In time for spring, biologist illuminates how seedlings regulate growth

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With seedlings and shoots still poking their leafy tops out of the soil, it's hard to read the newly published research of Brown University biologist Alison DeLong without musing that it provides a deeper understanding of what puts the spring in spring.

DeLong's paper, published in advance online April 21 in PLoS Genetics, reveals fertile new insights into the intricate network of proteins that controls plant growth and development, particularly at the seedling stage. But the research also runs deeper than the roots of any of the *Arabidopsis thaliana* specimens in her lab. The central enzyme in DeLong's investigation, protein phosphatase 2A (PP2A), operates in a wide variety of organisms, including in people, where it is associated with tumor growth. PP2A's universal role in life is to cleave a phosphoryl group off a protein to affect how it will function.

"Everybody has reversible protein phosphorylation," said DeLong, associate professor of biology in the Department of Molecular Biology, Cell Biology and Biochemistry. "It's a question of how an organism regulates the dephosphorylation reaction. You need to do that correctly in order to regulate growth correctly."

Striving for the light

In *A. thaliana*, what DeLong wanted to discover about PP2A was how it regulates the production of ethylene, a gaseous hormone that inhibits the elongation of plant cells. As a plant embryo germinates, cells in the emerging shoot elongate to reach above the soil. Its goal is to reach daylight so that photosynthesis can begin before the reserve of food in the seed runs out. PP2A's job is to keep a lid on ethylene production during germination.

"Keeping these ethylene levels low is actually quite critical during this phase of growth," DeLong said.

In a series of experiments comparing normal *A. thaliana* plants to those with mutations that disabled PP2A and other proteins, DeLong and and graduate student Kyle Skottke, the lead author, found the mechanism by which PP2A works. In seedlings, its phosphoryl-pruning effect suppresses the activity of a protein called ACS6 that is necessary to produce ethylene. In Petri dishes kept in the dark — analogous to growing underground — plants lacking a PP2A gene grew much shorter shoots than normal plants.

Unexpectedly, the team, including researchers from the University of North Carolina–Chapel Hill, also found that PP2A boosts the activity of a second class of ACS proteins. Those proteins are responsible for maintaining the normal baseline production of ethylene, which is important to have around at other developmental stages.

"For us the fun part of the story is that we went looking for the answer to a single question and then, in walking through the analysis to lead us to that single answer, we actually found a second phenomenon that we hadn't known to look for," she said.

A next step in DeLong's lab will be to look at how the protein network operates during later developmental stages. With spring settled, so to speak, the growing season is the next focus of her inquiry into the nature of growth.

Provided by Brown University