**Advanced Fluorescence Microscopy Techniques to Measure Bacterial:Fungal Interactions**

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**Project Goals: In support of the Department of Energy's mission towards energy security and reducing foreign energy dependence, the objective of this Science Focus Area (SFA) is to harness the soil microbiome as a means to achieve ecosystem steering and increase productivity in biofuel crop production. This SFA will focus on acquiring mechanistic insights into bacterial-fungal interactions in response to environmental perturbations to better understand soil dynamics. The challenge will be approached along a concerted effort across length scales from bioinformatics and metagenomic sequencing, to cell-cell interactions and molecular level validations. The insights acquired from these studies will inform predictive models that will work towards managing environmental conditions of soil to impact plant productivity especially for marginal land use.**

The complexity of interactions occurring between the diverse taxa found within the soil microbiome makes elucidating fundamental mechanisms for soil functioning a daunting task. Genomic, metagenomic, and metatranscriptomic sequencing efforts of soil microbes have provided a foundation for identifying key elements to focus experimental efforts and resolve complex mechanisms. Interkingdom interactions such as those shared between bacteria and fungi are especially interesting as these relationships are being understood to be quite cosmopolitan in nature. Ensemble multi-omic and other investigative tools are being explored to dissect these interactions to provide a holistic view of soil microbe behavior. However, there is a strong spatiotemporal contribution that dictates the influence of these behaviors. Here we are investigating the relationships of bacteria and fungi using advanced fluorescence microscopy techniques on cell-to-cell length scales to understand the heterogeneity of molecular responses between microbes that are separated spatially in soil microbiomes. Appreciating the spatial variation of molecular activity among soil microbes and even within single organisms, will provide better contexts to the distribution and diversity found soil environments.

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