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RESEARCH NEWS

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Researchers Learn What Sparks Plant Growth

Image Title: A photograph of *Arabidopsis* shoots. On the left is a wild-type plant (normal), on the right is a brassinosteroid receptor mutant (bri1) and in the middle is a bri1 mutant plant in which the receptor has been expressed only in the L1 layer (the epidermis). - Laboratory of Joanne Chory

A secret long held by plants has been revealed by Howard Hughes Medical Institute researchers. The new discovery, which builds on more than a decade of painstaking surveillance of cellular communication between different types of plant tissues, shows clearly for the first time how plants “decide” to grow.

The research, conducted by Sigal Savaldi-Goldstein and Howard Hughes Medical Institute investigator Joanne Chory at The Salk Institute for Biological Studies, puts to rest a century-old debate over which tissue system in plants drives and restricts cell growth.

"If we want to feed over nine billion people by the year 2050, then understanding the basic mechanics of plant growth is required."
- Joanne Chory

"Our work exposes the presence of cell-cell communication during growth, from the epidermis to the inner layers. Such a mode of communication is important for plants to maintain a coherent and coordinated growth of the shoot," said Savaldi-Goldstein, a postdoctoral fellow in Chory's lab.

Chory's research group is interested in identifying the mechanisms by which plants alter their shape and size in response to changes in their environment. Chory studies *Arabidopsis*, a member of the mustard family that is to plant biologists what the mouse is to mammalian geneticists.

"How do organisms decide when to grow and when to stop growing? These questions are especially important in plants because they are rooted in the ground and must alter their shape and size in response to their local environment. Thus, it's a question of survival," added Chory. "It took us 10 years to develop the tools to ask the question. It is very satisfying for me to see the results."

Roots and shoots are a plant's two major organ systems. For this study, published in the March 8, 2007, issue of the journal *Nature*, the scientists examined shoots and the three layers of tissues that make up the shoot system: the epidermis, which is the waxy, protective skin; the mesophyl tissue, which contains the plant's chloroplasts—cells that conduct photosynthesis; and the vascular tissue through which water and nutrients are transported.

During the last decade, Chory has made a number of significant discoveries involving a key family of plant hormones called brassinosteroids, as well as the receptors for the hormones and the genetic factors that regulate production and uptake of the hormone in the different layers of plant tissues. According to Chory, brassinolide is a potent growth hormone involved in the plant's response to light. Such responses, which include adjusting plant growth to reach light or strengthening stems to support leaves, are central to plant survival. Brassinosteroid biosynthesis has become a critically important area of plant biology research with significant implications for commercial agriculture.

“It's been a matter of some debate for a very long time if one of these tissue layers controls plant growth or if all three layers have to work together,” Chory said. “Our paper shows very clearly that the epidermis is in control—in both driving and restricting growth. In addition, our studies show that the cells in the epidermis “talk” to the cells in the inner layers, communicating that they too should expand.”

Savaldi-Goldstein made the discovery that the signal for growth originates in the epidermis by experimenting with dwarf *Arabidopsis* plants and the expression of brassinosteroids in the outer and inner layers of the shoot. When brassinosteroid hormone was expressed and taken up by receptors in the epidermis, dwarf plants grew to their full size. Savaldi-Goldstein and Chory also found that when a gene is expressed in the epidermis that inactivates brassinosteroid, the plant restricts growth. Thus, cell signaling began in the epidermis and followed into the inner layers of tissue, directing those cells to grow or to restrict growth.

The outer epidermis, which helps plants retain water and regulate the exchange of gases, clearly plays the role of environmental sentinel, communicating to plant tissues when conditions are right to seize the day for growth or hold back under less opportune conditions. More study is needed to determine all of the cues that spark the intimate dialogue between the cells of the epidermis and the inner cells of the shoot.

“Our study says that the major target tissue in the shoot for steroid hormones is the epidermis. Our results also show that these hormones act locally. As similar studies are done for other plant hormones and in other organs, such as the root, we will know the major sites of action of each plant hormone and will be able to make models to predict how they work together to give rise to the tremendous diversity of shape and form found in the flowering plants,” said Chory.

For the moment, the research is an important addition to the fundamental knowledge of plant growth and survival. But the research and the work to follow have much broader implications.

“If we want to feed over nine billion people by the year 2050, then understanding the basic mechanics of plant growth is required,” said Chory. “This knowledge will ultimately lead to our ability to increase yield, while decreasing the need for fertilizer and pesticides.”