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EDITED BY
Daniel Simeon-Dubach,
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Peter Riegman,
Erasmus Medical Center, Netherlands
Judita Kinkorova,
University Hospital in Pilsen, Czechia

*CORRESPONDENCE
Ana Paula Arez
aparez@ihmt.unl.pt

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Biobanking for tropical health: leveraging collaborative initiatives in the Lusophone world

Ana Paula Arez[1]*, Aline Souto[2], Manuela da Silva[3], Carlos Roberto Sobrinho do Nascimento[3], Isabel Couto[1], Silvana Belo[1] and Nelson Lima[4,5]

[1]Global Health and Tropical Medicine (GHTM), Associate Laboratory in Translation and Innovation Towards Global Health (LA-REAL), Instituto de Higiene e Medicina Tropical (IHMT), Universidade NOVA de Lisboa (UNL), Lisbon, Portugal, [2]Fiocruz Biological Collections, Vice-Presidency of Research and Biological Collections, Oswaldo Cruz Foundation – Fiocruz, Rio de Janeiro, RJ, Brazil, [3]Fiocruz Biodiversity and Health Biobank, Vice-Presidency of Research and Biological Collections, Oswaldo Cruz Foundation – Fiocruz, Rio de Janeiro, RJ, Brazil, [4]Micoteca da Universidade do Minho, Biological Engineering Centre, Universidade do Minho, Braga, Portugal, [5]LABBELS-Associate Laboratory, Braga/Guimarães, Portugal

Biological collections and biobanks are essential for scientific research and innovation, supporting various scientific fields such as health sciences, biotechnology, food and agriculture. They preserve and provide diverse organisms, biological materials and their associated data, enabling the study of biodiversity, diseases, and their evolution and ecological functions. These collections are crucial for addressing global challenges like biodiversity loss, sustainable food and feed production, and human health, including understanding variations in pathogenic and etiologic agents over time. Biobanks support the development of new therapies, biomarkers, and diagnostic tests while promoting equitable benefit sharing from genetic resource utilization and developing and implementing international standards, crucial for improving research reliability and reproducibility. Collaborative networks enhance biobank operation by organizing data, exchanging biological material and facilitating trans-biobank studies and protocols standardization/harmonization. The establishment of the Lusophone Network of Biobanks and Biological Collections is a significant step toward promoting collaboration, capacity building and capacity development among Portuguese-speaking countries, many of them dealing with tropical health issues, facilitating knowledge exchange and resource sharing for scientific advancement on a global scale.

KEYWORDS

biological collections, biobanking, Portuguese-speaking countries, capacity building, collaborative network, global health, biodiversity, access and benefit sharing

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1 Introduction

To discover more about the forms, functions, origins, distributions, and evolution of species or diseases, scientists have been searching for and gathering all kinds of organisms for ages. In many fields of science and innovation, namely in health sciences and biotechnology, the pooling and preservation of these species into biological collections—systematized repositories of life in all its forms—is essential to ensure high-quality research and teaching. Biological collections not only support basic discovery science but also sustain applied research, driving innovation and providing knowledge about past and current global challenges such as the effects of global climate changes, biodiversity loss and changes, sustainable food production, ecosystem conservation, and improving human health and security (1).

Under the general term of biological collections, variable types of biological material are considered: i) organisms (specimens), or their derived biological material (eg preserved tissue or DNA), along with the data associated with each specimen, ii) non-living specimens or preserved, commonly referred to as natural history collections or iii) living specimens including microorganisms or research and model organisms that are grown and maintained in genetic stock centers, germplasm repositories, or living biodiversity collections (1).

All biological samples such as tissues, blood and other body fluids, plants or seeds, prokaryotic and eukaryotic cells, or isolated biomolecules as well as the associated data are essential material for research and development in fields such as health sciences, biotechnology or agriculture. The collection, processing, preservation, and storage of these resources, in addition to the provision of access, are key activities of Biobanks or Biological Resource Centers (BRC). These infrastructures ensure proper quality of samples and data, ethical and legal compliance as well as transparent and efficient access procedures and have been considered by Time magazine in 2009 as one of the 10 ideas with the potential to change the world (2). Through biobanks, researchers can obtain, track, and maintain a wide range of biological samples, anticipating the need for future applications making Biobanks and BRC central infrastructures for biomedical research and a source of essential resources for innovation and translation in Tropical and Global Health.

