Italian Microbiome initiative and its industrial Implementation Action Plan

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On behalf of the National Committee for Biosafety, Biotechnology and Life Sciences of the Italian Presidency of Council of Ministers (CNBBSV) and its «Microbiome initiative» Working Group.

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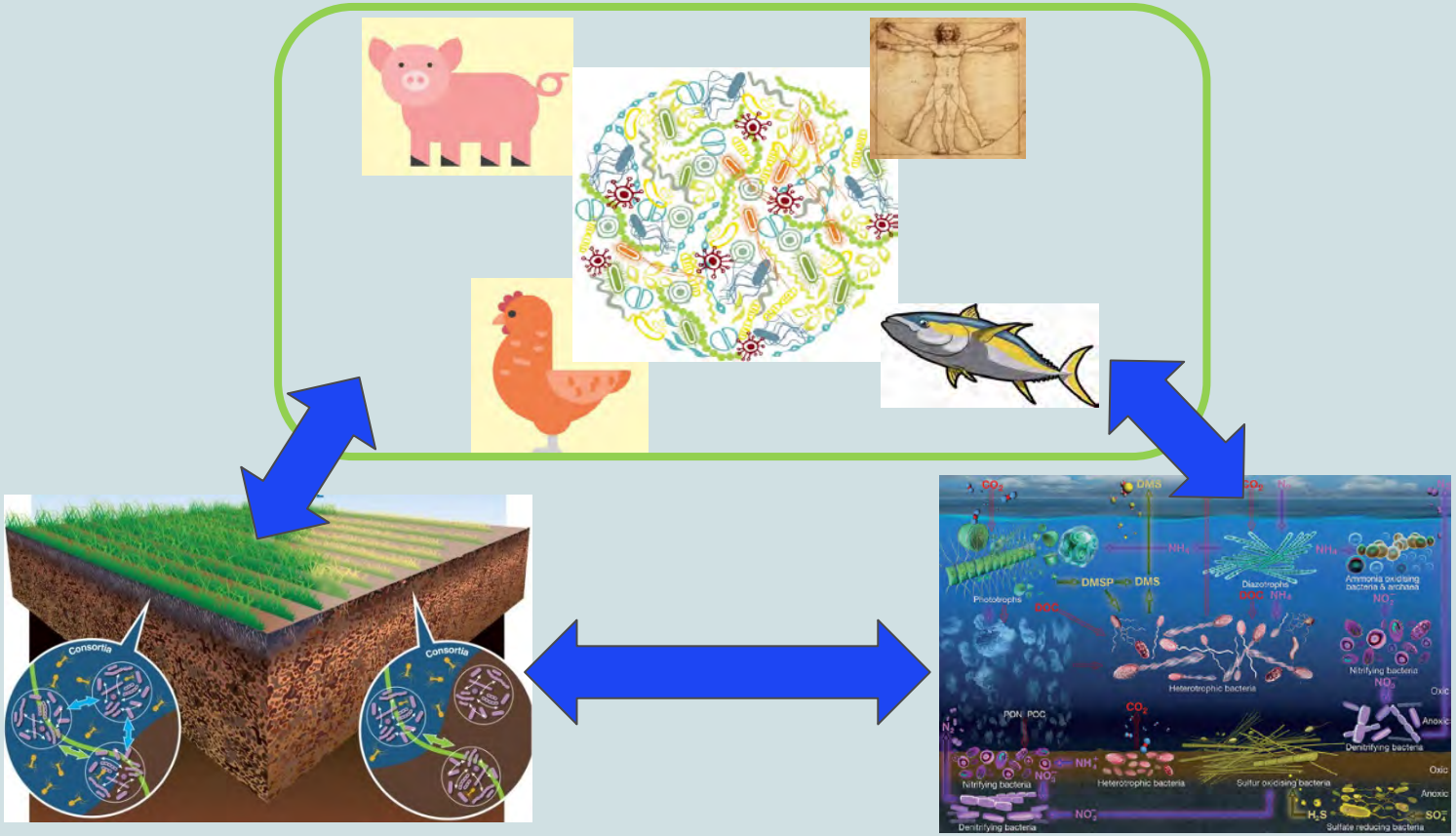
Microbiomes and the health of humans and of the food systems

Microbiomes (i.e. Bacteria, Archaea, Eukarya and viruses) **inhabit humans, plants, animals and the terrestrial and marine environments**. **They are** apparently **interconnected** and jointly **provide benefits to** the whole **planet** and its **populating organisms** (“*One Health” view).*



→ **Microbiome-based approaches can promote human health and a higher, healthier, and more sustainable productivity** across the **whole food system.**

BUT R&I is needed to **clarify the interplay between microbiomes and environment, nutrition and host variables to better design microbiome-based interventions.**

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Italian expertise and R&I potential in the Microbiome domains

EXPERTISES AND KNOW-HOW relevant expertise and know-how on human microbiome and virome (at preclinical and clinical levels) **and on microbiomes in foods, plants, terrestrial and aquatic animals, soils and sediments but are exploited in parallel**. **IT researchers are present in a large number of prominent international publications and in about 30 funded FP7 and Horizon2020 projects** in the microbiome domains. However, such EU projects are only **5% of** those **funded as part of FP7 and H2020** programmes (more than 600 projects).

