MOLECULAR PLANT PHYSIOLOGY

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Photosynthesis is the fundamental process that supports all life on earth. The capture of CO_2 from the atmosphere and its transformation into biomass is of vital importance to the health and productivity of natural environments and to the economic viability of agricultural industries. Our research uses a functional genomics approach to understand the fundamental genetic and biochemical factors that determine how photosynthetic organisms perform in their environments.

We investigate how CO_2 is captured from both atmospheric and aquatic environments by plants, algae and cyanobacteria and then used for growth. We also study how photosynthetic mechanisms are involved in the adaptation of these organisms to variable environments and how these mechanisms limit the efficiency of growth.

A long term aim is to identify genetic information that might be used to modify agricultural plant species in order to either increase yields, or to tolerate extreme environmental conditions such as high temperatures, higher levels of light and CO_2 and lack of water.

Isolating the Rubisco protein from red algae by chromatography.

HIGHLIGHTS

- We applied mass spectrometric analysis of polypeptides (proteomics) to positively identify several proteins present in unique protein micro-compartments known as carboxysomes (polyhedral bodies) from a freshwater cyanobacterium. Carboxysomes play an essential role in efficient CO_2 fixation in cyanobacteria. This work has important ramifications for understanding the composition of these proteinaceous structures and ultimately how they are assembled and function.

- We developed a system for measuring ^{13}C and ^{18}O discrimination in CO_2 during CO_2 assimilation by directly connecting the outlet of a portable Licor gas exchange system to a mass spectrometer. This system has facilitated the rapid measurement of discrimination under different environmental conditions and has been used to characterize the carbon isotope discrimination in transgenic *Flaveria bidentis* plants with reduced carbonic anhydrase.

- We developed a bacterial strain whose growth can be made dependent on functional expression of the photosynthetic CO_2- fixing enzyme Rubisco. The future challenge is to use the bacterium as a high through-put screen for directed molecular evolution of different mutated Rubisco genes to identify those that have acquired features necessary for functional assembly in foreign hosts.