The international standard ISO 20387 (3) defines a biobank as "a legal entity or part of a legal entity that performs biobanking", and the term biobanking as "the process of acquisitioning and storing, together with some or all of the activities related to collection, preparation, preservation, testing, analyzing and distributing defined biological material as well as related information and data". Although the term biobank is usually associated with human samples, the terms "biobank" and "Biological Resource Centers", the latter more associated with microbiological samples or samples of non-human origin (4), are often used as synonyms and biobank has become a "hat-holder" term (5). Furthermore, ISO 20387 expanded the concept of biological material, including substances derived from animals, plants and microorganisms, in addition to humans.

2 Biobanks and biological collections in the world

Biobanking facilities are well established in high-income settings but are much less developed in resource-restricted settings and this may be due to the high costs of laboratory reagents and consumables, insufficient infrastructure (such as sequencing centers, information technology, or bioinformatics facilities) and lack of qualified training among others. According to the Global Bank Directory, Tissue Banks, and Biorepositories (6), there are 178 biobanks of human samples in North America (Canada and USA), 90 in Europe, 4 in Middle-East, 23 in Asia and 13 in Australia; there is no reference to biobanks of human or non-human samples in Latin America or Africa. In the Biobank Locator developed by the University of British Columbia (7), there are 366 registered biobanks of which eight locate in Latin America countries (Argentina, Brazil, Mexico, Uruguay and Trinidad and Tobago) and 11 in African countries (Egypt, Ethiopia, Nigeria, Sudan and Uganda). Similar disproportion is observed concerning biological collections associated with biodiversity or microorganisms as shown at the Global Registry of Scientific Collections (8) or at the World Federation for Culture Collections (WFCC) (9), respectively. At WFCC, from a total of 853 collections, 155 are located in Latin America (Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Mexico, Uruguay and Venezuela) but only 25 are located in Africa (Egypt, Ethiopia, Morocco, Nigeria, Senegal, South Africa, Sudan, Uganda and Zimbabwe).

On the other hand, regions where most of the low-and middle-income countries (LMICs) are located still face a disproportionately high infectious diseases burden (10). Further development of infrastructure facilities such as biobanks in these settings is warranted since research on emerging or already prevalent infectious diseases calls for a work on collections of pathogens (including hosts or vectors from which the pathogens were isolated), related to human and animal health, to wildlife or the environment in an One Health perspective (11).

The establishment of biobanks in these areas began with biorepositories associated with specific agents and diseases such as the human immunodeficiency virus or tuberculosis, or associated with the response to epidemic outbreaks, especially after the Ebola crisis (10, 12, 13). Initiatives such as H3Africa (The Human Heredity and Health in Africa consortium for genetics research in Africa, National Institutes of Health (NIH) and the Wellcome Trust (WT) (14)), B3Africa (Bridging Biobanking and Biomedical Research Across Europe and Africa, EU Horizon 2020 (15)), Africa CDC Biobanking Network (16) or BCNet (The Low- and Middle-Income Countries Biobank and Cohort Building Network, World Health Organization (17)), or the European, Middle Eastern & African Society for Biopreservation and Biobanking (ESBB (18)) among others, are collaborative networks and platforms that have contributed very significantly for epidemic preparedness and research in Africa (19–21).

3 Relevance and applications of biological collections and biobanks

Biobanks follow recommendations and best practices of international organizations such as the Organisation for Economic Cooperation and Development [OECD (4, 22)] or the International Society for Biological and Environmental Repositories [ISBER (23)], among others, concerning facilities and procedures as well as ethical, legal, and social issues (ELSI) and governance. Through biobanks, biological specimens can be preserved in optimal conditions enabling the development of new biomarkers, therapies, diagnostic tests, and their use in personalized healthcare. Stored specimens or biological collections may be used to establish a baseline to evaluate the impact of new interventions, or for a variety of retrospective studies, which may become important in future and unforeseen circumstances, with the establishment of previously existing base values, as the recent example of the COVID-19 pandemic (24, 25).

The establishment of these biorepositories will also avoid future issues associated with transportation, and risk of disease transmission and most of all allow benefit sharing, helping these countries to preserve and store their own biodiversity. The international equity and solidarity with regard to benefit-sharing arising out of the utilization of genetic resources [meaning any product that could be derived from a living organism] was first established in 1992 on the Convention on Biological Diversity. This was followed by the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (26) in 2010, even if its application to biological collections or sharing of pathogens collected from humans have raised some concern (27, 28).

