Plant-Microbes Interfaces: *In situ* chemical monitoring and imaging of *Populus* and its root microbiome using engineered devices with a porous membrane

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Project Goals: The goal of the PMI SFA is to characterize and interpret the physical, molecular, and chemical interfaces between plants and microbes and determine their functional roles in biological and environmental systems. *Populus* and its associated microbial community serve as the experimental system for understanding the dynamic exchange of energy, information, and materials across this interface and its expression as functional properties at diverse spatial and temporal scales. To achieve this goal, we focus on 1) defining the bidirectional progression of molecular and cellular events involved in selecting and maintaining specific, mutualistic *Populus*-microbe interfaces, 2) defining the chemical environment and molecular signals that influence community structure and function, and 3) understanding the dynamic relationship and extrinsic stressors that shape microbiome composition and affect host performance.

A deeper understanding of complex biological systems demands spatial and temporal profiling of the chemical signals and metabolites that drive organization and function. Conventional chemical imaging technologies often rely on destructive techniques for sampling, preventing ongoing tracking of biological systems over time. The ability to observe chemical processes *in situ*—chemotaxis or signaling, for example—using nondestructive chemical imaging offers a new direction to understand the dynamics of developing biological systems. Therefore, we propose a promising pathway for non-destructively imaging chemical information within the microenvironment of complex living systems through space and time. A microfluidic device featuring a microchannel design, microporous membrane and a supporting gasket presents a viable tool for online chemical imaging of a biological setup. As part of the Plant-Microbe Interface project, we are interested in studying chemical interactions between *Populus* and its associated root microbiome. Currently, we are mapping the distribution, growth and motility of select microbes as well as growing *Populus trichocarpa* cuttings in our unique membrane-based microfluidic platforms. Our ultimate goal is to trace microbial distribution along the root and correlate this with the chemical environment in order to better understand the impact of the microbiome on plant growth promotion, nutrient uptake and stress tolerance.

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