Unexplored microbes hold incredible potential for science and industry

February 15 2008

Humans live in the midst of a seething, breathing microbial world. Microorganisms populate every conceivable habitat, both familiar and exotic, from the surface of the human skin, to rainforest floors, to hydrothermal vents in the ocean floors.

Despite the powerful and pervasive role of microbes in sustaining life, most of the microbial world remains a mystery. This is the subject of The Uncharted Microbial World: Microbes and Their Activities in the Environment, a new report released by the American Academy of Microbiology.

The report is the result of a colloquium convened by the American Academy of Microbiology in February 2007. Researchers in microbiology, marine science, pathobiology, evolutionary biology, medicine, engineering, and other fields discussed ways to build on and extend recent successes in microbiology, and the report is a record of their discussions and recommendations.

Microbes fulfill many functions that make life on Earth possible. They are the engines behind the global biogeochemical cycles that release oxygen and absorb greenhouse gases in the atmosphere. They recycle dead material into useful nutrients for new growth. They influence food webs, bioenergy production, waste management and treatment, food production, and symbiotic nitrogen fixation for plants.

"As the number of people on the planet grows, reliance on

microorganisms to perform these critical tasks will grow as well," says Carrie Harwood of the University of Washington, one of the report's authors. "The stakes are high, and we need to accelerate the pace of discovery."

Because microbes play so many roles in so many environments, they hold incredible potential for industry, agriculture, and medicine. Bioprospecting has already opened the door to many commercial applications -- including probiotics, biofuels, and wastewater treatment. The wealth of bacteria, viruses, and other microorganisms that have yet to be cultivated or understood offer a tantalizing untapped resource for industry, agriculture, and medicine.

Not only do microbes shape the environments around us -- they also play complicated roles in the human body. "We have very limited understanding of complicated microbial environments at work in the body, such as the gut and the teeth," Harwood says.

Much more microbial research is needed to understand microorganisms and tap into their potential, and the report offers a number of recommendations related to methodology and research tools, including:

-- Researchers need more methods to mimic the conditions microorganisms encounter in their natural habitats, particularly in conditions in low-nutrient environments and in nutrient and oxygen gradients that form at surfaces.

-- Microbiology needs to move beyond its dependence on pure cultures of organisms and appreciate the value of the defined but mixed communities of microbes. It may not always be possible to separate microorganisms that have coevolved to fit one another's functions and isolate them in pure cultures.

-- Current technologies for making measurements at the microscale need enhancement. Work is also needed to miniaturize scanning electron microscopy and other microscopic tools, develop biosensors, and to generally improve the ability to make in situ (in place) environmental measurements.

In addition, more collaboration across scientific specialties and with industry is needed. Collaborations are the hallmark of successful microbiology research, providing new perspective, fruitful dialog, and creative approaches.

"Collaborating on microbial studies can be challenging because academic departments are often structured in ways that inhibit interdisciplinary research," Harwood explains. "International collaboration also poses challenges, since strict customs measures have made it very difficult to move microbiological samples across borders."

More broadly, the report calls for improved training programs in microbial science that emphasize critical thinking and hypothesis or question building, noting that such preparation could begin in K-12 classrooms, where many students could be more effectively introduced to the excitement of natural discovery. At the graduate level, one of the key needs identified in the report is the lack of training in physiology -- knowledge that is critical to interpreting the vast amount of genomics data being generated by current research.

Source: American Society for Microbiology