Researchers Determine How Plants Decide Where to Position Their Leaves and Flowers

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One of the quests of modern biologists is to understand how cells talk to each other in order to determine where to form major organs. An international team of biologists has solved a part of this puzzle by combining state-of-the-art imaging and mathematical modeling to reveal how plants go about positioning their leaves and flowers.

In the January 31 issue of the *Proceedings of the National Academy of Sciences*, researchers from the California Institute of Technology, the University of California at Irvine, and Lund University in Sweden reported their success in determining how a plant hormone known as auxin affects plant organ positioning. Experts already knew that auxin played some role in the development of plant organs, but the new study employs imaging techniques and computer modeling to propose a new theory about how the mechanism works.

The research involves the growing tip of the shoot of the plant Arabidopsis thaliana, a relative of the mustard plant that has been studied intensely by modern biologists. With its simple and very well understood genome, Arabidopsis lends itself to a wide variety of experiments.

The achievement of the researchers is their demonstration of how plant cells, with purely local information about their nearest neighbors' internal concentration of auxin, can communicate to determine the position of new flowers or leaves, which form in a regular pattern, with many cells separating the newly formed primordia (the first traces of an

organ or structure). The authors theorize that the template the plant uses to make the larger parts comes from two mechanisms: a polarized transport of auxin into a feedback loop and a dynamic geometry arising from the growth and division of cells.

To capture the development, Beadle Professor of Biology Elliot Meyerowitz, division chair of the biology division at Caltech, and his team used green fluorescent proteins to mark specific cell types in the plant's meristem, the plant tissue in which regulated cell division, pattern formation, and differentiation give rise to plant parts like leaves and flowers.

The marked proteins allowed the group to image the cell's lineages through meristem development and differentiation leading to specific arrangement of leaves and reproductive growth, and also to follow changes in the concentration and movement of auxin.

Although the study applies specifically to the Arabidopsis plant, Meyerowitz says the mechanism is probably similar for other plants and even other biological systems in which patterning occurs in the course of development.

In addition to Meyerowitz, the paper's authors are Henrik Jönsson of Lund University, Marcus G. Heisler of Caltech's Division of Biology, Bruce E. Shapiro of Caltech's Biological Network Modeling Center, and Eric Mjolsness of UC Irvine's Institute of Genomics and Bioinformatics and department of computer science.

Source: Caltech