National Microbiome Initiative

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Microbiome – the collection of microorganisms associated with a particular habitat
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VIRTUALLY EVERY HABITAT ON EARTH
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Topics

- Origins of the National Microbiome Initiative
- Goals of the Initiative
- Commitments
- Challenges and Policy
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Obama Administration Priorities

- Applications needed for President’s priorities
  - Precision medicine
  - Energy
  - Agriculture
  - Climate change

- Economic growth
  - Private-sector investments in the microbiome have surged
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Fact finding

OSTP

- Convened 12 Federal departments and agencies
- Convened several groups of scientists
- Issued request for information in Federal Register
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Cross-cutting Themes Emerged

Common questions across biological systems
- What is a healthy microbiome?
- What is the nature of a robustness?

Technology needed to
- Detect, measure, and model in multi-dimensions the chemical currency of microbial communities
- Develop computational tools to analyze vast datasets
- Model community behavior

Applications
- Alter microbiomes predictably and reliably
Parallels Among Microbiomes

Examples
Gut Microbiome Behavior After Antibiotics

Figure 2. Overview of microbial response to the DWH oil spill. Data from numerous studies following the DWH oil spill are represented in this schematic using approximations from the published data referenced. 1, Kostka et al., 2011; 2, Yang et al., in press; 3, Redmond and Valentine, 2012; 4, Hazen et al., 2010; 5, Mason et al., 2012; 6, Valentine et al., 2010; 7, Kessler et al., 2011b; 8, Dubinsky et al., 2013; 9, Mason et al., 2014b; 10, Kimes et al., 2013; 11, Liu and Liu, 2013.
Weighted UniFrac distances between each July time point and the day before the mixing manipulation began, day -9. (a) Epilimnion (0 m) UniFrac distances. (b) Hypolimnion (4 m) UniFrac distances. The red line is the overall mean UniFrac distance for all possible epilimnion or hypolimnion July pairs. The dotted lines and red shading show one standard deviation from the overall mean. Pyrosequencing data were used for this analysis.
To harness microbiomes, we need to

Alter microbiomes predictably and reliably

Understand robustness
Attempting to change microbiomes is not new

- Mechnikov consumed liters of yogurt containing *Lactobacillus* each day.

- *Lactobacillus* disappeared from his microbiome upon cessation of yogurt consumption.

- Many microbiomes are resistant to and recover from change.
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Goals of the Initiative

❖ Interdisciplinary research on fundamental questions about diverse microbiomes.

❖ Platform technologies for probing and changing microbiomes and data access.

❖ New workforce through citizen science, public engagement, and educational opportunities.
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**Commitments**

- U.S. Government invested more than **$900 million** over 2012-2014 in microbiome research

**New Investments**

- **$120 million** of U.S. Government-supported research
- **$400 million** in new commitments from non-Government groups
Examples of Non-Governmental Commitments

• **Themes:**
  – Comparison across microbiomes
  – Universal tools to study microbiomes

• Universities will develop microbiome centers

• Foundations will support new research programs
  – Gates $100 million for human and agricultural microbiomes
  – Simons — $XX for tropical forest studies
  – Moore — $XX for ocean microbiome

• Private sector will initiate new research programs
Predicted Outcomes of National Microbiome Initiative

• Unifying ecological principles
• Tools to probe microbiomes — microscopic and chemical profiles
• Tools to change microbiomes
• Products for humans, animals, agriculture, and environmental quality
Policy Challenges for Human Microbiome

• Fecal transplants — safety? consistent performance?

• Probiotics — labeling, quality control, claims

• Drugs —
  – targeting microbiome with drugs
  – non-target effects of all drugs on microbiome

• Prebiotics

• Diet

• How to unite microbiome research to reveal universal ecological principles?
International Collaboration on Microbiome

• How can our governments collaborate to maximize benefit from microbiome research?

• Are there adequate mechanisms for our scientists to collaborate internationally?
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