Green light for clever algae

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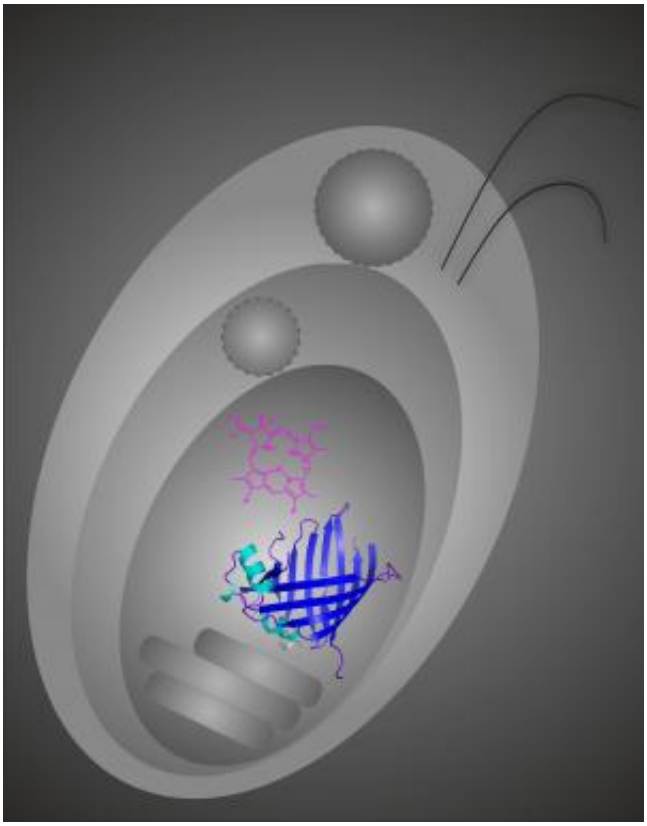

Schematic of the complex construction of a cryptophyte cell. The barrel-like docking enzyme GtCPES is found in an inner compartment, the chloroplast stroma. Here, the enzyme is responsible for the transport and docking of the magenta-coloured pigment phycoerythrobilin to the phycobiliprotein structure.

Phytoplankton not only constitutes the foundation of the food chain in the oceans, it also fixes carbon through photosynthesis and generates oxygen with the help of solar energy. A considerable part of

phytoplankton is made up of cryptophytes, complex single-cell algae. In the course of evolution, these algae have adapted their light-harvesting mechanisms to their environment and have thus become capable of utilising green light. The researchers headed by Prof Dr Nicole Frankenberg-Dinkel have been the first ones to reveal similarities and differences in the assembly of the light-harvesting machinery of the cryptophyte Guillardia theta compared to cyanobacteria and red algae. The publication of their results in the current issue of "The *Journal of Biological Chemistry*" is among the two per cent of the publications that were selected as "Paper of the week".

Cryptophytes: Matryoshka dolls of the waters

Unlike traditional eukaryotic cells – i.e. all cells with a nucleus – cryptophyte cells resemble a Russian doll in the form of an alga within an alga. They originated from a eukaryotic cell that engulfed and integrated a red alga. Thus, cryptophytes have acquired the ability to perform photosynthesis. Just like their red algal ancestors, cryptophytes utilise not only the green pigment chlorophyll for harvesting light, but have also the capability to use green light being missed by chlorophyll. This is due to blue or red-tinted proteins – so-called phycobiliproteins. After integrating the red alga, its genome was reduced over time and combined with the host cell's genome. During this process, a number of modifications on genetic, biochemical and physiological levels took place, which facilitated adaptation to new ecological niches. Although the algae maintained the basic principle of photosynthesis, their light-harvesting phycobiliproteins were largely modified and greatly differ from their cyanobacteria and red algae ancestors.

Protected pigment transport in a barrel

In many respects, the way light-harvesting works in Guillardia theta has

not yet been understood. RUB researchers have now for the first time gained insight into the complex biosynthesis of cryptophyte phycobiliproteins. "Guillardia theta has obviously combined tried-and-tested and novel synthesis methods and enzymes," says Prof Dr Nicole Frankenberg-Dinkel. The biosynthesis of the magenta-coloured light harvesting pigment phycoerythrobilin is similar to that of cyanobacteria. Docking of pigments on the phycobiliprotein structure, on the other hand, is performed by both known and novel enzymes. Prof Frankenberg-Dinkel's team of researchers succeeded in characterising one of these docking enzymes, GtCPES, in biochemical and structural terms. In collaboration with Dr Raphael Gasper-Schönenbrücher from the work group Protein Crystallography, headed by Prof Dr Eckhard Hofmann, they solved the atomic structure of GtCPES. GtCPES is shaped like a barrel that is sealed only at the bottom end and is open at the top to only let in the magenta-coloured pigment phycoerythrobilin. The barrel's function is to shield the sensitive pigment from external influences while it is being transported to its destination, i.e. to the apo-phycobiliprotein. Thanks to the barrel top's structural properties, the transfer of the pigment is carried out in the correct orientation to a clearly defined spot of the target protein surface.

More information: Overkamp, K. E., Gasper, R., Kock, K., Herrmann, C., Hofmann, E. und Frankenberg-Dinkel, N. (2014) "Insights into the biosynthesis and assembly of cryptophycean phycobiliproteins" *J Biol Chem*. 289, 26691-26707, DOI: 10.1074/jbc.M114.591131

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