Plants on Steroids: Key Missing Link Discovered

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(PhysOrg.com) -- Researchers at the Carnegie Institution's Department of Plant Biology have discovered a key missing link in the so-called signaling pathway for plant steroid hormones (brassinosteroids). Many important signaling pathways are relays of molecules that start at the cell surface and cascade to the nucleus to regulate genes.

This discovery marks the first such pathway in plants for which all the steps of the relay have been identified. Since this pathway shares many similarities with pathways in humans, the discovery not only could lead to the genetic engineering of crops with higher yields, but also could be a key to understanding major human diseases such as cancer, diabetes, and Alzheimer's.

Steroids are important hormones in both animals and plants. Brassinosteroids regulate many aspects of growth and development in plants. Mutants deficient in brassinosteroids are often stunted and infertile. Brassinosteroids are similar in many respects to animal steroids, but appear to function very differently at the cellular level. Animal cells usually respond to steroids using internal receptor molecules within the cell nucleus, whereas in plants the receptors, called receptor-like kinases, are anchored to the outside surface of the cell membranes. For over a decade, scientists have tried to understand how the signal is passed from the cell surface to the nucleus to regulate gene expression. The final gaps were bridged in the study published in the advanced on-line issue of Nature Cell Biology September 6, 2009.

The research team unraveled the pathway in cells of Arabidopsis thaliana , a small flowering plant related to cabbage and mustard often used as a model organism in plant molecular biology.

"This is the first completely connected signaling pathway from a plant receptor-like kinase, which is one of the biggest gene families in plants," says Carnegie's Zhi-Yong Wang, leader of the research team. "The Arabidopsis genome encodes over 400 receptor-like kinases and in rice there are nearly 1,000. We know the functions of about a dozen or so. The completely connected brassinosteroid pathway uses at least six proteins to pass the signal from the receptor all the way to the nuclear genes expressed. This will be a new paradigm for understanding the functional mechanism of other receptor-like kinases."

Understanding the molecular mechanism of brassinosteroid signaling could help researchers develop strategies and molecular tools for genetic engineering of plants with modified sensitivity to hormones, either produced by the plant or sprayed on crops during cultivation, resulting in higher yield or improved traits. "We perhaps could engineer plants with altered sensitivity in different portions of the plant," says Wang. "For example, we could manipulate the signal pathway to increase the biomass accumulation in organs such as fruits that are important as agricultural products, an area highly relevant for food and biofuel production."

Another of the study's findings has potentially far-reaching consequences for human health. The newly identified brassinosteroid signaling pathway component shares evolutionarily conserved domains with the glycogen synthase kinase 3 (GSK3). "GSK3 is found in a wide range of organisms, including mammals," says Wang. "Our study identified a distinct mechanism for regulating GSK3 activity, different from what had been identified in earlier work. GSK3 is known to be critical in the development of health issues such as neural degeneration,

cancer, and diabetes, so our finding could open up new avenues for research to understand and treat these diseases."

Source: Carnegie Institution