INFRASTRUCTURES: IT also possesses **relevant and complementary infrastructures in the biomedical and the main domains of the food systems**, like advanced NGS, proteomic and metabolomics platforms, Simulator of Human Intestinal Microbial Ecosystem (SHIME), animal facilities, databases and bioinformatics pipelines, Human and animal model phenotyping, etc.. **But we are missing others (germ free facility, data storage, etc) and have difficulties in maintaining/updating/renewing the existing ones.**

THE PRIVATE SECTOR: Some **national industries of the biotechnology, pharmaceutical, food and agriculture domains are interested in the microbiome opportunities but they need to be better engaged to allow them to know** and to responsibly **exploit microbiome knowledge**.

→ **the Italian Microbiome initiative**, **to integrate expertise, public and private actors, infrastructures, investments,** for a **wide exploitation of the national potential in the sector.**

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CONCEPT PAPER

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2019

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The Italian Microbioma initiative: main needs and opportunities

GENERAL: create a national network of experts, public and private actors and infrastructures to interconnect the different domains of the microbiome health and food system and to **better exploit its potential in Italy and on national specificities**. **Increase awareness, education and training**.

TECHNICAL: standardize the **approaches** and **improve technological tools** used **for analyzing and characterizing microbiomes** to minimize noise and bias and **a better comprehension of the microbiome functionality** along with **more robust data banking and analytics**.

In the Health domain: data on the baseline microbiota profiling of Italian healthy subjects in different body districts, different ages and lifestyles; new microbiome biomarkers for disease and diagnostic tools; new therapeutic approaches; metagenomics/metabolomics-based medicinal chemistry campaigns; neglected lifestyle, dietary and environmental drivers of dysbiosis; more robust demographic databases (dataset); nutritional protocols and physical activity programs; Mediterranean diet factors promoting a healthy microbiome structure; complete host virome analyses; probiotic formulation on gut microbiota eubiosis and host health; characterize next generation probiotics; evaluate novel food and traditional foods impacts on gut microbiota; role of microbiome on the drug metabolism and on cancer immunotherapy.

***In the Agrifood system*:** more knowledge on soil/marine sediment/water plant and animal associated microbiomes and its exploitation for a) the protection of national primary production from nutritional, biotic and abiotic stresses and the improvement of its sustainability and the specificity, quality and nutritional and healthy properties the products and deriving food and feed.

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Italian Microbiome Implementation Action Plan (IAP)

Presidenza del Consiglio dei Ministri

CNBBSV
COMITATO NAZIONALE PER LA BIOSICUREZZA LE BIOTECNOLOGIE E LE SCIENZE DELLA VITA

IMPLEMENTATION ACTION PLAN

(2020-2025)

FOR THE ITALIAN MICROBIOME INITIATIVE

July 2020

http://cnbbsv.palazzochigi.it/en/areas-of-work/bioeconomy/microbiome/

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25 NATIONAL INDUSTRIAL ASSOCIATIONS FROM THE HEALTH AND THE FOOD SYSTEMS DOMAINS WERE INVOLVED IN THE IAP CONSULTATION

PERSONE
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Microbiome R&I needs and opportunities in the Italian Bioeconomy strategy (BIT II, 2019) & Implementation Action Plan (2021)

http://cnbbsv.palazzochigi.it/media/1774/bit_en_2019_02.pdf

"National Bioeconomy Coordination Board"

CNBBSV, Presidency Council Ministers

Launched in March 2019 and confirmed with a decree in Jan. 2021

- Min. Agriculture, Food, Forestry Policies;
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- Min. Economical Develop.;
- Min. University & Research;
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- Agency territorial cohesion;
- Institute for Environmental Protection and Research;
- SVIMEZ;
- Italian Technology Clusters: Circular Bioeconomy SPRING, AgriFood CLAN, BlueGrowth BIG.

IMPLEMENTATION ACTION PLAN (2020-2025) FOR THE ITALIAN BIOECONOMY STRATEGY BIT II

January, 2021

http://cnbbsv.palazzochigi.it/en/areas-of-work/bioeconomy/strategies-and-implementation-action-plan/

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1. Italian Microbiome IAP: implementation of policies, standards, labels, financial instruments and emerging market-based actions

- Develop and promote **standards and related labelling**, for conventional microbiome-related products;
- Harmonize **EU legal framework in the sector, establishing the conditions for classifying strains with probiotic status**;

- Launch **showcases/public fora on microbiome and the human health and diseases** (communicable and noncommunicable diseases);

- Promote an entrepreneurial mind-set and **accelerate the scale-up of innovative solutions**;

- Encourage **tailor-made private finances** by raising awareness in investors (e.g. banks, “business angels”, insurers, pension funds, investment funds, crowdfunding schemes);
- Promote **microbiome priorities** in the pharma and food systems **in the** frame of **national and regional Smart Specialization Strategies and national funding programmes**;
- Act to increase the **EU financial support to the sector**, by helping them to improve their bankability and investment-readiness, structuring their financing and liaising with private investors.

