

Now is the time to uncover the secrets of the Earth's microbiomes

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Communities of microorganisms called microbiomes play critical roles in our lives, yet we know very little about them.

A group of 48 biologists and physical scientists from 50 institutions is aiming to change that. In the October 30 issue of the journal *Science*, they called for an ambitious research effort to understand and harness microbiomes. Such research could lead to advances in fields as diverse as medicine, child development, agricultural productivity, and climate modeling.

Now, in a far-ranging roundtable discussion, three of the paper's co-authors explain to The Kavli Foundation why this is the time to launch a major national effort—the Unified Microbiome Initiative—to study the planet's least understood ecosystems.

"In the past, we did not fully understand the complexity and richness of microbiomes, and we were limited because we could not grow the majority of bacteria in a lab, and so they were hard to study," explains Janet Jansson. Jansson is Chief Scientist of Biology in the Earth and Biological Sciences Directorate at Pacific Northwest National Laboratory (PNNL) and sector lead for PNNL research in the Department of Energy's Biological Systems Science Division.

Over the past 15 years, however, the cost of genome sequencing has fallen by a factor of 1 million. This made it possible for the first time to survey the richness of microbial communities. The research has led to

the discovery of hundreds of new and unexpected bacterial phyla, which are large groupings of related lifeforms.

New genomic tools have vastly expanded our understanding of the role microbiomes play in our lives, Rob Knight explains. He is a founder of the American Gut Project and holds joint appointments at the University of California, San Diego, School of Medicine and Department of Computer Science and Engineering.

"Remember, 10 years ago, microbes hadn't been linked to any of the things we now know they're involved in, such as obesity, allergies, depression and brain development. While the links between the microbiome and metabolism have certainly been very surprising, what surprised me the most has been the links between the microbiome and behavior. This was not even on the radar 10 years ago," Knight says.

The Unified Microbiome Initiative calls for developing a new generation of scientific instruments that would let researchers study how microorganisms within a community interact with one another and their environment. This knowledge would make it possible to manipulate microbiomes to improve healthcare, agriculture and the environment.

The impact of microbiome research on human health alone could be profound. Over the past 10 years, researchers have discovered that the composition of the gut microbiome - which contains 10 times more cells and 100 times more genetic information than the human body - can determine how medicines are metabolized.

And physicians have demonstrated that transplanting healthy microbiomes into patients afflicted with colitis, an inflammation of the lining of the colon, caused by *Clostridium difficile* is three to four times more effective than antibiotics.

"This is actually the first proof of principle that we can manipulate microbiomes in a very deliberate way to treat a serious human disease," says Jeff Miller, lead author of the *Science* paper. Miller is director of the California NanoSystems Institute, holds the Fred Kavli Chair in NanoSystems Sciences, and is a professor of Microbiology, Immunology & Molecular Genetics at University of California, Los Angeles.

Microbiomes also play an important role in global ecosystems. Jansson, for example, studies how microbiomes behave as Arctic permafrost thaws. She hopes to learn how this will affect the metabolism of microbiomes that cycle carbon so scientists can model the impact on climate change.

Microbiomes also play an important role in agriculture, where they provide plants with essential nutrients and even enzymes.

However, the ability to engineer microbiomes also raises some flags.

"Whenever we manipulate something in an animal or a human being, we need to consider the ethical issues. But the idea of potentially engineering Earth's microbial ecosystems raises very legitimate questions," Miller says.

More information: Read the full conversation with Janet Jansson, Rob Knight and Jeff Miller at: www.kavlifoundation.org/scienc...-time-map-microbiome

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