**Supplemental information**

**MicrobiomeSupport Consortium:**

Paulo Arruda1,2, Thomas Bartzanas3, Gabriele Berg4, Paula Iara Brennan5, Bárbara Bort Biazotti1,2, Marie-Christine Champomier-Verges6 Trevor Charles7, Mairead Coakley8, Paul Cotter8, Don Cowan9, Kathleen D’Hondt10, Ilario Ferrocino11, Kristina Foterek12, Gema Herrero-Corral6, Carly Huitema7, Janet Jansson13, Shuang-Jiang Liu14, Paula Malloy1, Emmanuelle Maguin6, Lidia Markiewicz15, Ryan Mcclure13, Andreas Moser16, Jolien Roovers10, Matthew Ryan17, Inga Sarand18, Bettina Schelkle19, Michael Schloter20, Ulrich Schurr21, Joseph Selvin22, Effie Tsakalidou3, Martin Wagner23, Steve Wakelin24, Wiesław Wiczkowski15, Hanna Winkler19, Juanjuan Xiao14

 Genomics for Climate Change Research Center, Universidade Estadual de Campinas (UNICAMP), Brazil

2Department of Genetics, Evolution and Bioagents, Institute of Biology, Universidade Estadual de Campinas (UNICAMP), Brazil

3 Agricultural University of Athens, Greece

4 Graz University of Technology, Austria

5 Ministerio de Ciencia, Tecnologia e Innovacion Productiva, Argentina

6 INRAE, French National Research Institute For Agriculture, Food and Environment, France

7 University of Waterloo, Canada

8 TEAGASC, Ireland

9 University of Pretoria, South Africa

10 Department of Economy, Science, and Innovation - Flemish government, Belgium

11 Department of Agricultural, Forest and Food Sciences, University of Torino, Italy

12 German Aerospace Center, Germany

3 Pacific Northwest National Laboratory

4 Institute of Microbiology, Chinese Academy of Sciences, China

5 Institute of Animal Reproduction & Food Research, Polish Academy of Sciences, Poland

6 rtd services, Austria

7 CAB International, United Kingdom

8 Tallin University of Technology, Estonia

9 EUFIC - European Food Information Council

20 Helmholtz Zentrum München, National Research Center for Environmental Health, Germany

21 Forschungszentrum Jülich GmbH, Germany

22 Pondicherry University, India

23 The Austrian Center for Feed and Food Quality, Safety and Innovation, Austria

24 SCION Research, New Zealand

**Methods**

**Bibliometric analysis**

Publications on Microbiome research were collected in Web of Science and analysed using scientometric and bibliometric methods to generate science maps. The computation of science maps is based on the two-dimensional representation of the co-occurrence matrix of terms in the relevant literature (reviewed journals, conference proceedings). The calculations were done with the tool BibTechMonTM, which was developed by the AIT Austrian Institute of Technology GmbH [1-3]. For the analysis the **general search string** for (microbiome\*) *OR* ("microbial communit\*") in Web of Science was used, resulting in **78,122 publications** **for the years 1990-2020** (search conducted on 24.02.2020). For analysis of thematic topics,the number of papers was further reduced to **34,137 by limiting the publication years to 2017 to 2020** and selecting only articles, reviews, meeting abstracts or proceedings papers. For an analysis of topics the best results were obtained with a network of the knowledge base. This network (see Fig. 2) shows the cited references as nodes. The bigger the node is, the more publications cite the reference represented by the node. Only references cited more than 10 times were used to calculate this network. The references that are connected through papers are closely connected in the network, thus are positioned close to each other.

The topics identified could be roughly grouped into **six thematic clusters** giving a broad overview of the focus areas of all the publications. The most prominent thematic cluster was research on the **human microbiome**. Some topics within this cluster focussed on the human microbiome and the connection of diet, personalized diet and health.

The second biggest thematic cluster comprises publications on **soil and plant microorganisms**. Compared to the thematic clusters of the human microbiome these topics appear rather condensed, indicating a less diverse knowledge base. Interestingly, topics on plant and soil microbiomes were rather grouped according to the plant niche (soil, rhizosphere, phyllosphere etc.) than according to plant species.

