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Protein plays role in helping plants see light

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Plants do not have eyes or legs, yet they are able to "see" and move toward and away from light. This ability, called phototropism, is controlled by a series of molecular-level signals between proteins inside and between plant cells. In a paper published in *The Plant Cell,* University of Missouri scientists report for the first time the elusive role a critical protein plays in this molecular signaling pathway that regulates phototropism in plants.

Directional light that induces phototropism is sensed by a plant through the action of two light-sensing proteins, phototropin 1 and phototropin 2. These proteins act as photoreceptors and initiate the phototropic signaling response in conjunction with a third protein, called NPH3.

"If the phototropic signaling pathway were like a baseball game, the phototropins would be the pitcher and NPH3 the catcher who work together to coordinate the signal, or pitch," says Mannie Liscum, a professor of biological sciences in the College of Arts and Science and in the Christopher S. Bond Life Sciences Center. "Prior to this study, no one knew how NPH3 and the phototropins cooperated to facilitate the signal."

Using a combination of genetic and biochemical methods, Liscum and colleagues found that NPH3 functions as part of a protein complex that modifies phototropin 1 by the addition of a small protein "tag" called ubiquitin. Either a single ubiquitin or a chain of ubiquitin proteins is added, depending on the amount of light the plant "sees."

If we continue the baseball analogy, ubiquitin is the hand signals NPH3 uses to coordinate with phototropin 1 the type and sequence of signals depending on the particular lighting situation.

"In low-light conditions, phototropin 1 is modified with single ubiquitin proteins and then apparently moves to a different part of the cell. In high-light conditions, phototropin 1 is modified with multiple ubiquitin proteins and is degraded by the cell to shut down further signaling," says Liscum.

The finding may have applicability to research beyond phototropism in plants.

"The tagging of proteins with ubiquitin represents a common biochemical event throughout the biological world. In fact, many human disease pathologies are associated with alterations in ubiquitin-tagging," says Liscum. "Our studies identifying a single enzyme complex that is capable of modifying a substrate in different ways simply based on the environmental conditions may therefore have implications on fields far askew from agriculture."

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