Trends in Microbiology | Microbe of the Month

Fremyella diplosiphon

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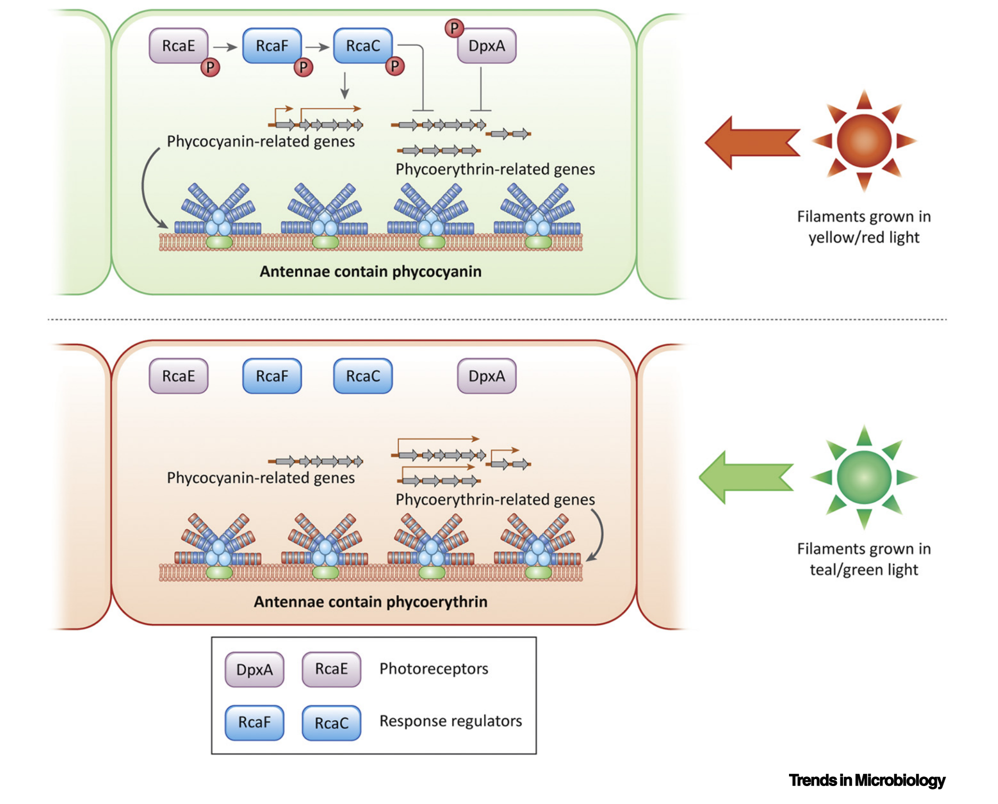
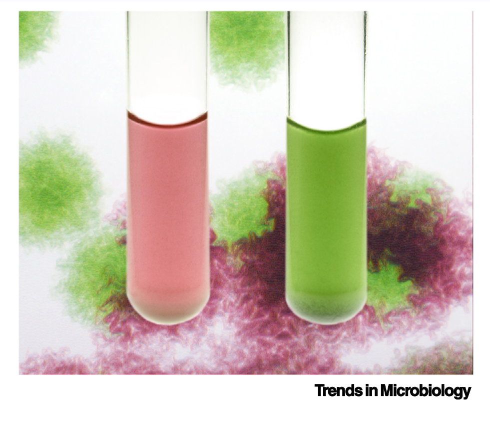


Fremyella diplosiphon is a freshwater filamentous cyanobacterium known for chromatic acclimation (CA), dramatic shifts between green and red phenotypes due to ambient light color changes. The color shifts within *F. diplosiphon* filaments during CA reflect changes in the chromoproteins of photosynthetic light-harvesting antennae. In red light, the chromoprotein phycocyanin is produced, absorbing red light and making cells blue-green. In green light the chromoprotein phycoerythrin is made, which absorbs green light and makes cells red. Chromoprotein production is controlled by the phytochrome superfamily photoreceptors RcaE and DpxA. Both are light-regulated histidine kinases of two-component systems. RcaE is activated in red light and inactivated in green light, while DpxA is activated in yellow and inactivated in teal light. The coordinate regulation of light-harvesting antennae biogenesis reveals the complex interactions between phytochrome family photoreceptors in bacteria.



TAXONOMY AND CLASSIFICATION:
Kingdom: Bacteria
Phylum: Cyanobacteria
Order: Nostocales
Family: Tolypothrichacae
Genus: *Fremyella*
Species: *diplosiphon*

KEY FACTS:

CA was first described in 1902.

F. diplosiphon, isolated from a Connecticut lake in 1952, was deposited at the University of Texas, then added to the Pasteur Culture Collection and designated *Tolypothrix* PCC 7601.

The sensory capacity of *F. diplosiphon* appears to be one of the most complex known in prokaryotes. Over 10 000 coding sequences are predicted in its genome, including 305 two-component system proteins and 27 different phytochrome superfamily members for light color sensing, the most in any known organism. Phytochrome family proteins are important photoreceptors in plants, fungi, and bacteria.

RcaE also controls development and cell size, shape, and filament length, and regulates the amount of another phytochrome family member called IflA, which becomes six times more abundant when cells are switched from red to green light. IflA senses the red:far red light ratio, increasing growth when the light environment is enriched with red light.

F. diplosiphon has an additional set of genes encoding phycocyanin that are transcribed only when sulfate levels in the environment are low, producing light-harvesting antennae that function as well as those with the phycocyanin made in nutrient-replete conditions. However, in low-sulfate-expressed phycocyanins, all methionines and the cysteines not required for chromophore attachment are absent. This 'elemental-sparing' response saves approximately 1000 sulfur atoms per light-harvesting antenna.

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Photograph showing tubes of liquid cultures of *F. diplosiphon* cells after growth in green light (left) or red light (right) superimposed on a photograph of mutant (green) and wild-type (red) colonies after growth on agar plates in green light: image by Roger Hangarter and Allissa Haney.

Literature

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