islands	Ana Cristina Costa		2		X	X	X	X		
BIODESERTS - Biodiversity of Deserts & Arid Regions	José Carlos Brito		2		X	X				
BIOEVOL - Biogeography & Evolution	Angelica Crottini		2		X	X				
CONGEN - Conservation Genetics and Wildlife Management	Paulo Célio Alves		2		X	X	X	X		
FBIO - Functional Biodiversity	Miguel Carretero		2		X	X				
MOVE - Movement Ecology	Nuno Queiroz		2		X	X				
NATHIST - Natural History, Collections and Taxonomy	Luís Ceríaco		2		X	X				
PopECo - Population Ecology and Conservation	Inês Catry		2		X	X			X	
RAINFORESTS - Ecology and Conservation of Tropical Rainforests	Luke Powell		2		X	X		X		
THEOECO Theoretical Ecology and Biodiversity Modelling	Henrique Pereira		2		X	X	X	X		
TRACE - Ecological monitoring and conservation	João Paulo Silva		2		X	X		X	X	
WILDEcol - Wildlife Conservation Ecology	Pedro Monterroso		2		X	X		X		
ApplEcol - Applied Population and Community Ecology	Pedro Beja			3	X	X	X	X	X	
AGRODIV - Biodiversity in Agricultural and Forest Ecosystems	Francisco Moreira			3	X	X	X	X	X	
COASTALWARMING - Marine Ecology, Diversity and Change	Fernando Pádua Lima			3	X	X	X	X		
ECOCHANGE - Predicting and Managing Ecological Change	João Honrado			3	X	X	X	X	X	
ECOINFRA – Infrastructure Ecology	Clara Grilo			3	X	X	X	X		
ENVARCH - Environmental Archaeology	João Tereso			3		X		X		

Group Name	Group Leader	TL1	TL2	TL3	RL1	RL2	RL3	RL4	RL5	RL6
FRESHCODE - FRESHwater COnservation, Diversity and Evolution	Manuel Lopes-Lima			3	X	X		X		
GlobalECO - Global Ecological Challenges under Socio-Environmental Change	Luís Reino			3	X	X		X	X	
INVASIONS - Invasion Science	Joana Vicente			3		X	X	X	X	
LPDM - Landscape Planning, Design and Management	Claudia Fernandes			3			X	X		
ROCKinBIO - Ecology for the conservation of Cultural Heritage	Joana Marques			3		X	X	X		
SES&ES - SocioEconomic Systems and Earth Systems	Paulo Azevedo			3		X	X	X	X	

New RGs can be created through the initiative of the BoD or the SC, in articulation with the IAB-Science, aiming to fill in gaps in particularly important and/or emerging research themes that meet the objectives of the research strategy. For this, a given researcher is invited to form a new group focusing on a given research topic, and asked to provide the objectives, strategy, and members of the group. Once approved, the new RGs are formally created and start to feature in BIOPOLIS-CIBIO web site. Specific groups can be created in case of new recruitments of senior researchers. The process of group creation can also be bottom-up, with researchers feeling prepared to lead a group making a proposal to the BoD and SC. The application also involves information on the name, objectives strategy and members of the group. If approved the RG is formally created.

7. Implementation

The implementation of the Strategic Research Programme is at the core of BIOPOLIS activity, and involves multiple components related to governance and organisational aspects, administration and finances, infrastructures and equipment, recruitment and management of human resources, communication, dissemination and exploitation of research results, data management, among others. These components have been considered in specific strategies developed to optimise the performance of BIOPOLIS activities and impact and will not be covered here. Instead, we provide in this Strategy a selection of aspects that are critical to achieve research excellence, despite some overlap with strategies provided in other deliverables.

7.1. Recruitment Strategy

The research community of CIBIO-BIOPOLIS is composed at present by a total of 184 researchers (154.1 FTE; as of 31-12-2021) at different career levels, most of which have contracts that were transferred from ICETA to BIOPOLIS, as planned in the work programme and already reported to the EC, while others have been contracted already by the BIOPOLIS Association. Together, these researchers cover a wide range of applied and fundamental research themes, including the Research Lines and Activities described in Section 5. Notwithstanding, additional researchers are needed to reinforce BIOPOLIS workforce, and to consolidate and expand its capacity to implement the Strategic Research Programme, and to support public policies and address societal challenges. In this context, BIOPOLIS will strategically invest in recruiting new researchers in cross-cutting and emergent areas, which will strengthen the research lines already developed by the TLs and RGs, opening new and promising avenues of research, and promoting much needed transdisciplinarity and cross-fertilization leading to innovation. To complement the extant workforce, the idea is to reinforce the priority areas by contracting at least one Coordinator or Principal researcher (1 FTE) for each Thematic Line, and one or two Assistant or Junior researchers (1 or 2 FTE) for each priority area identified, until the end of 2023. The priority areas to be covered by the recruitment of new researchers have been identified and are listed below:

