

Biodiscovery

Vision Statement:

The Marine Microbiome will Propel Biodiscovery, Providing New Sources of Value to Society

Background

Microorganisms contain a plethora of metabolic pathways that allow them to exist and thrive in a variety of challenging environments. These pathways can yield beneficial products such as medicinals, nutraceuticals, and compounds for industrial applications. Furthermore, characterization of new genes, proteins, and metabolic pathways can advance our basic scientific understanding of marine biodiversity, as well as identify targets for ecosystem monitoring, bioindication, and bioremediation.

Biodiscovery can be viewed from a variety of perspectives. Though often understood in an industrial or commercial sense, biodiscovery can yield numerous benefits to the not-for-profit sectors, such as academia and government. In academia, continually evolving research programs may be used to document and understand biodiversity, gain mechanistic understanding of ecological relationships, and increase the overall knowledge base of a discipline. Environmental managers may prioritize research that yields cause-effect understanding and indicators that can be used to manage the impact of anthropogenic activities on ecosystem services. From an industrial perspective, profitability is a necessary science outcome, so research priorities may include investigations into biomolecules, synthetic pathways, and other marketable technologies with protection of intellectual property and minimal restrictions. Although the aims and priorities of these groups may differ, collaboration will multiply the value of marine microbiome research into innovative products and services.

The potential for biodiscovery in the marine environment remains largely untapped due to the sheer size of the ocean realm and the inaccessibility of areas such as the deep sea. Furthermore, the search for bioproducts has largely been limited to single microbial types, rather than the microbiome as a whole. Such a narrow focus limits prospects for discovery, as 1) few marine microbes can be cultivated in isolation and 2) bioactive compounds may be produced only when multiple microorganisms interact as a community. Consequently, microbiome-scale biodiscovery is a promising and challenging task that will be best accomplished through multidisciplinary collaboration.

Goals

- Support the science of marine microbiome biodiscovery
- Demonstrate the value of microbiome research and development to resource and industrial managers for solving their current and near-term management needs
- Inspire marine microbiome entrepreneurship, develop the next generation of innovators, and stimulate job growth
- Facilitate Open Innovation and Technology Transfer through early connections between science and industry

Specific Objectives

- Go beyond traditional bioprospecting that focuses on single microorganisms, towards discovering biological compounds that are obtained only through complex interactions involving whole microbiome communities
- Create the basic framework to incorporate microbiomes into environmental monitoring approaches and practices through the development of standardized sampling technologies and protocols and establishment of recognized thresholds
- Develop methods to analyze and model microbiome communities, including metabolic profiles, and take full advantage of post-genomic technologies, such as shotgun metagenomes, transcriptomes, proteomes, single cell genomes, metabolomes, and synthetic biology along with bioinformatic analysis pipelines
- Manipulate and bioengineer microbiome products that ensure the sustainable use of marine bioresources
- Ensure open access and benefit sharing in balance with agreements and negotiations to protect intellectual property, that is needed to enter into industry partnerships to meet Cross-Cutting Challenges

Action Items

Short Term

- Identify champions to support the advancement of marine microbiome discovery
- Develop a portfolio analysis with an eye on creating connections and leveraging opportunities between government, academia, and industry, as well as using the input of special interest groups like NGOs, and the general public

Medium Term

- Implement demonstration project(s) using engaged stakeholders to model the biodiscovery process, including navigation of contractual obligations and connection to industry partners
- Provide access to technical training (bioinformatics, etc.) and opportunities that inspire entrepreneurship

Long Term

- Develop research projects to address priority topics to conduct the science and engineering needed to prime the research transition pipeline, with encouragement of small-medium enterprises
- Identify and develop guidelines and alliances to balance the need for open access to data and the need by industry to protect business interests in creating value from marine microbiomes through bioprospecting
- Communicate results to familiarize managers and policy makers about the microbiome and to develop management strategies that encompass ecosystems rather than single species