Plant Microbe Interfaces: Emerging Analytical Techniques for Controlling and Monitoring Structural Changes in Developing Multi-Kingdom Systems

Jayde Aufrecht,[1,3] Julie Hoang,[1] Jessie Uehling,[2] Larry Millet,[1] Ryan Hansen,[5] Collin Timm,[1] David Allison,[3] **Scott T. Retterer**[1,3,4]* (rettererst@ornl.gov), Jessy Labbé,[1,3] Rytas Vygalys,[2] Jennifer Morrell-Falvey,[1,3] Dale Pelletier,[1] and Mitchel J. Doktycz[1,3,4]

[1]Biosciences Division, Oak Ridge National Laboratory, Oak Ridge, TN; [2]Biology Department, Duke University, Durham, NC.; [3]University of Tennessee, Knoxville, TN; [4]Center for Nanophase Materials Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN; Chemical Engineering, Kansas State University, Manhattan, KS

http://PMI.ornl.gov

Project Goals: The goal of the PMI SFA is to understand the genome-dependent molecular and cellular events involved in establishing and maintaining beneficial interactions between plants and microbes. *Populus* and its associated microbial community serves as the experimental system for understanding how these molecular events manifest themselves within the spatially, structurally, and temporally complex scales of natural systems. To achieve this goal, we focus on 1) characterizing host and environmental drivers for diversity and function in the *Populus* microbiome, 2) utilizing microbial model system studies to elucidate *Populus*-microbial interactions at the molecular level and dissecting the signals and pathways responsible for initiating and maintaining microbial relationships and 3) develop metabolic and genomic modeling of these interactions to aid in interpreting the molecular mechanisms shaping the *Populus*-microbial interface.

Plant growth and the structure of its associated microbial community are mediated by complex physical cues and chemical signals exchanged between the different organisms. These interactions mediate the flow of chemical information, raw materials, and energy resources, shaping and being shaped by the physical architecture of the system in a continuous feedback loop. While molecular genetics and systems biology approaches reveal the genetic content and molecular signals that underpin these interactions, new methods that address the importance of spatial organization in modulating such interactions are essential. These emerging methods can help elucidate the role of environmental heterogeneity, niche size, connectivity, and solute transport on fluctuating microbial populations as well as architectural and mechanical changes in root structure. Here we describe efforts to examine interkingdom signaling between plants, bacteria, and fungi using a combination of atomic force microscopy, advanced optical imaging, biopatterning, and nanostructured fluidic environments with the goal of recreating the complex and emergent behaviors found in natural systems. The development of model fluidic environments combined with quantitative imaging and analysis techniques for capturing temporal information about microbe localization, fungal hyphae growth, and changes in root structure will be described.

The Plant Microbe Interfaces Scientific Focus Area is sponsored by the Genomic Science Program, U.S. Department of Energy, Office of Science, Biological and Environmental Research