TL1. Evolution, Genetics & Genomics

i. Bioinformatics and Computational Biology – These researchers will contribute to on-going research lines and to develop new tools approaches for ecological monitoring, the analysis of ecosystem patterns, function, and services, and to harness the power of agrobiodiversity to increase the economic and environmental sustainability of food production systems. Strengthening the research potential in these areas is essential given the vast amounts of data generated by the genomic platform of BIOPOLIS, the increasing importance of genomics in biological research, and the increased use of metagenomics and metabarcoding in environmental monitoring and management. These researchers are also essential to develop computational modelling applicable in areas from evolutionary biology to genomics.

ii. Functional genomics - Researchers in this area will strengthen the capacity of different groups working to describe gene (and protein) functions and interactions on a global (genome-wide) scale, and to explore their implications in fields such as evolutionary biology, plant biology and agrigenomics, among others. Although researchers of BIOPOLIS have already produced important contributions in this field, including high-profile papers recently published in Science, PNAS and Current Biology, it is expected that these new researchers will contribute to consolidate and further expand this promising field.

iii. Plant Biology – CIBIO is currently a mainly animal-focused research centre with only a few research group working mostly on plants. However, Biopolis research programme (in particular research pillar #3) includes substantial research and innovation activities on plants. This implies that plant research at CIBIO should grow. Being able to go from the agrosystem to the genes will be crucial to characterize agrobiodiversity using omics approaches and to identify genes underlying important agronomical traits. This implies consolidating expertise in plant functional biology (including plant genome editing) and plant genomics among others. Targeted plants will be important plant models and crops, in particular crops of strategic importance for Portugal (see pillar #3).

iv. Ecological genomics and metagenomics - Researchers in this emerging field will contribute to bridge the current gap between genetic studies in the laboratory, largely focused on understanding basic cellular and developmental processes, with systems-level analyses of genetic adaptations and interactions between organisms in their natural setting. This will contribute to understanding the genetic mechanisms underlying responses of organisms to their natural environments, and the underlying genetic basis of ecologically relevant phenotypic variation. This in turn will provide much needed inform for the conservation of biodiversity, soil conservation and sustainable management, agrobiodiversity, among many others.

TL2. Biodiversity, Ecology & Conservation

v. Biologging - This broad field involves researchers that use animal-attached electronic devices to study aquatic, terrestrial and aerial species, and their habitats. The new researchers will contribute to expand this important area of research, by developing, testing and implementing real-world applications of bio-loggers. They are also expected to contribute to considerable successes already achieved in terms of knowledge and technology transfer, through the start-ups ELECTRICBLUE and MoveTech. These researchers will also be key to develop insights into the mitigation and adaptation of ecological systems to climate change.

vi. Tropical biology – These researchers will strengthen the work made in association with TwinLabs in Portuguese-speaking African countries and elsewhere, and to support research under the UNESCO Chair Life on Land. We expect to complement in-house expertise, by attracting researchers in themes such as tropical biodiversity assessment and next-generation biomonitoring; conservation and sustainable use of tropical wildlife populations; and biodiversity

services in tropical production ecosystems under global change. These researchers will help advance the contribution of BIIOPOLIS to the Sustainable Development Goals at the global scale.

