European Commission

FOOD 2030 Pathways for Action

THE MICROBIOME WORLD: A LIFE SCIENCE OPPORTUNITY FOR OUR SOCIETY AND OUR PLANET

Research and Innovation

SYSTEMIC CHALLENGES

Microbiomes are in, on and all around us, understanding what microbiomes do, what they are, and how they interact is a new scientific frontier made now reachable by rapid advances in genomics. What we know and understand so far is that the microbiome has essential impacts on our health and on the food we produce, on plants and animals and on ecosystems in general. Unravelling their complexity offers huge potential for innovation and will be a major game changer in the way we manage our planet's resources to obtain our food and improve our health. It is estimated that more than half of the investments in microbiome research have been dedicated to understanding the human gut microbiome and yet approximately 40-50% of human gut species lack a reference genome. We know more of the stars and the planets in the universe than the DNA of our own plants and animals.

The systemic challenges directly addressed include:

- Ascertaining what constitutes a healthy microbiome through a deeper understanding of the host- microbiome nexus.
- Engaging the relevant stakeholders, food and healthcare professionals, industry, regulatory opinion leaders, and media and policymakers.
- Developing an open science and open frontiers global approach to overcome the barriers of scale, reach sufficient critical mass, data sharing, and the linking and training of different disciplines.

THIS FOOD 2030 PATHWAY CAN DELIVER CO-BENEFITS FOR

NUTRITION	CLIMATE	CIRCULARITY	INNOVATION
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Microbiome research and innovation has the potential to touch upon many areas, from primary production and sustainable agricultural to food production and food science, to human health and waste management. Thereafter the co-benefits spans from **reduction of GHGs emissions** to **increased adaptation options to climate change,** from **reduction of risk factors for NCDs** to **protection of biodiversity.**

RESEARCH AND INNOVATION ACTIONS NEEDED

Research and innovation actions needed cover both **technical** and **non-technical** interventions.

Tackling the challenges ahead of us, microbiome technical interventions should focus on **enhancing agricultural sustainability and productivity** to address the increasing demand for food while coping with the expected climate impacts. Microbiomes can improve **soil health and restoration** through bioremediation of degraded or contaminated habitats, enhancing soil carbon sequestration and preventing erosion of top soils. **Focusing on food quality** for producing higher nutritional quality foods and promoting the reduction of microbial contaminants, preventing the outbreaks of foodborne diseases such as COVID-19. Microbiome research could reduce our reliance on fossil fuel inputs in agriculture and decreasing the N_2O flux and thereafter help with **climate change mitigation**. Microbiome research and innovation is relatively new area therefore, technical interventions should aim at **new industrial sectors** developing new inoculants and enzymes for the industry.

The element we consider most essential for the non-technical interventions is **citizen engagement** and the co-creation with a wide diversity of actors. This will foster greater awareness raising and appreciation of the benefits and solutions, as well as the integration of multiple forms of knowledge. Secondly, the **education** of new generation of scientists on systemic microbiome research will ensure a holistic/systemic approach and could provide the public and policymakers with life-cycle analysis of microbiome-based solutions. Equally important are **public-private partnerships,** targeting **microbiome standards**, reference materials, and data linked with **large data infrastructures**.

BARRIERS AND LOCK-INS

There are significant hurdles to microbiome innovation: **lack of global coherency**, **weak translational science**, **skills and education**, and **citizen science** are some of the barriers that we need to work on. Additionally harmonisation of the **regulatory framework** will provide the right toll kit for innovation.

Enablers of change

To bridge the gap between today's potential and the moment at which concrete applications start generating societal impact, critical-scale efforts offering visible progress on **topics of public interest** will be essential. **Partnerships** (public-private; public-public), are fundamental for creating ownership and sense of responsibility in microbiome R&I. **International collaboration** with the world and the EU it is perhaps one of the most relevant enablers to create an coherent approach in this newly form area.

RELEVANT EU R&I PROJECTS

During FP7 and Horizon 2020 the EU invested approximately EUR 1.4 billion related to microbiome research, by supporting over 500 projects. In the FP7 programme, 370 projects were supported with an investment of EUR 850 million. In Horizon 2020 over 366 projects were supported with an investment of more than EUR 500 million. Some key projects include:

PROJECTS	DESCRIPTION
CIRCLES - Controlling Microbiomes Circulations for Better Food Systems https://circlesproject.eu/	2018-2023, EUR 10 M. CIRCLES will establish a new integrated economic system of products and services, proposing new food value chains based on microbiome knowledge.
HOLOFOOD - Holistic solution to improve animal food production https://www.holofood.eu/	2019-2022, EUR 10 M. Holistic solution to improve animal food production through deconstructing the biomolecular interactions between feed, gut microorganisms and animals in relation to performance parameters.
MASTER - Microbiome Applications for Sustainable food systems https://www.master-h2020.eu/	2019-2023, EUR 10 M. Microbiome Applications for Sustainable food systems through Technologies and Enterprise
SIMBA - Sustainable innovation of microbiome applications in food system https://simbaproject.eu/	2018-2022, EUR 10 M. SIMBA contribute to harness complex soil and marine microbial communities (microbiomes) for the sustainable production of food
MicrobiomeSupport - Towards coordinated microbiome R&I activities https://www.microbiomesupport.eu/	2018-2022, EUR 3.5 M. Platforms for collaboration and coordination of microbiome-related R&I programmes in Europe and worldwide. Carry out a mapping exercise at international level.

POLICY CONTEXT

This Pathway seeks to provide a way forward for future R&I policy in Europe and beyond. It is 1 out of 10 FOOD 2030 Pathways for Action, which target key R&I leverage points for transitioning towards sustainable, resilient, healthy and inclusive food systems that leave no one behind. The FOOD Pathways for Action will help to underpin Horizon Europe, support evidence-based policymaking and implementation, foster education, skills and capacities, boost innovation and investment, encourage synergies and policy alignment. The achievement of these objectives will be assisted by a dedicated Horizon Europe Food Systems Partnership expected to be launched in 2023 that will provide a multi-actor R&I governance platform and process to deliver co-benefits in line with the European Green Deal. This pathway, The Microbiome World, is among others relevant to: health, food and nutrition security, addressing policy objectives of Green Deal and Farm to Fork strategy; energy security and climate change; delivering on climate ambition and targeted impact on climate neutrality and adaptation to climate change — addressing the new bioeconomy strategy for a sustainable Europe; soil Health and Food mission and others missions; Sustainable Development Goals (SDGs), namely 2, 3, 12, 13, 14 and 15.

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