

Green energy management: How plants cope with variable light conditions

January 27 2010

Plants use energy derived from sunlight to form sugars from carbon dioxide and water by the process of photosynthesis. Recent discoveries made by a research group at Ludwig-Maximilians-Universitaet in Munich, Germany, provide new insights into the control circuit that enables plants to make optimal use of incident light.

As so-called primary producers, plants use solar energy to synthesize the foodstuffs that sustain other forms of life. This process of photosynthesis works in much the same way as the solar panels that supply energy for domestic heating. Like these, plant leaves must cope with variations in the level and quality of ambient light. LMU researcher Professor Dario Leister and his colleagues at LMU Munich have been studying how this is accomplished in the thale cress, Arabidopsis thaliana. "It turns out that, depending on lighting conditions, photosynthesis can rapidly switch between two modes of action, called states 1 and 2", says Leister, "and some years ago we reported that the 1-to-2 transition depends on the enzyme STN7, which attaches phosphate to a key protein." In their latest publication the researchers together with collaborators in Italy, have identified the enzyme that reverses this modification, thus flipping the system back to state 1. The discovery adds a critical element to the understanding of photosynthesis but has also practical implications for improving the growth of plants under low-light conditions, which favour state 2. (PLoS Biology, 26 January 2010)

The photosynthetic machinery is embedded in specialized membranes



called thylakoids located in the chloroplasts of leaf cells. Thylakoids contain two types of so-called photosystems, PSI and PSII. Each consists of an antenna complex and a reaction center. The antenna complex channels light energy to the reaction center, where it serves to detach electrons from <u>chlorophyll</u> molecules. The energy imparted to the electrons is captured in a controlled manner as they pass along a sequence of carrier molecules, and is used to power all other cellular activities.

The two photosystems contain different antenna proteins, called lightharvesting complexes (LHCs), and differ in their sensitivity to light of different colours. PSII is most sensitive to red light, while PSI responds best to far-red light. "However, the two photosystems act in series, with PSII passing excited electrons via carrier molecules to PSI, where they receive a second energy boost", explains Leister. "The distribution of excitation energy between the photosystems must therefore be balanced for optimal performance, and this is done in part by switching between two functional states."

Red light makes PSII run faster than PSI, but within minutes phosphate is added to a fraction of the LHCII molecules attached to PSII, and the transition to state 2, associated with the migration of modified LHCII to PSI, ensues. "We previously identified the enzyme that attaches phosphate to LHCII as STN7", says Leister, "and showed that STN7 is activated when the carriers that relay electrons to PSI are overloaded." When the modified LHCII proteins bind to PSI, they permit it to utilize more light and accept electrons from PSII, relieving carrier overload and balancing the activities of the two photosystems.

The reverse transition (2-to-1) requires the removal of phosphate from LHCII. In their latest publication, the researchers report how they found the phosphatase enzyme that performs this task. "First we individually inactivated the genes for the nine phosphatases known to reside in the



chloroplast, but none of the mutations affected state transitions", explains Leister. However, the team then hit upon another phosphatase, At4g27800, among chloroplast proteins that had been identified by mass spectroscopy.

It proved to be an inspired choice. "We confirmed that this protein, which we renamed TAP38, is associated with thylakoids, and we identified mutant strains that lacked it. These mutants remain locked in state 2, irrespective of <u>lighting conditions</u>, as one would expect if TAP38 is required for removal of the phosphate." And indeed, addition of purified TAP38 to the modified LHCII was found to lead directly to loss of the phosphate group.

The discovery adds a critical element to the circuitry that regulates state transitions, but it also has practical implications for improving the growth of plants under low-light conditions, which favour state 2. As Professor Leister reports, "plants in which the gene for TAP38 is inactivated grow faster than their normal counterparts in continuous low-level light. This is probably due to the more balanced allocation of light between the two photosystems". So perhaps the elegant energy management system elucidated by Leister and his colleagues will someday help reduce <u>energy</u> bills too.

More information: "Role of plastid protein phosphatase TAP38 in LHCII dephosphorylation and thylakoid electron flow" Mathias Pribil, Paolo Pesaresi, Alexander Hertle, Roberto Barbato and Dario Leister, *PloS Biology*, January 26, 2010

Provided by Ludwig-Maximilians-Universität München

Citation: Green energy management: How plants cope with variable light conditions (2010,



January 27) retrieved 28 April 2024 from <u>https://phys.org/news/2010-01-green-energy-cope-variable-conditions.html</u>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.