Plant cell architecture: Growth toward a light source

November 7 2013

Inside every plant cell, a cytoskeleton provides an interior scaffolding to direct construction of the cell's walls, and thus the growth of the organism as a whole. Environmental and hormonal signals that modulate cell growth cause reorganization of this scaffolding. New research led by Carnegie's David Ehrhardt provides surprising evidence as to how this reorganization process works, with important evidence as to how the direction of a light source influences a plant's growth pattern. It is published by *Science Express*.

The cytoskeleton undergirding each cell includes an array of tubule-shaped protein fibers called microtubules. By directing cell growth and development, this scaffold is crucial for supporting important plant functions such as photosynthesis, nutrient gathering, and reproduction.

The cytoskeleton does not appear to be remodeled by moving these microtubules around in the cell. Rather, it is altered by changes to the way these fiber arrays are assembled or disassembled. Ehrhardt's team—including lead author Jelmer Lindeboom, Masayoshi Nakamura, Ryan Gutierrez and Viktor Kirik, all from Carnegie—used advanced tools to watch the reorganization process of these microtubule arrays under different conditions.

These imaging data, combined with the results of genetic experiments, revealed a mechanism by which plants orient microtubule arrays. A protein called katanin drives this mechanism, which it achieves by redirecting microtubule growth in response to blue light. It does so by

severing the microtubules where they intersect with each other, creating new ends that can regrow and themselves be severed, resulting in a rapid amplification of new microtubules lying in another, more desired, direction.

"Our genetic data, together with previous studies that tie microtubule organization to cell growth, indicate that this restructuring is required for the plant to bend toward a light source as it grows, a phenomenon called phototropism," Ehrhardt explained. "Our findings also have broader implications for the construction of cytoskeletons in other types of cells, including human cells, because katanin is conserved between animals and plants."

"This is exceptional work, which draws upon decades of pioneering discoveries made by Carnegie's Winslow Briggs on blue light perception. For the first time Ehrhhardt's group demonstrates how blue light drives changes in cytoskeleton organization, which underlies the architecture and mechanical properties of the cell walls. These properties are critical for the light-induced bending" says Wolf B. Frommer, Director of the department. He terms the study: "fantastic work, a milestone in the history of blue light research."

More information: "A Mechanism for Reorientation of Cortical Microtubule Arrays Driven by Microtubule Severing" *Science Express*, 2013.

Provided by Carnegie Institution for Science