Another large group of papers is dealing with microbiome in **waste fermentation and various environmental issues** as wastewater or influence of potential pollutants or micro-plastics and marine plastics debris. Topics on **Food Microbiomes** formed not very distinct clusters, their knowledge base intermingled with topics on the diversity of microbiomes in various fermented foods and research on mastitis in cattle and goats as well as the respiratory tract microbiota in many other animals.

**Mapping microbiome research projects**

Information on microbiome research projects was collected in the period June-October 2019 via two different routes. Information on national research projects was collected via country contact points from the following countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Cyprus, Denmark, Estonia, France, Germany, Greece, Hungary, India, Ireland, Italy, The Netherlands, New Zealand, Poland, Slovakia, South Africa, Spain, United Kingdom, and United States. In addition, information was also collected from the following databases and websites from supra-national initiatives: the Cordis database for projects funded via the FP7 and H2020 programmes by the European Commission (https://cordis.europa.eu/projects/en), the platform database with information about ERA-NETS and Joint Programming Initiatives (https://library.wur.nl/WebQuery/platform/find?q=\*), the European Molecular Biology Organization (https://www.embo.org/), the Horizon Frontier Science Program (https://www.hfsp.org/search/node), the Bill and Melinda Gates Foundation (https://www.gatesfoundation.org/) and the Gordon and Betty Moore foundation (https://www.moore.org/). The following keywords were recommended to be used by the country contact points and were used for the desk study on supra-national initiatives: microbiome, microbiology, microflora, microbiota, microorganism, microorganisms, microbe, microbes, microbial, bacteria, fungi, protists, protozoa, archaea, prokaryote, prokaryotes, microbial communities, microbial interactions, bacteriophages, bacterioplankton. Titles and abstracts were screened to identify relevant projects that started in 2013 or later. Projects that were related to viral disease, development of new antibiotics, development of other medicines, only human cells (and not about microbiomes) or topics not related to microbiomes (e.g. physics of cell membranes) were removed. This resulted in a total of 6607 research projects.

Based on title and abstract, research projects were assigned to a target area. The topics of target areas were based on the Food 2030 policy [4]. The following main target areas were used:

* Microbiomes important for human health
* Microbiomes of food products and processing
* Microbiomes of primary production systems
* Microbiomes in the environment
* Microbiomes in waste streams
* Microbiome research within logistics and distribution of food products
* Other target area.

Each main target area contained several sub-categories (See Fig. 3).

Despite all efforts to comprehensively collect information on research projects, several limitations need to be considered. The accessibility to information varied per country. In some countries, central databases with research projects are available. In other countries like Italy and South Africa, it was harder to obtain relevant information as centralized public databases were missing. Countries with a decentralized structure of organizing their research activities (see next section) may have more difficulties in obtaining the complete overview of the microbiome-related research activities than countries with a centralized structure of organization. In some countries, representative institutions with information on policies, strategies or funding did not respond to information requests. As such, the quality and completeness of the collected information varies between countries that provided the data, data availability and the databases searched. Furthermore, the collected information is limited to the countries and databases searched.

**Examples of decentralized structures of research organization**

Brazil and Germany are two countries with a decentralized structure of research organization, which was considered as one of the reasons why research projects are of smaller size and may only be studied within one ecosystem.

In Brazil, the organization of funding of research occurs through several institutions at federal, state or municipal levels due to its large territory composed of 26 states. Funding of research in Brazil occurs, mainly, through public agencies. The main federal funding agencies are CNPq and FINEP (under the Ministry of Science, Technology and Innovation of Brazil), BNDES (under the Ministry of Economy) and CAPES (under the Ministry of Education). State funding is mostly concentrated in 26 Research Support Foundations (FAPs), among which Fapesp (the São Paulo Research Foundation) stands out as one of the main funding agencies for scientific and technological research in the country. Despite having a smaller contribution, funding from private initiatives has been growing over the years.

