Scientists see how plants optimize their repair

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Credit: Wikipedia.

Researchers led by a Washington State University biologist have found the optimal mechanism by which plants heal the botanical equivalent of a bad sunburn. Their work, published in the *Proceedings of the National Academy of Sciences*, could lead to the development of crops that can repair the sun's damage more easily, improving yields and profitability.

Helmut Kirchhoff, an assistant professor in WSU's Institute of Biological Chemistry and corresponding author of the *PNAS* paper, said plants have had to deal with solar damage since the evolution of photosynthesis some 3.5 billion years ago. The process produces energy for the plant but also creates modified oxygen molecules, called reactive oxygen species, or ROS, that can damage proteins and other important plant molecules.

"ROS production can't be avoided, only minimized," said Kirchhoff. "It becomes a big problem for plants under unfavorable environmental conditions, like too much heat, too much light or insufficient nutrition."

Kirchhoff and his colleagues focused on a specialized system of photosynthetic membranes inside the chloroplast, which converts sunlight to energy. The membranes contain sophisticated molecular-scale nanomachines that are the prime target of oxidative damage. Other nanomachines can repair the damage.

Earlier researchers have found that the machines make repairs in multiple steps. Each step depends on the success of its predecessor, and Kirchhoff and his colleagues determined that the required order of steps is established by the separating of different repair proteins to different membrane regions. This compartmentalization is guaranteed by folding of the membrane.

"Until now, it was not known how the order of events is guaranteed," Kirchhoff said. "Our results suggest that we have to understand the structural characteristics and dynamics of photosynthetic membranes to understand the repair of the energy-converting nanomachines. This has not been appreciated before."

It's possible that this insight could help scientists generate plant mutations with membrane architectures that make more efficient repairs, said Kirchhoff. Plants might be tailored by geographic regions or climate zones.

"It could be good to improve the repair machinery in hot and bright climates," he said, "but it would be counterproductive for temperate climate zones."

More information: Compartmentalization of the protein repair machinery in photosynthetic membranes, *PNAS*, 2014. www.pnas.org/cgi/doi/10.1073/pnas.1413739111

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