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Bio-Inspired Solar Energy Conversion[1]

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The areas of solar-powered catalysts for energy rich fuels formation and bio-inspired molecular assemblies for integrating photon-to-fuels pathways have been identified by the Office of Basic Energy Sciences of the U. S. Department of Energy as challenges for the next generation of sustainable, high-efficiency solar energy conversion systems [1]. The light-harvesting, energy-transducing and carbon compound-synthesizing (carbon dioxide-fixing) reactions that are encompassed by natural photosynthesis offer molecular paradigms for efficient free energy capture and storage. We seek to emulate these features in cell-free, protein-based systems. Our goal is to transform the robust (alpha,beta)8-barrel fold of an enzyme that naturally catalyzes radical reactions into a catalytic module for the reduction of carbon dioxide to formate, by using the cobalt-containing cobalamins and other organocobalt centers. The activation of the catalytic center will be driven by photo-reduction, by using soluble and attached organic or semiconductor architectures. Progress on the biochemical, chemical, physical, and molecular biological (including rational design of high binding affinity and reactivity towards carbon dioxide) approaches to the development of the photocatalytic system will be presented.

[1] Lewis, N.; Crabtree, G. In: Basic Research Needs for Solar Energy Utilization, Basic Energy Sciences Workshop on Solar Energy Utilization, Energy, U.S. Department of Energy, Office of Science: 2005.

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