Scaling the Plant Cell Wall

February 14 2005

Scientists are one step closer to understanding how plants synthesize the fibrous carbohydrates that make up their cell walls. Cell-wall polysaccharides, as they are known, constitute a major source of dietary fiber and have numerous commercial applications. Yet despite great interest and extensive efforts, scientists haven't identified many of the enzymes that link sugar molecules into these lengthy fibers—until now. Using a powerful method, researchers have characterized a family of these enzymes derived from rice and the mustard plant, Arabidopsis.

The team, which was supported in part by the National Science Foundation's Plant Genome Program, reported their findings in this week's print edition of Proceedings of the National Academy of Sciences.

For hundreds of years, scientists have studied plant cell walls—the protective sheaths that give plant cells shape and protect them from disease and dehydration. Many components of this interwoven meshwork of structural proteins and polysaccharides have been catalogued and characterized. However, identifying the molecular machinery that plants use to make them has been a major challenge. The enzymes that link sugar molecules into long chains have been particularly hard to identify. That's because the low abundance and unstable nature of these enzymes frustrates traditional approaches to isolate them. Many scientists thought the availability of genomic information would help.

In some ways, it has. The completed Arabidopsis and rice genomes revealed hundreds of candidate genes likely involved in cell-wall polysaccharide production, based on similarity to those discovered by classical methods. The major obstacle facing scientists now, is determining the function of the enzymes encoded by these genes.

In a breakthrough, Michigan State University scientists, lead by Kenneth Keegstra, have utilized a method to do just that. Keegstra's team bypassed the problems faced by their predecessors by expressing plant genes in cells cultured from the fruit fly Drosophila melanogaster. The advantage of this strategy is two-fold: fly cells possess all of the components needed to generate functional plant enzymes, but they lack cell walls and the proteins required to build them. Therefore, the team was able to study the plant proteins in a background free of competing enzymes.

Combining this protein production system with robust analytical assays, postdoctoral researcher Aaron Liepman expressed members of five families of Csl—or cellulose synthase-like—genes and attempted to determine their functions. Several genes from the CslA family encode ß-mannan synthase enzymes, relatives of a protein discovered last year in guar plants that is responsible for producing "gum"—the commercial additive that gives texture to ice cream and shampoo.

This study provides researchers with a new set of tools for understanding the machinery plants use to build their cell walls. According to Jane Silverthorne, an NSF program manager, it should greatly speed up progress into "what these enzymes do, where they are expressed, and how they work together to make the cell wall."

The results are also likely to have ramifications that extend well beyond providing insight into plant physiology. Figuring out how cell wall polysaccharides are made is the first step towards regulating their production in plants. This work brings scientists closer to developing plants that provide increased nutrition, cheaper food additives, and easily digestible animal feed.

Source: National Science Foundation