# Using microbial consortia may boost success of biotechnologies

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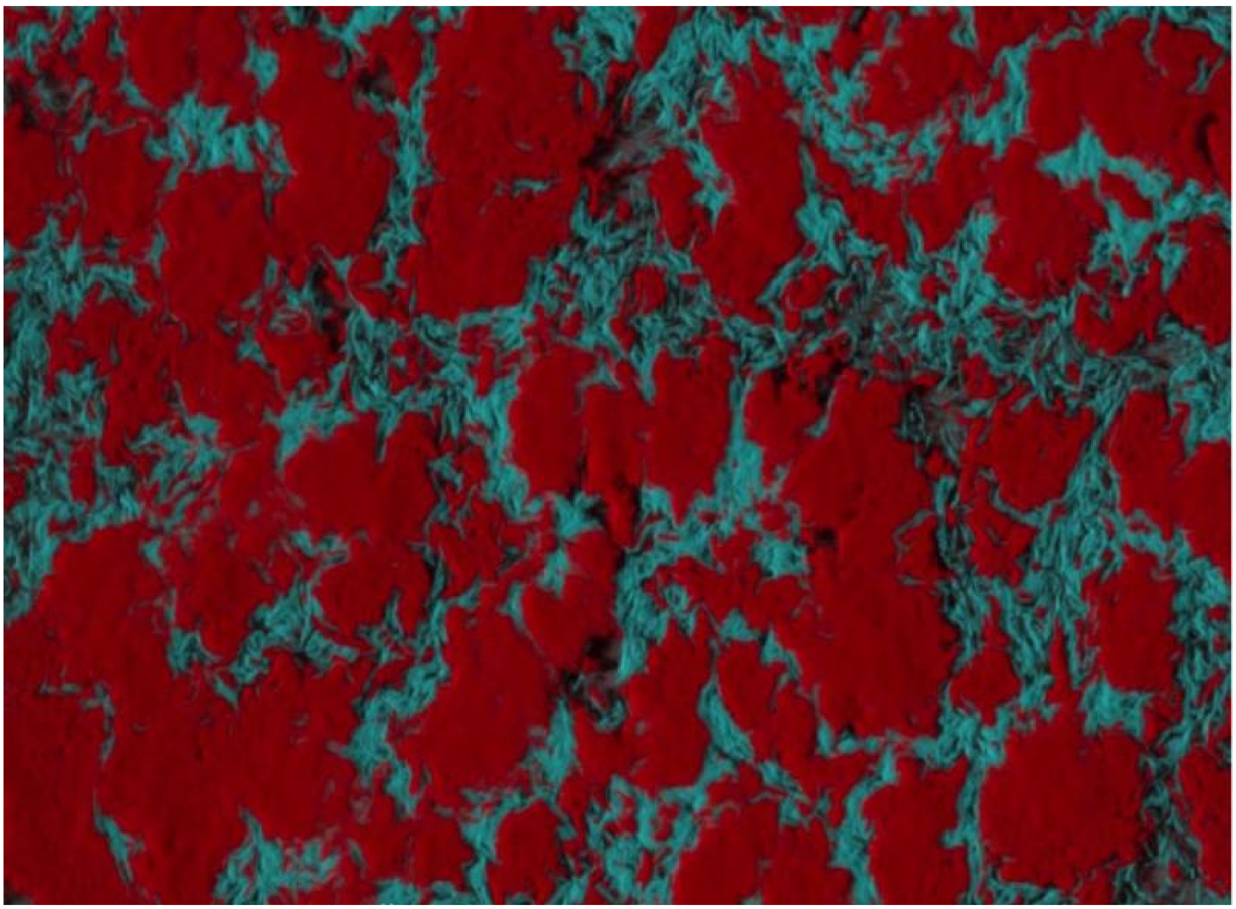

This is a synthetic microbial biofilm community built from a cyanobacterium, Synechococcus PCC 7002 (red), supporting a metabolically engineered “biofuel catalyst” strain of Escherichia coli (blue). PNNL researchers and collaborators examined the state of the science for bioengineering to determine how microbial multi-species consortia can be more successful in developing biotechnologies for renewable energy. Credit: H.C. Bernstein

Around the world, researchers are studying microbes to see if these tiny organisms can be used to solve a host of problems, from cleaning up toxic waste to providing renewable energy. Unfortunately, attempts to develop biotechnologies often fall short because they focus on a limited set of single, highly engineered organisms. Such organisms frequently do not perform as efficiently or stably in an application as they do in the laboratory.

Now, an internationally recognized group of scientists, organized by Pacific Northwest National Laboratory microbiologists Dr. Stephen Lindemann and Dr. Alexander Beliaev, has reviewed the state of the science to determine how biotechnological use of communities of multiple microbes, or microbial consortia, might transcend the limitations of single organisms.

They posit that the time is ripe for design and control of microbial communities, and that achieving the ability to engineer microbial ecosystems will require a level of understanding of the mechanisms driving microbial community function only possible from combining recent advances in systems biology, computational modeling, and synthetic biology.

These new perspectives stemmed from a panel at the 15th International Symposium on Microbial Ecology in Seoul and appear in the International Society for Microbial Ecology's (ISME) official publication, the *ISME Journal*.

Agriculture has long known that monocultures, or growing only one type of crop, can be susceptible to changes in the environment. For example, relatively small or poorly timed changes in rainfall can cause major losses in production for some crops. In contrast, growing several crops with different tolerances to drought might more stably provide food, no matter the weather for a given year. The same principle applies to microbes, which are drivers of global geochemical cycles and catalysts for renewable fuels and chemicals. Microbial communities can prove to be more reliable than engineered "superbugs" and more robust against unpredictable environment than individual microbes. This reliability is the key to using them for industrial purposes.

"The promise that this field has to offer is great," said Beliaev. "Transformative biotechnologies will help overcome the energy, health, and environmental problems of the future, and the process of learning to design and control ecological phenomena has and will undoubtedly continue to yield new insights on the fundamentals of life."

Seven scientists from PNNL, Montana State University, Fred Hutchinson Cancer Research Center, and the Swiss Federal Institute of Technology brought perspectives from different scientific approaches, research programs, and countries to analyze the state of the science. They used questions posed by experts who attended the ISME symposium to outline key issues.

Drawing on their years of experience and amassed knowledge, the group determined that successful biosystems design is contingent both on the understanding of microbial physiology and accuracy of computational models that describe how organisms interact. An iterative design-build-test approach that can predict interspecies dynamics and analyze energy and material flows in a community will help scientists better understand how these consortia can be used for biotechnologies.

PNNL's microbial research program continues to expand the foundation of biological systems design. Ideally, advances in this field will allow scientists to control safety, productivity, and stability of natural and designed microbial ecosystems.

**More information:** Stephen R Lindemann et al. Engineering microbial consortia for controllable outputs, *The ISME Journal* (2016). DOI: 10.1038/ismej.2016.26

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