Plant biology discovery furthers understanding of plant growth and development

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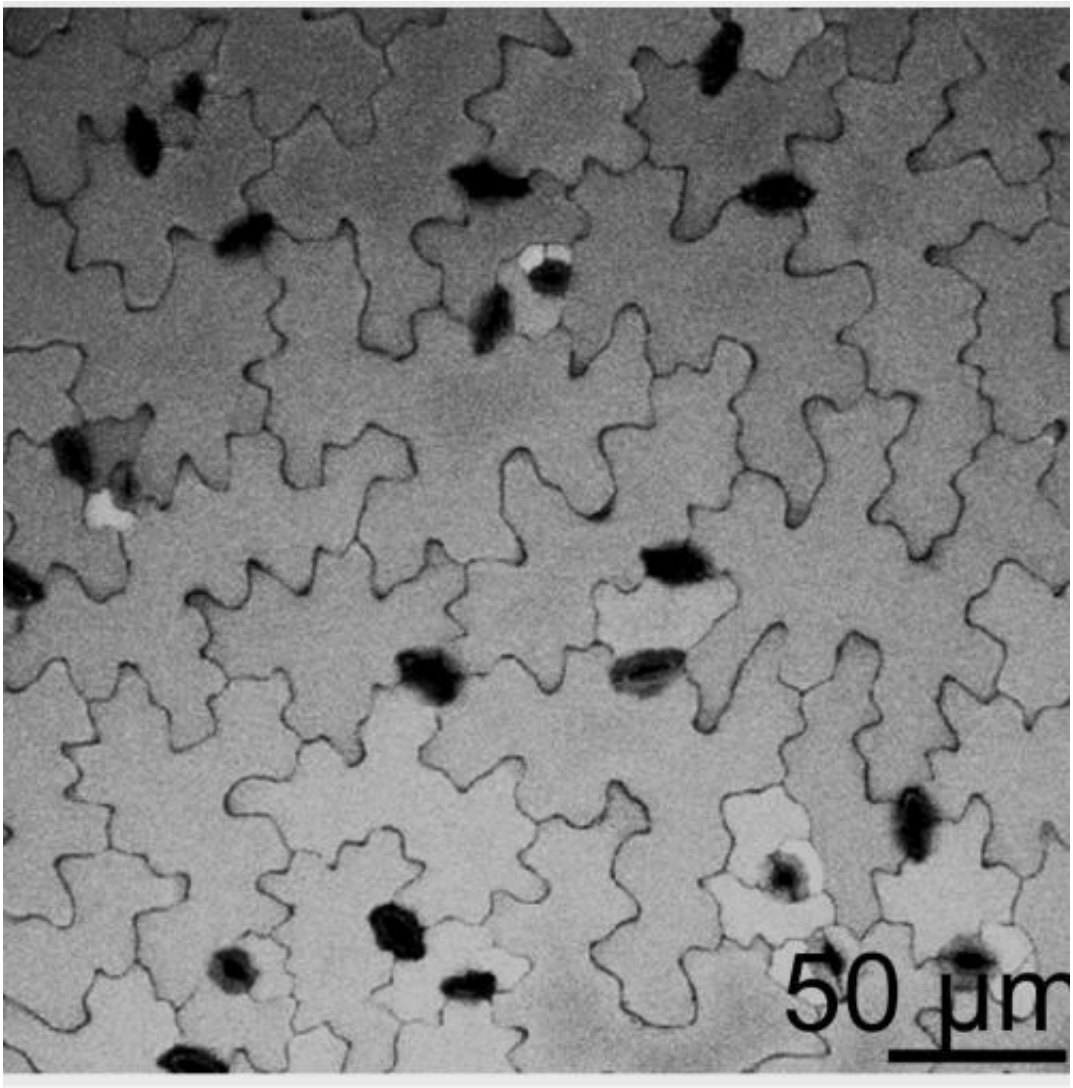

The lab of Zhenbiao Yang, a professor of cell biology at UC Riverside, has made a discovery that helps explain why leaf epidermal cells have jigsaw puzzle-piece

shapes. Credit: Yang Lab, UC Riverside.

Auxin, a small molecule, is a plant hormone discovered by Charles Darwin about 100 years ago. Over the years that followed it became understood to be the most important and versatile plant hormone controlling nearly all aspects of plant growth and development, such as bending of shoots toward the source of light (as discovered by Darwin), formation of new leaves, flowers, and roots, growth of roots, and gravity-oriented growth. Just how a small molecule like auxin could play such a pivotal role in plants baffled plant biologists for decades.

Then, about ten years ago, an auxin sensing and signaling system was discovered in the cell's nucleus, but it could not explain all the diverse roles of auxin.

Now, plant cell biologists at the University of California, Riverside have discovered a new auxin sensing and signaling complex, one that is localized on the cell surface rather than in the cell's nucleus. The discovery provides new insights into the mode of auxin action, the researchers say.

"This is a new milestone in auxin biology and will ignite interest in the field," said Zhenbiao Yang, a professor of cell biology in the Department of Botany and Plant Sciences, and the leader of the research project. "Our findings conclusively demonstrate the existence of an extracellular auxin sensing system in plants, which had long been proposed but remained elusive. Further, we have uncovered the decades-long mystery of how ABP1, an auxin-binding protein, works to control plant developmental processes."

ABP1 was identified more than 40 years ago, but its role was hotly

debated among plant biologists because its mode of action remained unclear—until the recent discovery by Yang's team.

The team also showed that the cell surface auxin sensing system involves "transmembrane receptor kinases" (TMKs)—enzymes widespread throughout eukaryotes that typically act as cell surface sensors for extracellular stimuli and translate them into intracellular responses.

"This breakthrough discovery of the cell surface ABP1/TMK auxin sensing system dramatically elevates the level of our understanding of how auxin plays diverse roles," said Natasha Raikhel, a distinguished professor of plant cell biology at UC Riverside, who was not involved in the research. "This signaling mechanism now serves as a paradigm for elucidating the molecular mechanisms underlying various auxin-modulated developmental processes and patterns. In addition to their major impact on the field of plant development and morphogenesis and plant signal transduction, Yang's discoveries also provide novel means of engineering plants with desired morphological traits and growth patterns."

Study results appear in the Feb. 28 issue of *Science*.

Yang's lab has been studying molecular mechanisms for the formation of the jigsaw puzzle-piece shape of pavement cells in leaf epidermis of the Arabidopsis plant, a small flowering plant widely used in plant biology laboratories as a model organism. It is the interlocking feature of these cells that provides the required physical strength and integrity for flat, thin leaves.

In previous work, the lab found that auxin activated the formation of the puzzle piece shape through ABP1 and ABP1-dependent activation of "ROP GTPases," which are pivotal regulatory proteins that act as a molecular switch in gating incoming signals from the cell surface. It was

unclear, however, whether ABP1 was a cell surface auxin receptor. Also, just how it led to the activation of ROP GTPases remained unknown.

"But now we have identified a family of TMKs that physically and functionally interact with ABP1 to perceive and transduce auxin signal at the cell surface," Yang said. "We show that ABP1 and TMKs form a new auxin sensing complex at the cell surface and that TMKs transmit extracellular auxin signals to ROP GTPases located just inside of the cell membrane. This novel auxin sensing and signaling system makes possible the formation of the jigsaw shape of leaf epidermal cells and many other auxin-mediated processes."

Next, Yang's team plans to investigate whether there are additional components in the cell surface auxin sensing complex, what specific pathways are regulated by the cell surface auxin sensor, and why plants need both the nuclear and extracellular auxin sensors.

Provided by University of California - Riverside