NREL NATIONAL RENEWABLE ENERGY LABORATORY

New Cyanobacteria Metabolic Pathway Critical to Energy Conversion

Highlights in Research & Development

A little-known metabolic pathway in photosynthetic organisms is actually a major pathway for converting carbon dioxide to biofuels and bioproducts.

NREL previously engineered a cyanobacterium, *Synechocystis*, so the organism could metabolize xylose and carbon dioxide into the chemical building blocks pyruvate and 2-oxoglutarate that can be used to produce a variety of biofuels and bioproducts. While testing this mutant strain under multiple growth conditions, scientists learned that the cyanobacterium excreted large amounts of acetic acid.

NREL Principal Investigator Jianping Yu holds a liquid culture of cyanobacteria. Photo by Dennis Schroeder, NREL 34206

Not being able to explain the production of the acetic acid through traditional pathways, researchers began investigating the phosphoketolase enzyme, as it was thought to be active in cyanobacteria. Using a previously studied phosphoketolase enzyme from a different organism, researchers were able to identify the gene slr0453 as the likely source of the phosphoketolase in *Synechocystis*.

Disabling the newly identified phosphoketolase gene in *Synechocystis* led to slower growth in sunlight—that is, conditions dependent only on CO_2 assimilation by photosynthesis. The *Synechocystis* strains with the disabled gene made less acetic acid in light and could not produce acetic acid in the dark when fed with sugars. Researchers successfully demonstrated that the phosphoketolase pathway was solely responsible for the production of acetic acid in the dark and also contributes significantly to carbon metabolism in the light, highlighting the physiological importance of the phosphoketolase enzyme for carbon utilization in *Synechocystis*.

Using a carbon-13 isotope, researchers tracked how xylose and carbon dioxide were converted into other organic chemicals. The results show that the phosphoketolase pathway actually carries a significant proportion of the central carbon metabolism in *Synechocystis*. The phosphoketolase pathway also avoids the carbon loss as carbon dioxide associated with traditional pathways, so a wide variety of bioproducts and biofuels can potentially be made more efficiently.

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Reference[s]: Wei Xiong, Tai-Chi Lee, Sarah Rommelfanger, Erica Gjersing, Melissa Cano, Pin-Ching Maness, Maria Ghirardi & Jianping Yu, "Phosphoketolase Pathway Contributes to Carbon Metabolism in Cyanobacteria," *Nature Plants*, 15187 (2015): doi:10.1038/nplants.2015.187.

Key Research Results

Achievement

Researchers found that the phosphoketolase pathway is active in photosynthesis in some organisms, like cyanobacteria.

Key Result

The pathway carries a significant proportion of central carbon metabolism and also avoids the carbon loss associated with traditional pathways, so a wide variety of bioproducts and biofuels can potentially be made more efficiently.

Potential Impact

The discovery shines new light on the complex metabolic network for carbon utilization in cyanobacteria, while opening the door to better ways of producing fuels and products from carbon dioxide or plant biomass, rather than deriving them from petroleum.

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