MICROBIAL ECOLOGY COLLABORATIVE

Wyoming's windswept landscape contains mountains, caves, geysers, glaciers, and prairie as far as the eye can see. Hidden from the human eye, vast microbial communities thrive within this landscape. Too small to be seen without magnification, microbes are living organisms found almost everywhere: air, water, plants, and soil. Microbial communities are composed of bacteria, fungi, algae, viruses, very small animals and others that live in and on both living and non-living material. Researchers at the University of Wyoming will embark on a five-year study, called Micro, of the state's vast microbial ecosystem funded by Wyoming's Established Program to Stimulate Competitive Research (EPSCoR) and the National Science Foundation.

"This is an age of discovery in microbiology," says Alex Buerkle, who studies genetic consequences of evolutionary adaptation and is a co-principal investigator on the project. "Just as modern telescopes have given astronomers the ability to see the universe with amazing detail, our new genomic sequencing capabilities have opened a whole new world in the study of life." The project will answer new questions about how microbes control Wyoming ecosystems and impact society through the technological revolutions in genomic sequencing, high-performance computing and tools that measure ecosystem productivity.

As a result, Wyoming will pioneer how biotechnology is used to study the natural world. Over 19,000 samples will be collected across the state in order to determine what microbes are present and how they are distributed across a landscape. Researchers will explore how specific microbes and their communities impact the ecosystem and the landscape. Using this enormous amount of data, predictive modeling can help determine how the research might be best applied. Potential questions include: Can we determine beneficial ways to use these microbes across the landscape that may improve crop, rangeland, and forest productivity? How might specific microbial transplants improve mine reclamation? Can sanitization be improved by understanding microbes in the flourishing craft brewing industry?

Because microscopy does not distinguish between all microbial species and their function, DNA sequencing will identify microbes and microbial communities in each sample. These samples will be analyzed to quantify patterns and discern how microbes impact the health of ecosystems across a landscape, much like the research showing the microbiome of humans impacts health. A large investment in data science and storage capacity as well as training a data-savvy workforce will be necessary to analyze the data coming in from the field.

There are multiple benefits to understanding the microbial ecology of the state including cleaner water, air, soil, and plant and animal productivity. Bioeconomic benefits include potential new microbial functions, a high performance computing and data science savvy workforce, new techniques for microbrewery sanitation and other that could drive new and existing entrepreneurial activity and diversity the economy of Wyoming.

Outreach – From ranching communities to resort towns to Sovereign nations and youth to the retired, Micro outreach programs are designed to build a bridge between Wyoming's diverse communities and the ongoing science. Outreach activities across Wyoming include applied research, workforce development, science and art collaborations, partnerships with industry and business incubators, and science journalism. These initiatives are all designed to make Micro and the scientific findings have a high impact on the research productivity and economic development of the state.

Workforce Development and Education Highlight – K-16 students will engage in applied research experiences. Middle and high school students will learn about microbial ecology in their science courses and their teachers will have the opportunity to participate in sample collection and a data science professional development course. This project offers relevant ways to integrate computational data science into science classes. Students will participate in sampling and analyzing data and disseminating project results. Community college students will participate in field-courses and gain hands-on research experiences. Finally, undergraduate and graduate students at the University of Wyoming will benefit from increased data science curriculum, fieldwork, and internship opportunities in the state's environmental consulting firms.

Diversity Highlight – We want to change the narrative of what a scientist looks like by celebrating difference and providing research experiences to groups traditionally underrepresented in science such as Native Americans, Deaf and Hard of Hearing Individuals, Hispanics, and first generation students. Over the next five years, we will grow the UW's capacity to provide STEM education opportunities for Native American students, as well as develop a mechanism for doing research on the Wind River Reservation in an appropriate manner, where the tribes own the data and guide the research. The sovereign nations in Wyoming have vast knowledge and understanding of our state, and incorporating their traditional ecological knowledge will make the research more robust and culturally relevant.