It is noteworthy to mention that, in Brazil, the minority of the funding institutions provide detailed or updated information about ongoing or finished projects/programs, which makes it difficult to carry out a broad study on public policies and financing in the country. Among institutions, Fapesp stands out for providing detailed or updated information about ongoing or finished projects or programmes (https://bv.fapesp.br.pt).

Despite the existence of a “National Strategy for Science, Technology and Innovation” guideline that addresses major challenges in technological and scientific research in Brazil, funding agencies have autonomy to foment research and innovation on regionally relevant topics. While this organization offers an alternative for funding research in a country with continental dimensions and contrasting social scenarios, it challenges the establishment of a systems approach for dealing with relevant subjects that are common in different fields, such as the microbiome.

In Germany, the organization of funding for research occurs at centralized, regional and institutional levels. Research funding in Germany is led by the Federal Ministry of Education and Research (BMBF) and the German Research Foundation (DFG) at central level. Both have own programs and calls for research fields. Other funding opportunities are the German Academic Exchange Service (DAAD), private foundations and regional ministries for funding. This diversity leads to a strong decentralization of funding and research and no central information center is available that presents research projects at the different levels of funding. Besides this, academic research and industrial research are separated in many cases.

One of the central national strategies provided by the BMBF (Bioeconomy 2030) includes microbiomes to a moderate extent in special fields of interest. For example, in the 9-years BonaRes programme scientists investigate how soils can be preserved as our livelihood and includes projects on soil and plant microbiomes. The BonaRes center includes the cross-project coordination, internal and external networking of BonaRes, modeling of soil functions, development of data structures and regionalization processes as well as the establishment of a web-based portal [5]. In addition, the NFDI4Microbiota programme funded by the BMBF and the DFG aims to be part of the German NFDI (National research Data Infrastructure). The vision is that researchers in microbiology (including bacteriology, virology, protistology, mycology and parasitology) can translate research data easily into a deep understanding of microbial species and their interactions at a molecular level. The mission is to be the central hub in Germany for supporting the microbiology community with access to data, analysis services, data/metadata standards and training (https://nfdi4microbiota.de/).

**References**

1. Kopcsa A, Schiebel E: **Science and technology mapping: A new iteration model for representing multidimensional relationships**. *Journal of the American Society for Information Science* 1998, **49**:7-17.

2. Boyack KW, Klavans R: **Co-citation analysis, bibliographic coupling, and direct citation: Which citation approach represents the research front most accurately?** *Journal of the American Society for Information Science and Technology* 2010, **61**:2389-2404.

3. Shibata N, Kajikawa Y, Takeda Y, Matsushima K: **Comparative study on methods of detecting research fronts using different types of citation**. *Journal of the American Society for Information Science and Technology* 2009, **60**:571-580.

4. European Commission: **Recipe for change: An agenda for a climate-smart and sustainable food system for a healthy Europe**. 2018.

5.https://www.bgr.bund.de/DE/Themen/Boden/Projekte/Informationsgrundlagen-laufend/BONARES/BONARES.html?nn=1542204

**Additional figures:**

****

**Fig. S1** Main target areas per research project of 6607 research projects. Research projects can be involved in more than one target area. The research projects were collected with a mapping exercise, which collected information about research and innovation activities from 25 countries and supranational initiatives (see supplement for detailed information about the mapping exercise).



**Fig. S2** Budget information of research projects. The budget was available for 4150 research projects in the database. Ca. 40% of the research projects have a budget in the category of 50-250 kEUR, which often support one early career scientist. Ca. 6% of the research projects have funding of more than 2500 kEUR. The projects in the bigger category involve projects with multiple scientists in collaborative projects as well as big personal grants that allow hiring multiple PhD students, Postdocs and research technicians.



**Fig. S3** the proportion of policies, R&I strategies and white papers that address microbiomes. There were 279 policies, white papers and 7Research and Innovation Strategies identified by the mapping. 69% of the policies, R&I strategies and white papers did not address microbiomes or only to a small extent.