ENVIRONMENTAL MICROBIOLOGY

Biohydrogen production gets airborne

The potential for developing commercially viable microbial H_2 production systems as a renewable source of biofuel has been limited by the need for an anaerobic environment to enable photobiological H_2 production in capable bacterial and algal species. Writing in *Nature Communications*, Bandyopadhyay *et al.* now show that the cyanobacterium *Cyanothece* sp. ATCC 51142 is capable of highly efficient H_2 production under natural aerobic conditions.

The marine bacterium *Cyanothece* sp. ATCC 51142 has a diurnal metabolic cycle: photosynthesis and carbon fixation occur during daylight hours, and then at night high rates of respiration create a suboxic intracellular environment that enables O_2-sensitive processes, including N_2 fixation and H_2 production. The authors developed a two-stage approach to monitor H_2 production by *Cyanothece* sp. ATCC 51142. In the first stage, they grew the bacteria aerobically in an alternating 12-hour light–dark cycle. A second 'incubation' stage was then carried out, in which the authors


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took cells from the end of a 12-hour light period and incubated them in air-tight vials for a further 12 hours under continuous illumination. Analysis of the head space at the top of the vial revealed high rates of H_2 production (>150 μmol H_2 per mg chlorophyll per hour) during this incubation period. Furthermore, the rate of H_2 production could be enhanced by growing the cells with high levels of CO_2 or glycerol.

The authors confirmed that H_2 production was mediated by the nitrogenase system found in the bacterium. Interestingly, in the absence of molecular N_2, nitrogenase systems channel all available electrons towards H_2 production. Accordingly, when the authors incubated glycerol-supplemented *Cyanothece* sp. ATCC 51142 cells in the absence of N_2, the rate of H_2 production increased to up to 467 μmol H_2 per mg chlorophyll per hour, which is an order of magnitude greater than the rates previously observed in other wild-type H_2-producing model photosynthetic microorganisms under anaerobic conditions.

> "*Cyanothece* sp. ATCC 51142 is a potentially viable system for producing biohydrogen as a renewable fuel source."

As glycerol and CO_2 are both abundantly available as industrial waste products, the fact that they substantially enhance aerobic H_2 production suggests that *Cyanothece* sp. ATCC 51142 is a potentially viable system for producing biohydrogen as a renewable fuel source.

Andrew Jermy

ORIGINAL RESEARCH PAPER
Bandyopadhyay, A. *et al.* High rates of photobiological H_2 production by a cyanobacterium under aerobic conditions. *Nature Commun.* **1**, 139 (2010)