Professor John Andrews FAA

Molecular Plant Physiology
Ph: 6125 5072
Email: john.andrews@anu.edu.au
Co-supervisors: Dr Spencer Whitney; Dr Heather Kane

Rubisco

The Basic Dimeric Unit of Rubisco

Our research focuses on the photosynthetic enzyme Rubisco. This enzyme is essential for carbon acquisition by the biosphere. The properties of Rubisco, and their effect on photosynthesis, dictate the efficiency with which plants use their resources of water, nutrients and light. However, Rubisco is inefficient; its catalytic process is slow and it has difficulty distinguishing CO_2 from the much more abundant gas, O_2.

The driving theme of our research is to understand the reasons for Rubisco's inefficiency. Aspects of this research look at (i) the catalytic chemistry of Rubisco and events that occur in the active site, (ii) genetic engineering of Rubisco in bacteria and plants, and (iii) photosynthetic processes involving Rubisco in the whole plant.

While our research interests are curiosity driven, there are also practical imperatives. The knowledge gained about the biochemistry and molecular biology of Rubisco at an intricate level might enable molecular manipulation of Rubisco to improve the ability of crops to grow in the higher atmospheric CO_2 levels and higher temperatures of the future. Such understanding might also lead to exploitation of Rubisco's catalytic secrets in artificial CO_2-sequestering systems.

Potential Project Areas

Honours and PhD projects are available within three research themes:

Structure/Function Studies

By studying different Rubiscos (*eg.* from higher plants, algae, cyanobacteria) and those modified by mutagenesis, we are gaining valuable insight into the active site of Rubisco at the molecular level. A number of mutant bacterial and transgenic tobacco lines are available for analysis.

Chloroplast Transformation

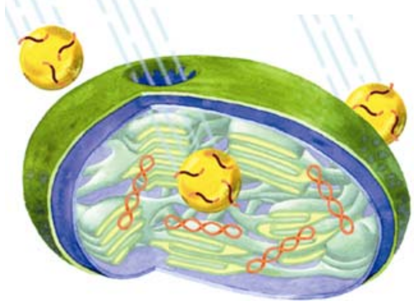
Using biolistic transformation of the tobacco chloroplast genome, we are elucidating the genetic framework necessary for stable protein translation and assembly in chloroplasts with a view to introducing foreign Rubiscos from bacteria and algae.

Catalytic Chemistry

There are critical questions to be solved in understanding, at the chemical level, the sequence of steps following the acquisition of CO_2 by Rubisco and involving the transformation of catalytic intermediates and movements of protons and water within the active site. Theoretical and practical projects are available.

Techniques

Chloroplast
Biolistic
Transformation



Plant molecular biology: standard DNA manipulation techniques, PCR, DNA mutagenesis, chloroplast genome transformation, DNA and RNA blot analyses.

Biochemistry: protein purification from plants, algae and bacteria; protein stability analysis, enzyme kinetics; protein sequencing; X-ray crystallography, mass spectroscopy, quantum chemical simulation of catalytic sequence, stable-isotope mass spectrometry,

Photosynthetic physiology: leaf gas-exchange biochemical measurements of photosynthetic metabolites

Selected Publications

Andrews TJ, Whitney SM (2003) Manipulating ribulose bisphosphate carboxylase/oxygenase in the chloroplasts of higher plants. Arch Biochem Biophys **414**: 159-169

Whitney SM, Andrews TJ (2001) Plastome-encoded bacterial ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO) supports photosynthesis and growth in tobacco. Proc Natl Acad Sci USA **98**: 14738-14743

Mauser H, King WA, Gready JE, Andrews TJ (2001) CO_2 fixation by Rubisco: Computational dissection of the key steps of carboxylation, hydration, and C-C bond cleavage. J Amer Chem Soc **123**: 10821-10829

Andrews TJ (1996) The bait in the Rubisco mousetrap. Nature Struct Biol **3**: 3-7