Max-Planck-Innovation

Technology Offer

Carbon-neutral and carbon-positive photorespiration bypass routes supporting higher photosynthetic rate and yield

File no.: 0402-5003-MG

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Background

Carbon fixation is arguably the most important biochemical processes on earth, supporting our biosphere by transforming inorganic carbon into organic matter and literally feeding all life forms. The reductive pentose phosphate cycle (rPP, also known as the Calvin–Benson–Bassham Cycle) is responsible for ≥95% of the carbon fixed in the biosphere. Although under a strong selective pressure for eons, this process displays major inefficiencies, some are due to the low catalytic rate and the incomplete selectivity of CO_2 over O_2 of the central enzyme of the pathway, the ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco).
The side reactivity of Rubisco with O_2 has deleterious consequences. First, it slows down the CO_2-fixing activity of the enzyme, reducing the effective rate of the rPP cycle and photosynthesis. Second, the product of Rubisco's oxygenation reaction, 2-phosphoglycolate (2-PG), needs to be reassimilated into the rPP cycle in a process termed photorespiration. However, the plant photorespiration pathway is inefficient for several reasons, the most important of which is that it releases CO_2, thereby counteracting the function of Rubisco and reducing the effective rate of the rPP cycle

Technology

The research group of Arren Bar-Even from the Max-Planck-Institute of Molecular Plant Physiology designed synthetic photorespiration bypass routes that directly tackle the deficits and inefficiencies of photorespiration. These synthetic pathways lead from 2-PG to an intermediate of the rPP cycle, while avoiding CO_2 and NH_3 release. These synthetic routes were analyzed and compared according to multiple physicochemical parameters, including thermodynamic feasibility, kinetic favorability, and minimal overlap with central metabolism. Pathways with promising properties were further analyzed manually at high resolution with special emphasis on those that can be implemented in many parallel ways to ensure that multiple backups are available to overcome any potential bottleneck component. The most promising routes are expected to support 60% higher biomass yield per turn of the rPP cycle and >30% higher yield per ATP.
Currently, as part of the FutureAgriculture project, funded by the EU (Project number 686330), a consortium headed by Arren Bar-Even is aiming to implement the synthetic pathway *in vitro* and *in vivo* in cyanobacteria and plants.

Licensing/CooperationInformation

Max-Planck-Innovation, the tech-transfer agency of Max Planck Society is currently looking for licensees or developmental cooperations.

Patent Information

EP priority application was filed June 2015. PCT patent application was filed in June 2016.