TL3. Sustainability, Ecosystems & the Environment

vii. Nature-based solutions - Researchers in this important new field will contribute to develop nature-based-solutions to mitigate and adapt to climate change, to create more sustainable urban areas, and to reduce the impact of environmental hazards, among many other applications. These researchers will also be critical to access European and national funding that will be increasingly available in the next few years, consolidating a line of research with multiple implications to address key societal challenges.

viii. Ecological restoration - These researchers will consolidate the capacity of BIOPOLIS to address research questions and applications in ecological restoration, including for instance rewilding and post-fire ecosystem restoration. At the outset of the United Nations Decade on Ecosystem Restoration, this is a promising and important field of research that will greatly contribute to the Green Deal for Europe and the European Biodiversity Strategy 2030. This is also a research area that will greatly contribute for BIOPOLIS accessing international funding, as calls under the Green Deal will fund multimillion projects in this field.

ix. Sustainability and social-ecological research - These researchers will help bridging the gap between natural and social scientists, thereby building capacities to engage in complex projects related to the themes of sustainability, ecosystems and the environment. They should promote transdisciplinary perspectives, enforcing the views that research towards the conservation and sustainable use of biodiversity and ecosystem systems needs to be intertwined with the study of social and economic systems and their relations to the environment. They will also contribute to increase links with public entities dealing with biodiversity and ecosystem services.

These initial priority themes for recruitment should be considered flexible, as they need to be adjusted to ever changing challenges and opportunities. This revision will be made by the SC and the BoD, in articulation with the RGs and the TLs. Funding for recruitment will come from the Teaming BIOPOLIS project and the national complementary funds, as well as funding from FCT, private corporations, and other sources.

7.2. Attracting and retaining talented researchers

Attracting and retaining talented researchers in priority area (Section 6.1), both in Portugal and worldwide, is one of the key objectives of BIOPOLIS, which aims to establish a top performing and highly creative scientific workforce, while contributing to reversing the problems associated with “brain drain”. To achieve these goals, BIOPOLIS has put together a robust strategy and will develop several actions, which will be further improved and reinforced during the next decade. Briefly, the strategy involves the following aspects:

i. Enhance capacity to obtain large international projects, with high visibility and resources, that can be attractive for top level researchers. This component will build on the successes achieved in the past five years, with the award of two ERA Chairs (EnvMetaGen and TROPIBIO), with an overall budget of nearly 5 M€, and the Teaming project (BIOPOLIS), with an overall budget of 15 M€, which are specifically targeted at building capacity and attracting talent to Portugal.

ii. Implement open, fair and transparent recruitment procedures for all research positions. BIOPOLIS has adopted recruitment procedures aligned with the Charter for Researchers & Code of Conduct for the Recruitment of Researchers, following open, transparent and merit-based recruitment. These processes aim to provide fair opportunities to all researchers wanting to apply to a position, thereby ensuring that the best person for the position is chosen. These procedures are established to avoid biases towards in-house researchers, thereby enhancing the ability to attract the best researchers wherever they are based.

iii. Provide competitive salaries and side benefits to top level researchers. Salaries in Portugal are generally not competitive for top-level, international researchers. This limits the researchers that can be attracted to Portuguese institutions and causes a brain drain of talented Portuguese researchers that find much better living conditions elsewhere. Therefore, BIOPOLIS is setting a human resource strategy that involves competitive salaries and side benefits, as described in the Human Resource Strategic Plan (Deliverable 2.1). These salaries are supported by European and private funds, and so they can go beyond the current practice in Portugal.

iv. Create a welcoming and attractive working atmosphere. Policies to increase quality of life at work will also be designed and implemented. To attract and retain international researchers, the working language at BIOPOLIS is English, which permits overcoming language obstacles. Moreover, the integration of international researchers is supported by dedicated officers, who provide help with bureaucratic, administrative, and logistic difficulties facing international researchers moving to Portugal (tax administration, social security, housing, schools).

v. Offer excellent conditions to develop research. Top level, international researchers only consider moving to a Portuguese institution if they feel this will not compromise their scientific performance and career progression. Therefore, BIOPOLIS will offer top level researchers a package of conditions to develop research, such as seed funds, exceptional lab facilities, collaboration of technicians, and administrative support, among other aspects.

vi. Integration in international networks and partnerships. The robust international strategy of BIOPOLIS is essential to attract and retain top level researchers, both because it increases the global visibility, and it permits our researchers to be well-connected with the best universities and research centres worldwide. This integration will be strongly favoured by the partnership with the University of Montpellier in the scope of the Teaming project, but also with a range of other top-level institutions with which BIOPOLIS has or is preparing collaborative protocols, including for instance the Universities of Harvard, Cornell, Oxford and Cambridge, among many others.

