Researchers discover key mechanism that regulates shape and growth of plants

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UBC researchers have discovered a key mechanism that -- much like a construction site foreperson -- controls the direction of plant growth as well as the physical properties of the biopolymers that plants produce.

The finding is a major clue in a 50-year-long quest to explain how plants coordinate the behaviour of millions of cells as they grow upward to compete for light, penetrate soil to obtain nutrients and water, and even open petals to flower.

"We've known for decades that structures in plants called microtubules act as scaffolding to define the direction of cell expansion," says Professor Geoffrey Wasteneys, a UBC botanist and Canada Research Chair in Plant Cell Biology.

"These are tiny multipurpose cylinders that grow, shrink and self-organize to transport cargo, capture and position large structures such as chromosomes, and establish the shape of cells. But we haven't been able to determine how these tiny microtubules are organized into scaffolds in the first place."

An interdisciplinary team of plant cell biologists and mathematicians led by Wasteneys discovered that the inherent geometry of the cell itself plays an important role in the self-organization of microtubules into parallel arrays that guide cell growth and division. They also identified that a protein called CLASP plays a key role as a foreperson, modulating the geometric constraints of the cell.

Their findings will be published in the August 16 issue of the journal *Nature Communications.*

The research team used a specialized microscope that collects 3D images of plant components genetically engineered to fluoresce when irradiated with specially filtered light. They observed a striking difference in the way microtubules were arranged in normal plants compared to those of a dwarf mutant that fails to produce CLASP.

"Paradoxically, the microtubules appeared to be better organized in the severely stunted mutant plants than they were in the non-mutant plants," says Chris Ambrose, the post-doctoral fellow in Wasteneys' lab whose observations led to the discovery. "By examining how microtubules behave at the sharp edges between adjacent cell faces, we noticed that in the mutant, microtubules would grow into the edges and then undergo catastrophic disassembly. In the non-mutant plants containing the CLASP protein, microtubules would easily bend through 90 degrees and continue growing on the adjacent cell face upon encountering an edge."

Ambrose and Wasteneys then joined forces with UBC mathematicians Eric Cytrynbaum and Jun Allard to run three-dimensional computer simulations to test the ideas that emerged from imaging the living plant cells.

The researchers found that the simulations, which typically take about a day to run on a super computer, closely recapitulated the microtubule patterns observed in living cells.

"Simulation after simulation showed us that microtubules would form parallel arrays in the same patterns seen in living cells," says Allard, now a post-doctoral researcher at the University of California, Davis. "We confirmed that the self-organization depends on the extrinsic cues from the cellular geometry, and that the presence of the CLASP protein along select edges modified the pattern dramatically."

The finding may also be relevant to the burgeoning interest in stem cell biology in the biomedical research field. "Microtubules and the CLASP protein are common to all cell types in plants animals, fungi and many unicellular organisms," says Wasteneys. "So what we find out about their behaviour in plant cells is relevant to understanding their function in cells types as diverse as neurons and disease-causing protozoans."

Provided by University of British Columbia

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