Also, epidemiological research and genomic studies of both infectious and chronic diseases depend not only on high quality samples but also require the collection of biological samples from very large groups of subjects distributed over a wide geographic area to fulfill statistical requirements. In addition, field activity regarding the collection of isolates and/or pathogens should follow standardized procedures to guarantee research reproducibility and enable the comparison of samples collected in different settings or timepoints, within and between studies (29). Pre-analytical procedures such as the collection, processing, preservation, and storage of these samples, in accordance to international standards, essential to improve analytical data reliability and reproducibility, as well as accurate data management and provision of access are key activities of biobanks and it is desirable to internationally harmonize criteria for sample collection and storage in a global standard for biobanking activity (5, 29).

4 Networks of biobanks and collaborative platforms

Improved functionality resulting from greater data organization and harmonization of standard operating procedures (SOP) is immediately benefited by networks of biobanks (30). Networks such as the Biobank consortium EuroBioBank (EBB) (launched in 2001 with the aim of preserving human samples related to rare diseases) (31), BBMRI-ERIC (Biobanking and Biomolecular Resources Research Infrastructure – European Research Infrastructure Consortium) which brings together biobanks from across Europe (32, 33), or the MIRRI-ERIC (Microbial Resource Research Infrastructure - European Research Infrastructure Consortium) which brings together more than 50 BRC (34), in Europe, ISBER, a global forum created in 1999 (35), WFCC, an international organization that supports and coordinates the activities of culture collections (9, 36) or the FELACC (Latin America Federation For Culture Collections) (37) in America and the above-mentioned networks in Africa, are examples of developments in this field.

Other important issue of networks is the possibility of trans-biobank collaborative studies. Trans-biobank data integration is becoming common, increasing the sample size and allowing more robust associations, especially in genome-wide association studies (38).

Except for MIRRI-ERIC, whose headquarters are in Portugal, the only members of the Community of Portuguese Speaking Countries (CPLP) included in some of the networks mentioned above are Brazil and Portugal. The African Portuguese Speaking countries (PALOP) in particular, still lack the capacity, infrastructure, regulation and trained human resources to effectively establish biobanks. Yet, several institutions from PALOP have already started creating biological collections and biorepositories, while others have expressed great interest in doing so. Consequently, there is a significant demand for the exchange of experiences related to training and skills in the establishment of biological collections and these collaborative efforts have the potential to reinvigorate local activities, promote the dissemination of knowledge, contribute to the equitable sharing of benefits following each country's ethical and legal guidelines (39).

Therefore, a Lusophone Network of Biobanks and Biological Collections that encompasses all those institutions is being launched to share experiences and increase their visibility and impact at a global level. The inaugural meeting of this network took place on April 19, 2023 at IHMT NOVA, in Lisbon, Portugal, in a hybrid format, as part of the pre-congress activities of the 6th National Congress of Tropical Medicine, bringing together representatives of institutions from Angola, Brazil, Cape Verde, Mozambique, Portugal and the two national networks (National Network of Biobanks, biobanco.pt and The Portuguese Network of Microbiological Resources, PT-mBRCN/MIRRI-PT) (Figure 1, Table 1). Units with very different characteristics are represented, ranging from repositories of microbiological samples to strict biobanks of human samples or natural history collections and diversity in terms of maturity of existing infrastructure, strategies, programs, sources of financing and governance policies between institutions and countries was clearly evident. Important thematic areas associated with biobanking activity and infrastructure to be addressed by the Network include i) the implementation of SOPs (addressing protocols, access and sharing of biological material, pathogens, results, software and its parameterization, etc.); ii)

