Energy Biosciences

Energy Biosciences research aims at providing scientific knowledge and improved understanding of biological principles, mechanisms, and organisms. It helps guide the development of renewable energy systems, bioconversions of organic matter to fuels and chemicals, and supplies background genetic and biochemical information in support of future energy technologies.

OLIGOSACCHARINS: PLANT CELL MESSENGERS

The genetic material within each cell of a garden plant is the source of the directions on how that cell develops. But it is well known that this genetic material is the same in practically every one of the multitude of cells that make up a plant. How then does it happen that cells develop differently, so that plants have roots, stems, leaves, and flowers? The answer is that different portions of the genetic material are "turned on," or expressed, in the various cells. A system of chemical messengers turns on the genetic material for forming leaves in some cells and for forming roots in others.

Basic Energy Sciences researchers at the University of Georgia shed considerable light on the identity of one family of chemical messengers. The findings are causing a significant amount of rethinking about plant growth. The accomplishment was an astonishing result of two Basic Energy Sciences studies of the plant cell, neither of which was originally related to the ultimate outcome. One study had to do with the structure of the plant cell wall, and the other was related to a plant's defense against disease.

Probably the best known component of the plant cell wall is cellulose. Chemically, it is a long chain of a single kind of molecular unit called glucose, one of the family of sugar molecules. Cellulose chains form fibers that make the cell wall strong and stiff.

But as it came to be learned, the cell wall has components structurally more interesting than cellulose. The cellulose fibers are embedded in a matrix of other polysaccharides. Compared to cellulose, the matrix is more complex. For example, molecules of the matrix not only form chains, but also have branches of various lengths connected to the chains at any of a number of possible positions. And, unlike cellulose which is formed by many repeats of a single sugar, glucose, the matrix polysaccharides are each composed of between five and ten different sugars. The variety of combinations of the sugars in the matrix polysaccharides is large.

The discovery of the chemical complexity of the cell wall matrix led to questions about the functions that it might perform. By coincidence, the same research group was working on a seemingly unrelated Basic Energy Sciences project that suggested the direction for the answers. This research was aimed at elucidating the signal that informed the plant when it was being infected by a fungus, for when a fungus infects a plant, molecules akin to antibiotics, called phytoalexins, are produced by the infected plant. What feature of the fungus is recognized by the plant cell to trigger the production of the phytoalexins? The researchers found the answer among the fungus cell wall's matrix molecules.

In one series of experiments, a mixture of oligosaccharides (short chains of glucose units) taken from the cell wall matrix of the fungus was applied to plant cells. It was determined that oligosaccharides fragments of infecting fungal cell wall caused the plant to begin making phytoalexins. Although oligosaccharides had been studied for many years, it had not been suspected that some of them could signal such plant cell reactions. Oligosaccharides with biological regulatory activity have been called oligosaccharins.