2.Italian Microbiome IAP: Microbiome-based industrial actions in the pharma and food systems domains (a)

- **Production of Next generation probiotics** *(characterization new LBPs, identifying the most active ones in restoring healthy microbiome status and reliable efficiency biomarkers; approval probiotics health claims)* (TRL3)
- **Use of probiotic formulation on human gut microbiota eubiosis and host health** *(formulation of oral multi-probiotics combinations resistant to gastric environment, addressing/overcoming regulatory issues)* (TRL 4)
- **Exploit knowledge on Microbiome and drug metabolism** *(longitudinal and cross-sectional studies on microbiome from human clinical trials, throughout drug development phases, with post marketing studies, with analysis of efficacy and ADMET data, and multi-omics/microbiological studies correlations with the microbiome fingerprint; In vitro screening of active principles and drug formulations)* (TRL 3)
- **Exploit knowledge on microbiome and metabolism of nutraceuticals and xenobiotics** *(test characterized extracts in simulated human gut microbiota models to determine metabolomic profiling of products and for their ability to a) impact on cross the intestinal barrier, b) interact with probiotics, c) affect the microbiota diversity and d) impact on cellular activation and epigenetics and set-up formulation technologies, pilot pharmacokinetic studies in human volunteers and pilot proof-of-concept clinical studies)*(TRL 4);
- **Exploit knowledge on microbiome and prevention and progression of some pathologies** *(Systematic collection and analysis of microbiome and metabolites at different stages of disease and assessment of the microbiome changes during disease progression, and development of microbiome-based products either as novel foods, foods for special medical purposes, or drugs, also able to on the small intestinal axis to contrast Neurological and Psychiatric, respiratory, Cardiovascular diseases, Diabetes* (TRL 3 and 4)
- **Exploit the nexus Microbiome, Enteral Nutrition and Special Nutrition** *(targeted approaches with probiotics to restore the microbiota and prevent inflammation and infection during a patient's recovery)* (TRL 4)

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2.Italian Microbiome IAP: Microbiome-based industrial actions in the pharma and food systems domains (b)

- **Exploit role of microbiomes in Carbon fixation and nutrients availability in soils, sediments, water (***increase soil organic matter through the addition of compost, biochar, biodegradable soil mulch and biofertilizers and sequential stimulation and monitoring of native microbiomes)* (TRL 4)
- **Exploit role of microbiome in the sustainable animal production, health and welfare with reduced use/replacement of antimicrobials** *characterization of microbiomes from different animal species, production systems, body sites, with of eubiotic substances and their effects on animal welfare, feed conversion, GHGs (TRL 3 and 4); Develop microbiome based feed additives to increase animal resistance against pathogens (TRL 4) and non-antibiotic therapeutics to treat specific animal diseases (TRL 3). Indigenous microbioma management in silage to prevent pathogenic microorganisms and mycotoxins*)(TR 4)
- **Exploit role of microbiome on the vegetal primary production and antibiotics replacement** *Develop microbiome based "biofertilizers" to increase root systems (TRL 5), "bioactivators" for improved plant assimilation of nutrients (TRL 4) and "BioProtecting agents" to reduce effects of pathogenic fungi/insects (TRL 3).*
- **Exploit role of microbiome in the production of food and beverage (***new raw materials able to improve nutritional properties of fermented confectionery products (TRL 7); development confectionery products able to induce positive effects on the microbiota (TRL 6);*
- **Determine and contrast mycotoxins effects on Microbiome;**
- **Exploit microbiome knowhow in environmental biotechnology applications (***Develop microbiome management approach to efficiently enable soil/sediment/wastewater/biowaste microbiome structure and functions, and to optimize/improve efficiency, stability and reproducibility of full scale processes/practices/technologies)*(TRL7-8)

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3. Italian Microbiome IAP: Promote field-scale cooperation, awareness, education, training, skills across microbiome sciences

- **Promote/sustain the establishment of tailored partnerships among farmers, bioremediation/wastewater/biowaste exploiting companies and microbiome scientists to develop and then validate full scale microbiome-based approaches** to optimize efficiency, stability and reproducibility of the full scale soil, sediment and wastewater bioremediation and biowaste exploitation processes/technologies;
- **Facilitate microbiome based products acceptance by the society/consumers,** via portals gathering affective information, organizing “open days” in companies and technical information campaigns;
- **Teach microbiome concepts in high schools, in specialist vocational life sciences courses** (schools of agronomy, schools of medicine, medical specialization schools, chemistry, pharmacy and biology courses, agricultural teaching, school education), in training courses, Summer Schools, Continuing Professional Development Modules, Satellite Workshops etc;
- Support the **inclusion of microbiome and the pharma and food system concepts inside academic** Health and Bioeconomy-related **Bachelors’ degrees, Masters’ degrees programs.**

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