7.3. Promoting successful application to research funding

Attracting project-based funding is one of the key components of the strategy for assuring the long-term sustainability of research excellence at BIOPOLIS. Particular attention will be given to creating the skills and capacities to participate successfully in Horizon Europe (2021-2027), and future framework Programmes, while maintaining or even enhancing the abilities to access funding from Portuguese agencies (FCT, ANI). This is particularly important given the huge opportunities created by Horizon Europe and the European Green Deal, where issues related to sustainability, biodiversity and ecological restoration are clear priorities. To achieve these goals, the following actions will be implemented:

i. Creation and implementation of a Project Support Office. This Office coordinates the research and innovation project work of BIOPOLIS, including information watch, raising awareness of opportunities, a proposal writing support service, assistance to partner searches, project and consortium management. The staff will include dedicated Project Support Officers, working in close collaboration with researchers and Project Management Officers.

ii. Training of researchers to preparing and writing research proposals, with the organization of in-house training sessions and participation in external workshops. In-house workshops on research proposal preparation will be organised at least each semester, which will be attended by research staff and post-doctoral researchers with project concepts and ideas. Workshops will include the discussion of case studies and will benefit from inputs by international invited researchers. BIOPOLIS will also support the participation of researchers in external training courses, to complement in-house training, as well as internal reviews and interviews.

iii. Regular application to research funding, benefiting from the foreseeable increase in funding opportunities in Portugal and the EU. To foster this activity, the Project Support Office will continuously review and disseminate information on oncoming funding opportunities, at national, bilateral, European and international levels. The Project Support Office will provide support on the preparation of applications, particularly on non-scientific aspects of proposal writing. Researchers will be incentivised to spend time on finding funding and writing proposals, by considering the success in attracting research funding as key elements for career development, remuneration packages, the allocation of lab space and technicians' time, and the allocation of funding. This strategy has already started to pay off, with several projects recently approved, with an overall budget to CIBIO-BIOPOLIS nearing 2 million euros.

7.4. Promoting stakeholder engagement through problem-solving research.

This component involves the development of innovation-led, problem-solving research together with the public administration, business corporations, and other stakeholders, providing a mechanism to align research with the needs of society, while simultaneously contribute to the sustainability of BIOPOLIS. The following main actions will be taken.

i. Creation and implementation of a Project Support Office. This Office will manage short- and medium-term contracts to develop specific projects leading to new products, services or processes, and it will focus on establishing more long-term partnerships whereby the public administration and corporations co-fund a research group tackling more general research and innovation issues.

ii. Development of an ambitious portfolio of Invited Chairs and Programmes. Collaboration with corporations will benefit from the Invited Chair Programme of FCT. The current Chairs will be maintained, Chairs currently under negotiation will be implemented, and new Chairs will be created through actively seeking partnerships with corporations. The network of Business partnerships will thus be greatly increased, through regular and systematic contact with corporations, either through meetings and other direct contacts, or through participation in business, technical and scientific events.

iii. Internationalisation of collaborations with stakeholders. Since many of the research and innovation outputs of BIOPOLIS are relevant in all countries, and many projects will be co-developed with international research institutions, a particular effort will be developed for establishing new contracts and partnerships at the international level. This will involve partnerships with key institutions, including the creation of a virtual BIOPOLIS Lab in Agropolis International, to foster collaborations in France.

7.5. Internationalisation and networking

BIOPOLIS strongly supports networking and internationalisation by its researchers. To meet this objective, BIOPOLIS researchers benefit from the successes and achievements of CIBIO during the last decade, with highlights including: (i) establishment of a global network of collaborations that resulted in hundreds of papers co-authored with researchers from foreign institutions; (ii) the establishment of strong links with top universities from around the world, particularly in North America, Europe and Australia; (iii) the participation in a number of International and European research networks and infrastructures, involving for instance the national representation in LifeWatch ERIC, and the participation in other ERIC and ESFRI; (iv) the involvement in intergovernmental organizations such as IPBES and GBIF; (v) the creation in 2014 of a Laboratoire International Associé in Portugal, of French CNRS; and (vi) the creation and implementation of the innovative concept of TwinLab, formalizing partnerships for research, advanced training and capacity building with institutions from Angola, Mozambique, Cape Verde, Namibia, Zimbabwe and South Africa, which among other achievements has resulted in the awarding to BIOPOLIS of the UNESCO Chair Life on Land.

