SIGNALLING

Sensing peroxide

Nature **578**, 577–581 (2020)

Receptor-like kinase (RLK) or protein (RLP) receptors, with or without an intracellular kinase domain attached, are the jack of all trades for plant sensing of extracellular signals. These types of cell surface receptors have been shown to perceive a wide array of molecules, from immunogenic non-self peptides and specific carbohydrate cell wall polymers representing invading pathogens and danger, to wounding and stress signals, such as extracellular ATP. They also have fundamental roles in development, as they perceive endogenous hormone-like peptides in many biological processes and monitor the integrity, or participate in the formation of, cellular structures. In fact, the *Arabidopsis* genome encodes for several hundred of these receptors, the majority of which have a leucine-rich repeat (LRR) extracellular domain.

In a recent publication in *Nature*, a team led by Zhen-Ming Pei at Duke University added one more signal to the already vast repertoire of molecules perceived by plasma membrane receptors: hydrogen peroxide (H_2O_2). H_2O_2 is an endogenous signal produced during photosynthesis in response to various biotic or abiotic stresses, and also during development, most notably for single cell growth such as in pollen tubes or root hair. Using a strategy that has already been proved successful before, the researchers performed a genetic screen using plants expressing a calcium-level reporter, aequorin.

The team isolated one mutant with an almost inexistent calcium increase, specifically in response to exogenous H_2O_2. The effect was particularly visible in guard cells, which displayed impaired stomatal closure. The gene, named *HYDROGEN-PEROXIDE-INDUCED* Ca^{2+} *INCREASES* (*HPCA1*), encodes for a quite typical LRR-RLK except for the presence of unusual cysteine pairs in the extracellular domain. In response to an increased apoplastic concentration of H_2O_2, these cysteines are oxidized and form disulfide bonds which, according to the model, lead to autophosphorylation of the kinase domain and interaction with yet unknown calcium channels in order to open them.

While the precise molecular mechanisms downstream of HPCA1 remain to be determined, this discovery of the first cell surface H_2O_2 sensor in plants is significant, as this molecule is a crucial secondary messenger in many biological processes, most notably in response to environmental changes. Perceiving peroxide outside of the cell might be a way for the cell to raise the alarm early and start a transcriptional program without the need to detoxify intracellular reactive oxygen species that might interfere with cytoplasmic content. One more interesting characteristic discovered from the large and fascinating world of receptors.

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Published online: 3 March 2020
https://doi.org/10.1038/s41477-020-0626-2