Cross-cutting challenges

Vision Statement:

Addressing cross-cutting challenges will unlock the potential for a microbiome-based blue economy, leading to high quality food products, biological discoveries, and healthy marine ecosystems.

Challenge 1. Demonstrate the socio-economic value of marine microbiomes - The socio-economic value of sustainable food production, biodiscovery, and climate change mitigation is widely recognized. Our challenge is to demonstrate how marine microbiomes contribute to these activities.

We must translate the science of marine microbiomes into investable propositions, such as

- *discover and produce pharmaceutical products from marine microbiomes*
- *manipulate the gut and skin microbiomes of fish to enhance food production*
- *forecast changes in the cycling of carbon by ocean microbiomes and its impact on climate change*[1]

Challenge 2. Increase our capacity to share infrastructures - A needs-based approach for microbiome research is required to address local and global scale challenges with the successful engagement of science, industry, policy, NGOs, civil society and citizens.

We must increase our capacity to mobilise and share existing infrastructures across these sectors in order to

- *explore at basin scale, e.g. sampling from research, merchant, and citizen boats*
- *monitor at local scale, e.g. coordinating marine stations, oil platforms, and wind farms*
- *engineer solutions, e.g. sharing use of biobanks, analytical tools, mesocosms and bioreactors*

Challenge 3. Transfer technology across science and industry - The study of the human gut microbiome led to holistic health diagnostics and innovative treatments in just over a decade. Marine microbiomes offer the same potential to transform ocean science.

We must ride the technology wave and transfer its potential by

- *rapidly adopting next generation genomics and imaging methodologies*
- *embarking genetic and bio-optical sensors on autonomous sampling vehicles*
- *using bioinformatics, artificial intelligence, and complex systems modelling*

Challenge 4. Assess the risks and ethics related to microbiome science & technology - Solutions to local and global problems may involve manipulating abiotic conditions (e.g. nutrients) and modifying the genetic code of microbes in controlled or natural environments.

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[1] "Cycling of carbon" refers to the uptake and respiration of CO_2, its transfer to pelagic (water column) and benthic (seabed) food webs (e.g. supporting fish, corals, seaweed), or its sequestration in sediments.

We must act responsibly and assess the risks and ethics of technological solutions, including evaluation of issues such as

- *using genetically modified microbes to enhance food production*
- *modifying the composition of microbiomes to prevent harmful algal blooms*
- *fertilising the ocean to favour microbiomes that mitigate climate change*

Challenge 5. Preserve bio-resources and share their benefits - The UN Convention on Biological Diversity (CBD) set out the Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation.
We must guide science and industry in addressing the CBD, fostering

- *long-term preservation in biobanks*
- *proper documentation of rights for redistribution*

full traceability of their use and benefits

Challenge 6. Spark fascination about marine microbiomes - Communication about ocean science tends to focus on large-size, charismatic organisms such as whales, sharks, octopuses, lobsters or starfish. It is time to learn about the marine microbiomes.
We must contribute to ocean literacy, working with

- *artists and aquariums on developing concepts for charismatic marine microbes*
- *schools and citizen science programmes linked to pleasure and sport sailing*

the World Microbiome Day to bring attention on marine microbiomes

Challenge 7. Develop standards and common methodologies - The study of marine microbiomes combines classical microbiological techniques with next-generation genomics and modeling, which generates a wealth of heterogeneous knowledge in need of integration.
We must adopt common methodologies that are

- *coherent across exploration, monitoring and engineering activities*
- *adaptable to the capacity of the different sectors (science, industry & citizens)*
- *interoperable and fit for integrative science*

Challenge 8. Adopt best practices and the FAIR principles for scientific data - Over the last decade, Europe, Canada and the U.S.A. developed number of research infrastructures aimed at making knowledge Findable, Accessible, Interoperable and Re-usable (FAIR).
We must promote research infrastructures and train science and industry in using

- *data services, including ontologies, long-term preservation and interoperability*
- *cloud computing services that allow big data assembly and shared analysis pipelines*
- *discovery services such as text mining, linked publications and bibliometrics*