To further enhance these achievements, BIOPOLIS has upgraded its internationalization strategy, which has been presented in a separate document (Deliverable 4.4). Briefly, the strategy involves the following main points:

i. **Expand international strategic partnerships**. BIOPOLIS will strive to reinforce its partnerships with top universities and research centres around the world, thereby increasing the opportunities to work with the best researchers in cutting-edge research fields.

ii. **Enhance participation in the European Research Area.** BIOPOLIS will reinforce its network of collaborations with top-level institutions within Europe to increase participation in projects funded by Horizon Europe, and other European research and innovation programs, namely those emerging from the European Green Deal.

iii. **Attract talent from around the world**. BIOPOLIS will work towards becoming an attractive employer and cooperation partner for talented researchers at all career levels around the world, as well as to attract promising international students to its doctoral program (see Section 4.1).

iv. **Address sustainable development goals in developing countries**. BIOPOLIS will develop strategic partnerships with developing countries, based on the TwinLab network, with a special focus on Portuguese-speaking countries in Africa, to foster the training of local researchers, build capacities, promote exchange of knowledge and experiences, and develop research with societal relevance.

8. Evaluation and monitoring

The implementation of the Strategic Research Programme will be regularly monitored and evaluated using a battery of Key Performance Indicators, which have been defined together with its corresponding targets in the DoA of the revised GA (Part B, Table 2.1b), and revised in Deliverable 9.4. Short-, medium- and long-term targets have been defined for each KPI, with periods adjusted to account for the one-year extension of project's implementation: short term – Years 1 to 3 (01/10/2019 to 30/09/2022); Medium term – Years 4 to 7 (01/10/2022 to 30/09/2026); and Long Term – Years 8 to 10 (01/10/2026 to 30/09/2029). From all the indicators proposed, we list in Table 1 a set of 15 considered particularly important to judge research performance in its multiple dimensions. The values achieved for each KPI at the end of RP3, together with its comparison with the baseline and target, have been reported in the third Implementation Report (D10.3). Evaluation and monitoring will continue to be undertaken to adjust and improve the Strategic Research Programme whenever necessary, and they will provide critical information required for the major revisions planned for Months 70 (July 2025) and 96 (September 2027).

Table 1: Key Performance Indicators (KPI) more directly related to the monitoring and evaluation of research performance in its multiple dimensions (full list of KPI in D9.2). Impact values presented are non-cumulative, and relative to the current achievements. The medium-long term impact of BIOPOLIS to the Innovation Index of Portugal (IIP) relative to the European Innovation Scoreboard are ranked between Fair (F), Large (L) and High (H).

Baseline	Y1-3	Y4-7	Y8-10	Impact to the IIP	Specific objectives[a]
I1.3. *Percentage of funding for research obtained from EU programmes*					SO:1, 11, 12
5%	20%	45%	50%	L	
I1.4. *No. of Invited Chairs funded by business corporations*					SO:1, 9, 11, 12
5	10	12	16	H	
I3.1. *No. of research projects nationally funded*					SO: 1, 8, 11, 12
5	10	12	15	H	
I3.2. *No. of research projects internationally funded*					SO: 1, 8, 12
1	2	5	8	H	
I3.3. *No. of international scientific meetings organized by BIOPOLIS researchers*					SO:5, 7-9, 11
1	2	3	4	H	
I3.4. *No. of scientific publications in top ranked journals (SCI impact factor >10)*					SO:5, 7-9, 11
5	8	15	25	H	
II4.3 *No. of contracts with the public administration*					SO:6, 7-9, 11
2	**4**	**8**	**10**	**H**	
II4.4 *No. of contracts with actors in the agrifood sector and with SMEs*					SO:6, 7-9, 11
0	1	5	8	H	
II5.3. *No. of non-academic people involved in scientific outreach activities or enrolled in exchange training programmes with business, administration, and other non-academic entities*					SO:9-11
8	15	20	30	H	
II6.1. *No. of patents, open innovative solutions, and other research outputs that are exploited*					SO:10-12
1	3	6	10	H	
III7.1. *No. of new top-ranked researchers attracted*					SO:1, 2, 8, 9, 11
2	5	8	12	L	
III8.1. *No. of collaborations with foreign top ranked institutions*					SO:7-9, 12
1	3	6	10	H	
III8.2. *No. of international consortia led by BIOPOLIS*					SO:1, 2, 4, 7-9, 12
0	1	2	3	H	
III9.2. *No. of doctoral thesis submitted*					SO:3, 4, 5, 10,11
12	14	20	14	H	

[a] This column refers to the specific objectives of BIOPOLIS listed in the Grant Agreement.

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