Mastermind steroid found in plants

November 15 2010

Scientists have known for some time how important plant steroids called brassinosteroids are for regulating plant growth and development. But until now, they did not know how extensive their reach is. Now researchers, including Yu Sun and Zhi-Yong Wang at Carnegie's Department of Plant Biology, have identified about a thousand brassinosteroid target genes, which reveal molecular links between the steroid and numerous cellular functions and other hormonal and light-activated chain reactions. The study, published in the November 16, 2010, issue of *Developmental Cell*, provides the first comprehensive action map for a plant hormone. The research will help accelerate basic plant science and crop research.

Steroids are important hormones in animals and plants. Unlike animals, plants do not have glands to produce hormones. As a result, each cell has the ability to generate hormones. Animal cells typically respond to steroids using receptor molecules within the cell nucleus. The receptors in plants, called receptor-like kinases, are anchored to the outside surface of the cell membranes. Research has shown that brassinosteroids are involved in acclimation to environmental stresses, promote cell elongation, and enhance resistance to pathogens, thus increasing plant growth and crop yield. But it has been unclear how one steroid hormone controls so many different processes. The breadth of its role has also been incomplete because its target genes have not been identified until now.

"We performed a genome-wide analysis of genes that are direct targets of brassinosteroid in the model plant Arabidopsis, a relative of mustard."

explained coauthor Yu Sun. "We identified DNA sequences in the genome where a transcription factor resides—that is a protein that begins the process of turning a gene on or off. In this case, a protein called BZR1 is the major transcription factor responsible for bassinosteroid-regulated gene expression. It acts at the end of a chain reaction triggered by a steroid binding to the receptor called Brassinosteroid Insensitive 1 (BRI1) at the cell membrane. We were very surprised by the large number of genes involved. Arabidopsis has about 32,000 genes in total and this hormone appears to be masterminding a lot of different physiological responses."

Scientists have observed a wide range of effects of brassinosteroid on plant growth and plant responses to the environment. They have also worked out the molecular chain that pass the signal from cell surface receptor to BZR1 in the nucleus. How this signaling chain controls various growth and physiological behavior and what cellular machinery it controls was unclear. The scientists found that brassinosteroid target genes turn on a wide range of proteins, including cell-wall enzymes, such as cellulose, a large number of genes concerned with transporting materials throughout plant body and organizing the scaffolding that gives cells their shape, among other developmental processes. Although brasssinosteroid has been known to have a close relationship with several other hormones and light signals, the mechanisms involved with the steroid's interactions with them are not known. The researchers found that BZR1 protein directly controls the activity of many genes involved in plant responses to other hormones and light. The brassinosteroid action map provided in this study shows for the first time that multiple hormonal and light signals are integrated into an extensive network to control plant growth and development.

Provided by Carnegie Institution