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## No-Mow Grass May Be Coming to Your Yard Soon

For anyone tethered to a lawnmower, the Holy Grail of horticultural accomplishment would be grass that never grows but is always green.

Now, that vision of suburban bliss--and more--seems plausible as scientists have mapped a critical hormone signaling pathway that regulates the stature of plants. In addition to lawns that rarely require mowing, the finding could also enable the development of sturdier, more fruitful crop plants such as rice, wheat, soybeans, and corn.

In a paper published in the May 4, 2006, issue of the journal *Nature*, Howard Hughes Medical Institute scientists report they have deciphered the signaling pathway for a key class of steroid hormones that regulates growth and development in plants. "By manipulating the steroid pathway...we think we can regulate plant stature and yield," said Joanne Chory, a Howard Hughes Medical Institute investigator at the Salk Institute for Biological Studies, and the senior author of the new report.

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Manipulation of plant stature has been a longstanding goal in horticulture, agronomy, and forestry. The ability to precisely control plant size would have broad implications for everything from urban forestry to crop and garden plant development. Beyond perpetually short grass, trees could be made more compact for better growth in crowded cities, and berry bushes could be made taller for ease of harvesting.

To chart the pathway, Chory and colleague Grégory Vert of the Salk Institute's Plant Biology Laboratory examined the molecular influence of a

family of plant hormones known as brassinosteroids. Scientists have found brassinosteroids in all plants where they have looked for them. As critical chemical messengers of plant development, they are found in low levels in virtually all plant cells, including seeds, flowers, roots, leaves, stems, pollen, and young vegetative tissue.

"Without them, plants are tiny dwarves, with reduced vasculature and roots, and are infertile," Chory explained. "They also regulate senescence or aging. Since brassinosteroids mainly regulate cell expansion, though, they are one of the most important hormones that regulate stature."

Knowing the molecular chain of command--how the hormone acts to influence genetic events that govern development at the cellular level--gives scientists a way to reshape the steroid pathway to develop plants that grow in specified ways.

"We might be able to dwarf grass and keep it green by limiting brassinosteroids or increase the yield of rice by having more brassinosteroids in seeds," Chory said. Another recent study by Makoto Matsuoka's group in Japan, she said, showed that limiting brassinosteroids in rice affected leaf angle and improved yield in densely planted fields.

Vert and Chory's work helps trace a molecular pathway that is ancient--perhaps more than a billion years old--in both plants and animals. "Remarkably, steroid biosynthetic enzymes are highly conserved from plants to metazoans (animals), suggesting that the use of steroids as hormones preceded the plant-animal split over a billion years ago," Chory explained.

In animals, the route steroid hormones use to exert their influence in the nucleus of a cell, where gene expression is regulated, is direct, through the use of nuclear receptors. Plants, said Chory, don't have nuclear receptors, which would provide more direct access to the nucleus. Rather, plant steroids are perceived outside the cell by the extracellular domain of a cell surface receptor. Perception then regulates genetic events in the nucleus in a more roundabout way, similar to a well-studied pathway in animals known as the Wnt signaling pathway. Wnt is a secreted molecule that influences the nucleus of a cell through cell surface receptors to regulate cell-to-cell interactions and many of the events of embryogenesis in metazoans.

"Because one of the brassinosteroid signaling components was similar to a protein found in the Wnt signaling pathway, we thought that the logic for brassinosteroid signaling (in plants) would be very much like the Wnt pathway," said Chory. "We were wrong."

Instead, brassinosteroid perception leads to a cascade of biochemical events that alter the ability of key proteins to dimerize and activate gene expression within a cell's nucleus. In plants, there are scores of genes involved in growth and development that can be influenced by brassinosteroids, Chory noted.

"Many of these genes are predicted to be involved in growth, like cell wall metabolism. Their up-expression would be predicted to promote cell expansion," according to Chory.

The work of other groups, she noted, has shown that brassinosteroids can negatively regulate their own expression as part of a feedback loop that, ultimately, determines the size of a plant. In nature, that feedback loop has served plants well, helping them adjust their height and size to fit the growing conditions of any environmental niche.

Through traditional methods of plant breeding, humans have been manipulating plant stature for thousands of years. In recent years, through the methods of genetic engineering, more precise methods for altering industrial plant strains have come into play.

But access to a pathway used by plant hormones to dictate size promises broader influence over the many genes involved in the process of growth. Levers that could be used to alter a hormone pathway to influence plant development and stature, according to Chory, include modifying the levels of the hormone, manipulating the chemical structures of hormones, and recoding the signals sent along the pathway.