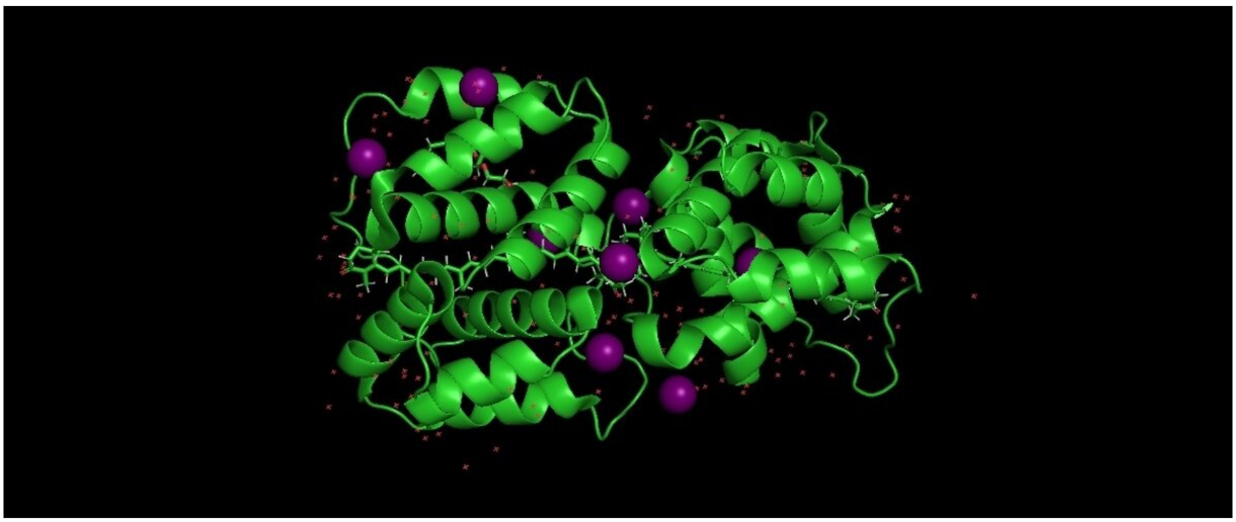
Our first look at a new light-absorbing protein in cyanobacteria

April 4 2019, by Igor Houwat And Maria Agustina Dominguez-Martin



Credit: Michigan State University

Cyanobacteria are tiny, hardy organisms. Each cell is 25 times smaller than a human hair, but don't let the size fool you. Their collective ability to do expand photosynthesis is why we have air to breathe and a diverse and complex biosphere.

Scientists are interested in what makes expand cyanobacteria great at photosynthesis. Some want to isolate and copy successful processes. Those would then be repurposed for human usage, like in medicine or for renewable energy.

One of these systems is expand photoprotection. It includes a network of proteins that detect surrounding light levels and protect cyanobacteria from terrible damages caused by overexposure to bright light.

The lab of Cheryl Kerfeld recently discovered a family of proteins, the Helical Carotenoid Protein (HCP), who are the evolutionary ancestors of today's photoprotective proteins. Although ancient, HCP still live on alongside their modern descendants.

This discovery has opened new avenues to explore photoprotection. And for the first time, the Kerfeld lab structurally and biophysically characterizes one of these expand proteins. They call it HCP2. The study is in the journal BBA-Bioenergetics.

The Science

Structurally, the HCP2 is a monomer when isolated in a solution. But, in its expand crystallized form, it curiously shows up as a dimer.

"We don't think that the dimer is the protein's form when it is in the cyanobacteria," says Maria Agustina (Tina) Dominguez-Martin, a post-doc in the Kerfeld lab. "Most likely, HCP2 binds to a yet unknown partner. The dimer situation during crystallization is artificial, because the only available molecules in the environment are others like itself."

The scientists try to determine HCP2s functions. It is a good quencher of expand reactive oxygen species, damaging byproducts of photosynthesis. But since many other proteins can do that as well, Tina doesn't think that is HCP2's main function.

"We have yet to identify a primary function," Tina says. "The difficulty is that the HCP family is a recent discovery, so we don't have much basis for comparison."

Other experiments include:

- Measuring HCP lightwave absorption bandwidths
- Identifying what expand carotenoid it interacts with
- Examining whether they quench antennae proteins that capture light for photosynthesis (they don't)

Future applications

The ability to detect light is key for applications, especially in biotech. One promising area is optogenetics, a technology that uses light to control living cells. Optogenetics systems are like light switches that activate predetermined functions when struck by a light source.

HCP2 could play a part in such applications. But this is all far down the road.

"There are 9 evolutionary families of HCP to explore. That adds up to hundreds of variants with possibly distinctive functions that we have yet to discover," she adds. "With that in mind, we're characterizing other proteins from the HCP family to expand our available data set."

Because these proteins likely play a role in photoprotection, they may represent a system that scientists could engineer for "smart photoprotection," reducing wasteful photoprotection which would then help photosynthetic organisms become more efficient.

More information: Maria Agustina Dominguez-Martin et al. Structural and spectroscopic characterization of HCP2, *Biochimica et Biophysica Acta (BBA) - Bioenergetics* (2019). DOI: 10.1016/j.bbabio.2019.03.004