Nanoscience provides insights into the world's smallest ecosystems

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Microbiomes, communities of one-celled organisms, are everywhere in nature. They play important roles in health and agriculture, yet we know surprisingly little about them. Nanoscience might help.

In a far-ranging discussion, two top researchers spoke with the Kavli Foundation about how nanoscience can help us understand and manipulate natural microbiomes.

Microbiomes are communities of bacteria, fungi, protozoa, algae, other one-celled microbes, and viruses that interact with one another in complex ways. These ecosystems are enormously complex. A few grams of soil or marine sediment might contain as many as several hundred thousand different species of microbes.

"There are all these amazing chemistries that microbes perform that can do really wonderful things for humanity, like providing new antibiotics and nutrients for crops. It's pretty much an unlimited resource of novelty and chemistry—if we can develop improved tools to tap into it," said Eoin Brodie, a staff scientist in Lawrence Berkeley National Laboratory's Ecology Department.

In the past, researchers have sought to understand these communities by growing different microbes in cultures and observing their behaviors. Yet only a small fraction of these microorganisms grow in pure cultures.

Nanoscience could provide new ways to unravel these complex

ecosystems, according to Jack Gilbert, a principle investigator at Argonne National Laboratory's Biosciences Division.

One way to gain insight into microbiomes is to tag an amino acid or food particle with quantum dots and irradiate them so they glow. This would show which microbes were active and how they respond to different environmental stimuli over time, Gilbert explained.

Nanoscience could also help researchers to "knock out" microbiome species the way we knock out genes in DNA. This would enable scientists to study what individual strains contribute to the community.

Brodie believes we could use nanoscale sensors similar to those being developed to investigate the brain to study the soil. These chip-sized devices would be inexpensive and powered by radio waves, so they would not need batteries to take readings and transmit data. Researchers could seed the soil with tens of thousands of these sensors and observe how the microbiome changed as plant roots push through the soil.

Similar sensors could help us understand how bacteria develop antibiotic resistance and form disease reservoirs in hospitals, said Gilbert, who is studying the evolution of microbiomes in medical facilities.

Both Brodie and Gilbert believe we could achieve important results by manipulating microbiomes.

Brodie, for examples, believes that by modifying bacterial colonies that transform atmospheric nitrogen into fertilizer and that already live on many plants, we could reduce or eliminate the need for fertilization.

Gilbert believes microbiomes could improve health. A growing body of research links such inflammatory disorders as asthma and eczema with personal microbiome health. Gilbert is trying to create ideal habitats for

healthy microbiomes in our homes, office buildings, and public spaces. These habitats would expose people, especially infants, to the microbes they need to strengthen their immune systems.

Gilbert calls the confluence of nanoscience and microbiome research a nascent field.

Brodie agrees: "We clearly need to work across disciplines and keep extending our networks of researchers. We need to keep reaching out."

More information: Read the full conversation with Brodie and Gilbert on the Kavli Foundation website: www.kavlifoundation.org/scienc … res-many-microbiomes.

Provided by Kavli Foundation

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