Biologists Unlock Secrets of Plants' Growing Tips

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(PhysOrg.com) -- Biologist Magdalena Bezanilla and colleagues at the University of Massachusetts Amherst have used a technique they call multi-gene silencing to, for the first time, simultaneously silence nine genes in a multicellular organism. It allowed them to discover molecular secrets of how certain plant tissues know which end is their growing tip, also referred to as polarized growth.

The biologists conducted these experiments in a moss, but the findings illuminate processes in two tissues—root hairs and pollen tubes—found in all seed plants. Root hairs are extremely fine individual cells that grow out of a plant's root, greatly increasing its surface area to collect water, essential minerals and nutrients. Pollen tubes travel down the flower to fertilize the plant's egg. Scientists have "a very limited knowledge" at the molecular level of how such cells determine the direction they're growing, says Bezanilla.

Knowing how to interrupt pollen tube formation in plants such as corn and soybeans, for example, could help prevent genetically engineered crops from interbreeding with wild populations. Aiding root hair growth could boost drought-resistance to other economically important plants.

Bezanilla and colleagues' research paper in a recent issue of Proceedings of the National Academy of Sciences describes their work in the Physcomitrella patens moss species, which provides a simple, fast-growing model plant. Conveniently, it has a developmental stage when all cells are undergoing tip growth. Another advantage is that its whole genome is known.

The researchers focused on two proteins, actin and forming. Actin, in this case a kind of scaffold-builder needed to form root hairs and pollen tubes, forms filamentous polymers and is important for many cellular processes in species ranging from yeast to man. Formins, like actin, are found in many species and help to control actin polymer formation. Formins are critical for actin-based cellular processes.

Tools in a biologist's kit can now remove the function of specific proteins—usually one or two at a time—to silence a gene, but in this study the researchers succeeded in silencing a remarkable nine genes at one time. Bezanilla and colleagues systematically silenced the many actin-regulating formins and determined which members of this protein family are needed to generate cells for proper tip growth.

As for silencing nine genes at once, Bezanilla says, "It can be difficult to identify the function of a single gene when it is nested in a highly redundant system or family where another family member will simply step in and take over performing a similar or overlapping function for the one that's missing." By using their technique for multi-gene silencing, she adds, "we discerned how to silence the whole family and dissect gene function in that wider context."

Other tools in the researchers' kit are methods for re-introducing the silenced genes, either normal or modified versions, the biologist explains. By "swapping parts" from closely related formin proteins and measuring tip growing activity for each combination, her research group eventually concluded that only one intact subclass of formins drives normal growth and controls how the plant recognizes its growing tip. "If you take away any part of the formin, tip growth stops," says Bezanilla.

Interestingly, the researchers also discovered that this particular subclass of formins is the fastest yet known in any organism. “What’s interesting here is that these mosses don’t grow very fast in nature,” Bezanilla comments. “So we don’t understand why it would need the fastest formin, but it could be that what the plant actually needs at its growing tip is the ability to be flexible and dynamic, that is, adapt quickly to whatever situation is encountered,” she adds.

This required collaboration with biochemist Laurent Blanchoin and colleagues at the University of Joseph Fourier, Grenoble, France. Bezanilla says this teamwork combining *in vitro* and *in vivo* studies in a single work “is really the future of where science should be going because as important as it is to know the biochemical function of a particular protein molecule you’re studying, knowing its role in the whole organism is even more important.”

“Finding out that one protein gets its tasks done twice as fast as another in a test tube is interesting, but this difference could be meaningless to a cell,” she explains. “Marrying the in vivo and in vitro approaches is critical to our full understanding of biological processes.”

More information: Proceedings of the National Academy of Sciences

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