Biologists identify light-regulated mechanism in cyanobacteria as aid to optimizing photosynthesis

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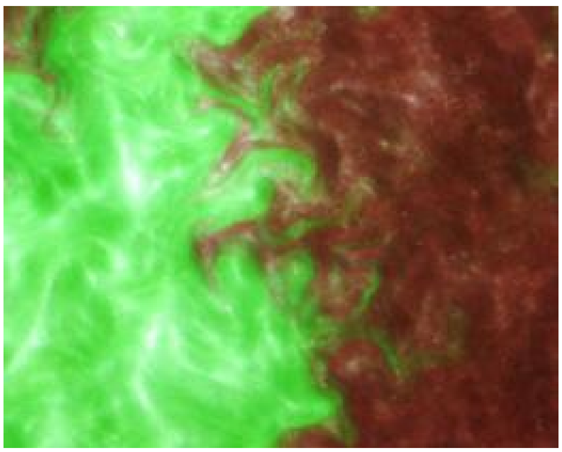

Light microscopy image of a normal 'Fremyella diplosiphon' colony (green, left side) adjacent to a 'F. diplosiphon' mutant capable of only producing the light-harvesting pigment phycoerythrin (red, right side), growing on an agar plate in red light.

(PhysOrg.com) -- Indiana University biologists have uncovered how a control system works in producing the important light-harvesting antennae that power photosynthesis in cyanobacteria, the microorganisms that are progenitors of all land plants and responsible for nearly half of the Earth's current oxygen production.

Implications of fully comprehending the mechanism, called "light-regulated transcription attenuation," include the potential for increasing agricultural yields, making bio-solar energy production more feasible, and improving understanding of a globally important biological process that is vital for providing the energy needed to sustain virtually all life on Earth, according to David M. Kehoe, an associate professor within the Department of Biology in the IU Bloomington College of Arts and Sciences and a fellow of the Indiana Molecular Biology Institute.

"This mechanism -- transcription attenuation -- was first discovered four decades ago, but until now it had never been identified as a control system in cyanobacteria," he noted. "It had also never been shown to be regulated by light, so these results expand our understanding of how photosynthesis is regulated and, for the first time, indicate that light can regulate cell activity through the process of transcription attenuation."

Gene expression begins with transcription, the creation of a complementary RNA copy of a DNA sequence, and attenuation is the RNA-based regulatory strategy that bacteria use to prematurely terminate transcription when specific circumstances arise.

"The light harvesting antennae capture the sun's energy, thus providing the power for photosynthesis," Kehoe said. "Cells can change the size, shape, and composition of these antennae as environmental conditions change in order to optimize light capture."

Kehoe is lead author on the work, "Light-dependent attenuation of phycoerythrin gene expression reveals convergent evolution of green light sensing in cyanobacteria," which appeared online this week in early editions of *Proceedings of the National Academy of Sciences*. The work was co-authored by IU Department of Biology Ph.D. candidates Ryan Bezy, now an assistant professor at Mount Mercy University, Cedar Rapids, Iowa, and Lisa Wiltbank, both researchers from Kehoe's laboratory. The research was funded by the Division of Molecular and

Cellular Biosciences within the National Science Foundation.

The light color sensory system in cyanobacteria allows for pigmentation change in response to red and green light, which in turn increases fitness by optimizing photosynthesis. Scientists have a good understanding of the sensory system that controls cellular production of red-light absorbing pigments, but had yet to resolve one of the two control systems -- the Cgi pathway -- which controls the production of green light-absorbing pigments called phycoerythrins (PE).

With this new research, Kehoe's group better characterized how the Cgi pathway regulates PE synthesis through a never before identified type of signal transduction pathway in which the attenuation of the transcription of a specific gene cluster, the cpeC operon, was regulated by light color.

The researchers used the cyanobacterium Fremyella diplosiphon, which has a genome approximately 10 million base pairs long, compared with the human genome, which contains just over 3 billion base pairs. F. diplosiphon is predicted to have more than 10,000 genes, making it one of the most complex bacteria described to date, while humans have between 25,000 and 30,000 genes.

More information: "Light-dependent attenuation of phycoerythrin gene expression reveals convergent evolution of green light sensing in cyanobacteria," *Proceedings of the National Academy of Sciences*, Oct. 31, 2011, doi: 10.1073/pnas.1107427108

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