A Structural Approach to Engineering Biohybrid Photocatalysis

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In oxygenic photosynthesis, two membrane protein complexes called photosystem I (PSI) and photosystem II perform solar-to-chemical energy conversion by using light to generate low potential electrons. When PSI is excited by light, its primary electron donor has a very low reduction potential, approximately −1.2 V. Platinum nanoparticles (PtNPs) designed to bind the surface of PSI are capable of harvesting these low potential electrons and catalyzing redox chemistry. These PSI-PtNP biohybrids have been shown to perform photocatalytic hydrogen production. Recently, structural data from one such biohybrid containing PSI from the cyanobacterium *Synechococcus lividus* provided indications of the specific interactions involved in PtNP binding while also highlighting inefficiencies in PtNP usage and placement on the PSI surface. We have since determined two additional PSI-PtNP biohybrid structures containing PSI from the cyanobacterium *Thermosynechococcus vestitus* and a chemically treated PSI-core from another cyanobacterium *Synechococcus leopoliensis* to further elucidate the nature of PSI-PtNP interactions. We are now using these structures to develop engineering strategies to most efficiently use PtNPs and maximize the rate of redox activity.