Clues to How Plants Form New Cell Walls Could Aid Biofuels, Nanotechnology

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When plant cells divide, they assemble molecular building blocks into new cell walls made of carbohydrate and protein, but scientists know almost nothing about how this process occurs. A team of researchers including Maura Cannon of the University of Massachusetts Amherst has found that the first step in building new plant cell walls is the assembly of a scaffold made of structural proteins, a process similar to using a metal or wood scaffold to construct the walls of a building.

Cannon was joined by colleagues from Ohio University and the University of Sussex, England. Results were published in the Feb. 12, 2008 issue of The *Proceedings of the National Academy of Sciences*.

Unlocking the secrets of how plants build cell walls could lead to better materials for the production of biofuels such as ethanol from cellulose, plant fibers that are a cheaper and more plentiful alternative to the starches currently used. “Plant cell walls are the most abundant biomass on Earth,” says Cannon, a professor in the biochemistry department. “If we know how the cell wall assembles, we can exploit this information to engineer plants with cell wall structures and compositions that are commercially desirable.”

Nanotechnology, which depends on molecules that can assemble themselves into an organized structure without external direction, is another field that could benefit. “The structural proteins in plant cell walls know how to self-assemble,” says Cannon. “They do it all the time. Since the most abundant proteins on Earth can self-assemble, we should

be able to figure out how the process works. Such knowledge will be fundamental to the success of the emerging nanotechnology industry."

Cannon's research is based on Arabidopsis thaliana or Thale Cress, a flowering weed from the mustard family that is common in North America. Arabidopsis was the first plant to have its entire genome sequenced, and scientists have created a library with mutated copies of every gene. Cannon and graduate students Qi Hall and Yumei Wang selected Arabidopsis embryos with a mutation in a specific gene called RSH. This lethal mutation results in embryos with irregular cell shapes and sizes. Electron micrographs of the embryos showed that normal cell walls were unable to form, indicating that the protein produced by the RSH gene was critical to their formation.

Protein produced by the RSH gene in wild-type Arabidopsis plants was purified and studied by Marcia Kieliszewski at Ohio University and Derek Lamport at the University of Sussex and identified as AtEXT3, an extensin protein that turned out to have some interesting qualities. Laboratory tests showed that molecules of AtEXT3 are able to recognize each other and link together at sites that contain a specific amino acid.

Atomic force microscopy performed by Liwei Chen at Ohio University showed AtEXT3 forming a network of ropes that overlap and link to form a scaffold that branches like the limbs of a tree. Areas with positive charges are exposed in the scaffold. Cannon proposes that AtEXT3, which concentrates along the new wall formed when plant cells divide, forms a network with positive charges that attract molecules of negatively charged pectin like a magnet. "The positively charged AtEXT3 scaffold serves as a guide for the deposition of pectin to form a highly organized matrix," says Cannon.

Cannon's research can be applied to any plant, since structural proteins are part of the cell wall of all plant species. A recent grant from the

National Science Foundation allows Cannon and Kieliszewski to continue working on AtEXT3. “Once we know which parts of the molecule are most important, and determine how they affect the cell wall, we could make synthetic extensins that produce designer plants with a cell wall composition and structure that meets the needs of industry,” says Cannon. “The possibilities would be endless.”

Source: University of Massachusetts Amherst