Press release
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Photosynthesis even at high temperatures: helper protein ensures the formation of chlorophyll

New study reveals the protective function of the chaperone cpSRP43 against heat shock

Prof. Dr. Bernhard Grimm together with Shuiling Ji (center) and Dr. Peng Wang (left) in the greenhouse of the Institute of Biology of the Humboldt-Universität zu Berlin (Photo: Dr. Sohail)

Plants make use of complex metabolic processes to produce chlorophyll – the pigment that gives them their green colour and enables photosynthesis. The fact that so-called chlorophyll biosynthesis works smoothly even in the presence of heat is due to a certain helper protein: the chaperone cpSRP43. It ensures that, even in the midday heat, important metabolic enzymes retain their shape and see to it that chlorophyll is produced. This is shown by scientists from the Institute of Biology at the Humboldt-Universität zu Berlin (HU) and from the California Institute of Technology (Caltech). For the study, which has now been published in the journal *Nature Plants*, the researchers exposed plants to heat stress and analysed enzymes in the laboratory. In doing so, they discovered the important function of the chaperone cpSRP43 in protecting chlorophyll formation against heat.

The metabolism of plants is also sensitive to heat

Plants cannot hide from extreme environmental conditions and have to quickly adapt their metabolic activities to different temperatures or light intensities. The numerous enzymes and regulatory proteins that are involved in the complex metabolic processes also react sensitively to the changing environmental conditions. Heat or high light intensity can significantly impair the function and three-dimensional structure of proteins and render them inoperative. In order to prevent this and ensure that the proteins retain their function, plants have also developed various protective systems that protect the proteins from oxidation, aggregation or structural changes. These also include chaperones, which act as supporting proteins and ensure that important proteins are correctly folded, that is, adopt and retain their proper three-dimensional shape.

Chaperone cpSRP43 protects enzymes against incorrect folding

One of the most important metabolic processes in plants is chlorophyll biosynthesis. Even in extreme heat or in the presence of strong solar radiation, plants have to maintain chlorophyll production in order to ensure sufficient photosynthesis for converting solar energy into biochemical energy. How plants achieve this has now been shown by Shuiling Ji, Dr Peng Wang and Prof. Bernhard Grimm from the Plant Physiology group at the HU Berlin Institute of Biology, together with colleagues from Caltech. The chaperone "chloroplast signal recognition particle 43" (cpSRP43) protects important enzymes from incorrect folding due to heat during chlorophyll biosynthesis.

Chlorophyll biosynthesis is made possible even in the presence of heat

It has long been known that the chaperone cpSRP43 and its partner protein cpSRP54 jointly support another metabolic process in plant cells: they ensure the transport of LHCPs (light-harvesting chlorophyll-binding proteins) through the chloroplasts and their integration into the thylakoid membranes. In in-vivo studies by using plants and in-vitro laboratory tests of the enzymes, the researchers found that when there is increased heat stress, cpSRP43 separates from its partner cpSRP54 and, in an independent action, protects enzymes that are important for chlorophyll biosynthesis. It ensures the stability and solubility of the enzymes GluTR and CHLH and its regulator factor GUN4, thus guaranteeing that, even at high temperatures, these crucial proteins are able to function consistently and unimpeded in the metabolic pathway of chlorophyll biosynthesis in plant cells.

"The decoupling of the chaperone cpSRP43 from its partner

when exposed to heat and its autonomous function as a thermal protectant constitute an important regulatory mechanism in plant cells. This mechanism is essential in order for the plants to be able to adapt to changing climatic conditions," says the leader of the group, Prof. Dr Bernhard Grimm, explaining the study results.

Publication

Shuiling Ji, Alex Siegel, Shu-ou Shan, Bernhard Grimm, & Peng Wang (2021). "Chloroplast SRP43 autonomously protects chlorophyll biosynthesis proteins against heat shock". To be published on 2nd September 2021 in *Nature Plants*, DOI: 10.1038/s41477-021-00994-y
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