Microbiomes should be incorporated into The One Health Joint Plan of Action

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The One Health Joint Plan of Action was created by major international organizations to tackle global health issues related to human, animal, plant, and environmental health. This article emphasizes the importance of integrating microbiomes into this framework to enhance health systems and prevention strategies

In 2022, four major international organizations—the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the World Health Organization (WHO), and the World Organisation for Animal Health (WOAH)—introduced the One Health Joint Plan of Action (2022-2026). This initiative outlines an ambitious framework to address global health challenges at the intersection of human, animal, plant, and environmental health. In particular, the document recognizes that individual disease-causing microorganisms and those that carry antimicrobial resistance (AMR) interact at this intersection. Yet despite its comprehensive scope, the plan omits explicit mention of microbiomes. This omission undervalues the potential for microbiome-based solutions to address global health challenges and misses an opportunity to move towards more proactive prevention through microbiome-based approaches.

Two global summits, ‘Microbiomes, Biodiversity & Their Impact on Global and One Health’, held in October 2023 in Annecy, France, and in February 2025 at the University of South Florida (Tampa, FL), brought together a diverse group of microbiome scientists, industry leaders, educators, and food systems experts to develop a roadmap that explicitly integrates microbiomes into the One Health framework.

Microbiomes as the foundation of One Health systems

Microbiomes are the complex communities of microorganisms that inhabit all ecosystems on Earth. They perform vital functions for all multicellular life and are engines of planetary nutrient and carbon cycling. In plants, animals, and humans, microbiomes engage in symbiotic relationships with their hosts and aid in pathogen suppression, immune regulation, and digestion, among other services. In the environment, they regenerate soils, purify water, degrade pollutants, and regulate greenhouse gases. Moreover, pathogenic and AMR-carrying microorganisms do not live in isolation but are embedded in these complex microbial communities that also move between humans, animals, plants,

and ecosystems. These insights demonstrate that addressing One Health objectives requires a deeper understanding of microbiome dynamics within and across host and environmental systems.

Aligning microbiomes with the six action tracks of the One Health Plan

The One Health Joint Plan of Action identifies six action tracks. Integrating microbiome science into each offers additional opportunities for innovative solutions and prevention strategies.

1. Enhancing One Health capacities to strengthen health systems:
   Microbiome science offers a unifying perspective, reframing the interface as a biome-biome interaction. Practical applications of this reframing have implications for training and regulatory approaches.
2. Reducing risks from zoonotic epidemics and pandemics:
   Microbiome research can illuminate pathogen dynamics within host and environmental microbiomes, enabling earlier detection and intervention. Predictive modelling and microbiome surveillance networks could enhance early warning systems for emerging diseases.
3. Controlling endemic zoonotic, neglected tropical, and vector-borne diseases:
   Microbiome-based interventions can address diseases with complex host-vector-environment interactions. Surveillance systems monitoring microbiome shifts can provide early warnings of disease risks, while legal frameworks could incorporate microbiome considerations into public health and agricultural policies.
4. Strengthening food safety:
   The soil-plant-animal-food continuum underscores the centrality of microbiomes in ensuring food safety and sustainability. Microbiome-based approaches in agriculture, including probiotics (bioinoculants) and prebiotic inputs, can reduce the use of chemical fertilizers. Bioremediation strategies, such as employing beneficial microbes to inhibit mycotoxin-producing fungi, can safeguard crops. Public awareness campaigns, farmer education, and consumer initiatives can promote microbiome-friendly practices.
5. Combating antimicrobial resistance (AMR):
   The indiscriminate use of antimicrobials has disrupted microbiomes, fostering antimicrobial resistance. Microbiomes can be leveraged to mitigate AMR through targeted antimicrobial strategies, microbiome restoration, and monitoring of resistance genes in crops, livestock, and aquaculture.
6. Integrating the environment into One Health:
   Environmental microbiomes are pivotal to biodiversity conservation and ecosystem resilience. Regenerative agriculture practices, such as reducing tillage and using organic fertilizers, can enhance soil microbial diversity and carbon storage. Microbial inoculants can aid ecosystem recovery, while microbiome monitoring can inform biodiversity targets under frameworks like the Paris Agreement.

Recommendations for integrating microbiomes in One Health

Realizing the potential of microbiome science within the One Health framework requires coordinated global action. The Quadripartite (FAO, UNEP, WHO, WOAH) should lead efforts to revise the Joint Plan of Action, establish high-level working groups, and secure political commitment. Key recommendations include:

- Global microbiome surveillance and monitoring:
  Microbiome data must be incorporated into existing databases, enabling interdisciplinary research and surveillance. Standardized protocols for monitoring, data sharing, a nd cross-sectoral integration of microbiome data should be developed.
- Microbiome-informed antimicrobial resistance (AMR) strategies:
  AMR surveillance should be conducted within broader microbiome surveillance.
- Food safety and security:
  Policymakers could incentivize the use of microbiome-based products, such as evidence-backed probiotics and soil inoculants, to enhance food safety by reducing the use of chemicals that inhibit beneficial microorganisms.
- Protecting microbiome diversity in ecosystems:
  Microbiome diversity should be recognized as a useful indicator of environmental health. Industrial and agricultural practices that harm microbiomes should be regulated, while those that support microbiome restoration and resilience should be encouraged.
- Integrating microbiome science into One Health education:
  Microbiome literacy programs should target diverse stakeholders, from healthcare professionals, veterinarians, and farmers to policymakers. This training should emphasize the systemic role of microbiomes in health and sustainability, interdisciplinary research on microbiome interactions at the human-animal-environment interface, and dietary guidelines that support gut microbiome health. Advanced training in technologies like metagenomics and field-based workshops should complement theoretical education.
- Public-private partnerships:
  Collaborative efforts can fund research to advance microbiome-based solutions in agriculture, medicine, food safety, and environmental management. These partnerships can drive innovation and make microbiome interventions accessible to all countries.
- Policy integration:
  Governments should prioritize microbiome health in regulations addressing food safety, environmental conservation, and antimicrobial use. Policies promoting microbiome-based practices can advance Sustainable Development Goals.

Incorporating microbiomes into the One Health agenda is essential for addressing interconnected health challenges. Microbiomes influence disease dynamics, environmental resilience, food security, and antimicrobial resistance. By integrating

microbiome science into the Joint Plan of Action, the Quadripartite can foster more precise, sustainable, and cross-sectoral solutions to global health issues. This approach will enhance resilience to health threats, improve nutrition, combat AMR, and promote sustainable ecosystems, underscoring the transformative potential of microbiome-based strategies for global health.

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