Unexpected complexity: A 3-D look into plant root relationships with nitrogen-fixing bacteria

February 28 2019

Root nodules, which allow some bacteria to fix nitrogen into soils for greater plant productivity, have a surprisingly complex metabolism, which could be optimized to develop more sustainable agriculture. Credit: US Department of Energy

By taking nitrogen out of the air and turning it into plant nutrients, some bacteria help plants like beans, peas, and clovers thrive. How? A study shows that the traditional view of this symbiotic relationship doesn't capture the entire picture. Scientists resolved a 3-D map of the metabolic products of bacteria found in plant root nodules. This spatial perspective could help unravel the overall complexity of these highly interdependent organisms.

As these bacteria interact with legumes like soybeans, nodules grow on the roots of the plant. In these nodules, bacteria convert atmospheric nitrogen into molecules the plants need to grow. Understanding the metabolic processes occurring within these nodules is essential to develop more sustainable agricultural practices for food crops used all over the world.

Previous studies led scientists to believe the distribution of bacterially derived metabolic by-products within the nodules was uniform. Scientists from EMSL, the Environmental Molecular Sciences Laboratory, a Department of Energy Office of Science user facility, joined with colleagues at the University of Missouri and the George Washington University to dig deep into the metabolic structure of soybean root nodules. They used one of EMSL's high-field Fourier transform ion cyclotron resonance mass spectrometers to visualize the array of metabolites within the nodules. Of the approximately 140 regulating substances identified, some were located together in distinct anatomical compartments. A few, however, were more unevenly distributed throughout the middle of the nodule, where the bacteria reside. This discovery points to a previously unrecognized biochemical complexity in the nodules that are key for symbiotic plant-microbe interactions. Armed with this understanding, scientists can suggest ways to optimize crop production and sustainability.

More information: Dušan Veličković et al. Observed metabolic

asymmetry within soybean root nodules reflects unexpected complexity in rhizobacteria-legume metabolite exchange, *The ISME Journal* (2018). DOI: 10.1038/s41396-018-0188-8

Provided by US Department of Energy