II.F.5 Bioenergetics of Photosynthetic Energy Transduction: Control of Pathways through Redox Biochemistry

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Abstract

Photosynthetic microorganisms have evolved complex metabolic networks consisting of multiple biochemical pathways that balance energy generation with utilization. Photosynthetic electron transport (PET) reactions establish the appropriate cellular adenosine triphosphate/nicotinamide adenine dinucleotide phosphate ratio, which represents the collective contributions of cyclic electron flow, linear electron flow, and alternative electron flow. One hypothesis for the function of electron flow pathways peripheral to the core PET reactions is the adaptation to differential changes in metabolic and environmental conditions. These pathways cycle photosynthate and afford enormous flexibility in cellular energy homeostasis for acclimation to fluctuations in ambient conditions and nutrient availability. Remodeling of photosynthetic complexes, and the differential regulation of biochemical pathways, redox enzymes and electron carriers implies coordinated responses among adaptive pathways, but the mechanisms for how these are controlled is not well understood. The broad goal of this project is to determine how molecular networks and enzyme mechanisms coordinate electron transfer reactions for energy balancing in model photosynthetic microbial systems. To develop a biochemical understanding of this process, we are conducting structure-function and mechanistic studies on enzymes that couple to the reductant pools, as well as optical and spectroscopic measurements of photochemical energy conversion in biohybrid complexes for solar energy conversion.

Selected Publications

1. Noone, S., Ratcliff, K., Davis, R., Subramanian, V., Meuser, J., Posewitz, M.C., King, P.W., Ghirardi, M.L. "Expression of a clostridial [FeFe]-hydrogenase in *Chlamydomonas reinhardtii* prolongs photo-production of hydrogen from water splitting." *Algal Res.* **2017**, *22*, 116–121.

2. Mulder D.W., Guo Y., Ratzloff M.W., King P.W. "Identification of a catalytic iron-hydride at the H-cluster of [FeFe]-hydrogenase." *J. Am. Chem. Soc.* **2017**, *139*, 83–86.

3. Holland, S.C., Artier, J., Miller, N.T., Cano, M., Yu, J., Ghirardi, M.L., Burnap, R.L. "Impacts of genetically engineered alterations in carbon sink pathways on photosynthetic performance." *Algal Res.* **2016**, *20*, 87–99.

4. Brown, K.A., Harris, D., Wilker, M.B., Rasmussen, A., Khadka, N., Hamby, H., Keable, S., Dukovic, G., Peters, J.W., Seefeldt, L.C., King., P.W. "Light-driven dinitrogen reduction catalyzed by a CdS:Nitrogenase MoFe protein biohybrid." *Science.* **2016**, *352*:448–450.