10.3389/fitd.2024.1438842

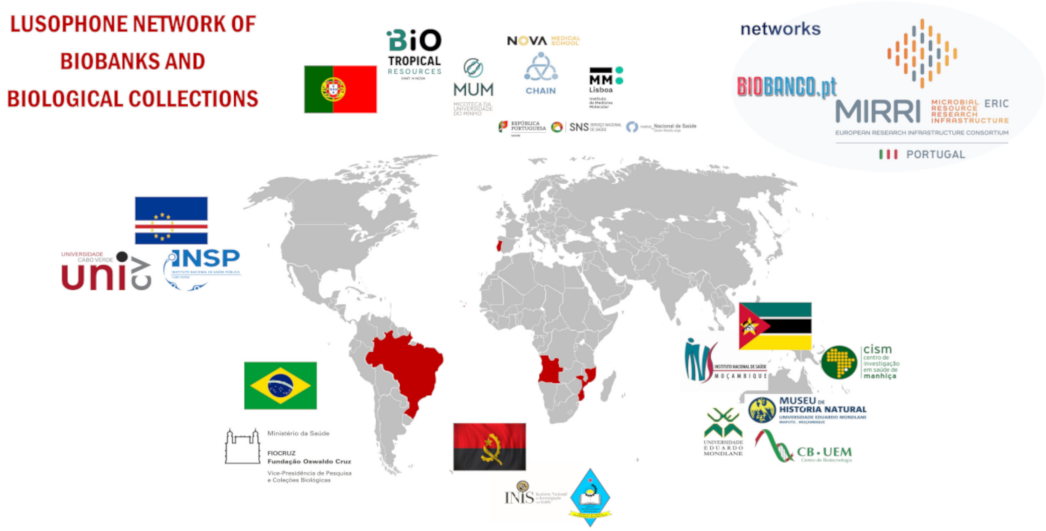

FIGURE 1
Geographic distribution of the founder members of Lusophone Network of Biobanks and Biological Collections (2023).

TABLE 1 Institutions and networks present at the inaugural meeting of the Lusophone Network of Biobanks and Biological Collections, held in April 2023 at IHMT NOVA.

Country	Institution/Network	
Angola	National Institute for Health Research (INIS)	
	University Agostinho Neto (UAN)	Faculty of Medicine
Brazil	Oswaldo Cruz Foundation (Fiocruz)	Fiocruz Biological Collections
		Fiocruz Network of Biobanks
		Fiocruz Biodiversity and Health Biobank
Cabo Verde	University of Cabo Verde (Uni-CV)	Faculty of Sciences and Technology (FCT)
	National Institute of Public Health (INSP)	
Mozambique	The Manhiça Health Research Center (CISM)	
	National Institute of Health (INS)	Department of Technological Platforms in Health
		Department of Reference Services
		Biobank
	University Eduardo Mondlane (UEM)	Natural History Museum (MHN)
		Biotechnology Center (CB-UEM)
		Biobank of Animal Biodiversity (BBA)

(Continued)

TABLE 1 Continued

Country	Institution/Network	
Portugal	University NOVA Lisbon	Institute of Hygiene and Tropical Medicine (IHMT)
		Faculty of Medical Sciences (NMS)
	Institute of Molecular Medicine João Lobo Antunes (iMM)	
	National Institute of Health Dr Ricardo Jorge (INSA)	
	University of Minho	Micoteca da Universidade do Minho (MUM)
	National Network of Biobanks (biobanco.pt)	
	Portuguese Network of Microbiological Resources Centre (PT-mBRCN/MIRRI-PT)	

analysis of existing regulations and their consensual adaptation and application; iii) mechanisms for assuring the sustainability of these structures; iv) advanced training of human resources in the various programs or advanced/summer courses available in the more developed infrastructures and/or respective networks. Members of this Lusophone Network will also have transnational free of charge access to European research infrastructures through Horizon Europe funded projects such as ISIDORe (40), CanSERV (41), MICROBES-4-CLIMATE (42) and AgroServ (43), which involve PT-mBRCN/MIRRI-PT partners. Following a first stage of implementations and divulgation [eg (44)], several projects are currently being prepared involving members of the network with varying degrees of maturity and within which, one of the aims is to implement biological collections, train human resources and develop the infrastructure.

5 Conclusions

In conclusion, biological collections and biobanks play a fundamental role in scientific research and innovation across various scientific fields, including food and health sciences. These repositories of life, encompassing a wide array of organisms and biological materials, serve as invaluable resources for understanding biological diversity, diseases, and their evolution. Moreover, they support both basic and applied research, driving innovation and addressing pressing global challenges such as biodiversity loss, sustainable food and feed production, ecosystem conservation, and human health.

While biobanking facilities are well-established in high-income regions, there remains a significant gap in resource-restricted settings, mostly located in tropical areas, and this disparity is particularly concerning given the disproportionately high burden of infectious diseases in these regions. Collaborative networks and platforms enhance the functionality of biobanks through greater data organization and trans-biobank collaborative studies. The establishment of the Lusophone Network of Biobanks and Biological Collections represents a significant step towards promoting collaboration within members as well as with international organizations such as BBMRI-ERIC, MIRRI-ERIC, ISBER, ESBB and WFCC among others. This will improve knowledge dissemination, and capacity building among Portuguese-speaking countries. By sharing experiences and resources, these institutions can strengthen their infrastructure, governance policies, and human resources, ultimately contributing to the advancement of scientific research and innovation on a global scale.

Author contributions

AA: Conceptualization, Writing – original draft. AS: Writing – review & editing. MS: Writing – review & editing. CS: Writing – review & editing. IC: Writing – review & editing. SB: Writing – review & editing. NL: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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