Scientists shed light on braking mechanisms in cellular signaling

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A team of researchers studying a flowering plant has zeroed in on the way cells manage external signals about prevailing conditions, a capability that is essential for cells to survive in a fluctuating environment.

Researchers at UC Berkeley, the Plant Gene Expression Center, UC San Francisco, and the Carnegie Institution for Science identified a novel mechanism by which the strength of such an external signal is reduced, or attenuated. Their work focuses on the tiny mustard plant *Arabidopsis*, which is frequently used by scientists as an experimental model. Their findings are published in *Science* June 6.

Attenuation of signaling is analogous to the brakes on a car. While acceleration is desirable, acceleration without restraint can be disastrous. In this research, *Arabidopsis* seedlings were taken from subterranean darkness into sunlight, which triggered a response leading to "rapid and extensive" redirection of gene expression, ultimately resulting in familiar green seedlings.

But a brake on this acceleration of new gene expression is also necessary to restabilize the cells at a new equilibrium. The research team discovered a nuclear-localized, bimolecular signaling configuration by which the braking mechanism is directly linked to the accelerator, thereby providing simultaneous acceleration and restraint. By identifying the mechanism involved in this attenuation process, the team's discovery has potential implications ranging from agricultural to cancer research.

Cellular signaling triggered by external cues such as sunlight enables organisms to adapt to the prevailing conditions. When the organism perceives something that requires a response, a series of chemical signals is activated. This signaling is generally very robust at first. But at some point it is necessary to dial it back or turn it off entirely—a restraint that falls to different, less-understood signaling pathways. These types of restraint functions are of great importance but poorly understood, as scientists have focused mostly on how the cells get stimulated in the first place.

Light-signaling in *Arabidopsis* involves the binding of an activated photoreceptor molecule (called phytochrome) to a transcription factor (gene-switch) called PIF. This binding destroys PIF, switching off its target genes. However, the researchers found that in imposing PIF's destruction, phytochrome signs its own death warrant and is simultaneously executed, thus reducing the incoming light-signaling intensity.

"Understanding such molecular mechanisms underlying the light response kinetics is important for engineering crops that can better adapt to environmental fluctuations," said Carnegie's Zhiyong Wang, one of the co-authors.

This bimolecular mutually assured destruction (MAD) mechanism of signaling attenuation appears to represent a new configuration, thus broadening our understanding of the range of mechanisms nature has evolved for this critical function.

More information: "A mutually assured destruction mechanism attenuates light signaling in Arabidopsis" www.sciencemag.org/lookup/doi/ … 1126/science.1250778

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