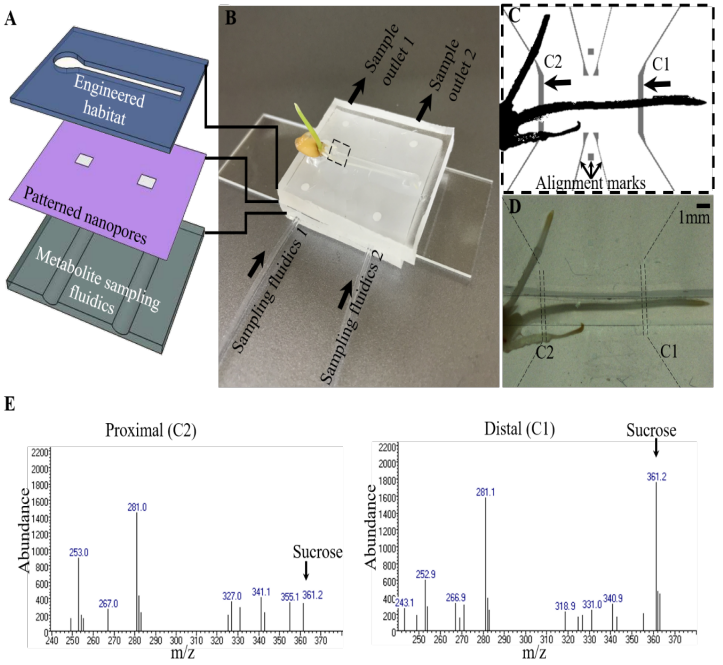
PMI SFA Publication Highlight

U.S. DEPARTMENT OF ENERGY | Office of Science

Novel Approach: A nanofluidic platform for spatially and temporally tracking chemical information in the microenvironment of live plant roots

Objective	• Develop an analytical measurement platform for imaging biological systems while simultaneously monitoring their chemical microenvironment
New science	• Multilayered microfluidic structures were created by integrating a polyester track-etched (PETE) nanofluidic membrane between microfluidic structures for containing the sample and for collecting exometabolites • Concurrent imaging and time-dependent collection of metabolites from a growing plant root was achieved by diffusive sampling through spatially patterned regions in the PETE membrane • Analyses of the collected samples by gas chromatography-mass spectrometry (GC-MS) allowed identification of exometabolites • Metabolite profiles were observed to depend on sample location and time as the plant root grew
Impact	• Measurement of metabolites is challenging because they are often not amenable to extrinsic tags, are diverse in nature, and are present with a broad range of concentrations. This new, nano-enabled approach to chemical imaging provides a means for tracking the production and distribution of chemical information that can reveal how chemical signals shape the composition and function of complex biological systems.



Microfluidic device for simultaneous imaging of live root development and for metabolite sampling. (A) Schematic showing assembly of the three layers used to produce a culture system for a growing root, infusion-patterned nanoporous membrane for sampling, and sample collection for analysis of metabolites. (B) Photograph of a germinated seed growing in the device. (C) The primary root is placed in the sample microenvironment layer. The underlying sampling channels (C1 and C2) allow sampling of metabolites at two individually accessible locations. (D) Brightfield image showing the plant root after 6 h of growth in the device. The underlying metabolite sampling channels, highlighted by dashed lines, are obscured by the sandwiched nanoporous membrane. (E) Mass spectra derived from extracted-ion chromatogram (XIC) of sucrose indicating differential levels of sucrose in samples collected proximal and distal to the seed.

Label-free time- and space-resolved exometabolite sampling of growing plant roots through nanoporous interfaces.
Patabadige DEW, Millet LJ, Aufrecht JA, Shankles PG, Standaert RF, Retterer ST, and Doktycz MJ. (2019). *Scientific Reports,* doi: 10.1038/s41598-019-46538-5.

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