ELECTROCATALYTIC REDUCTION OF CARBON DIOXIDE (CO_2) BY AN ARTIFICIAL TRANSMEMBRANE PROTEIN

Chelsea L. McIntosh*, Jeanine M. Cordova, Giovanna Ghirlanda, and Anne K. Jones, Department of Chemistry and Biochemistry and the Center for Bioenergy and Photosynthesis, email: clmcinto@asu.edu (Advisor: Anne K. Jones)

The ability to create proteins and enzymes through both computational design and directed evolution has become more and more commonplace in modern science. There still exists a large chasm in the understanding underlying design and evolution studies, though, residing in the fact that most studies involve water soluble enzymes whose catalysis lies mainly in acid-base reactions while relatively little is know about either membrane-soluble enzymes or enzymes that catalyze reactions involving the transfer of electrons, oxidoreductases. A total grasp of how all proteins and enzymes fold and catalyze the reactions they do would not only enable science to prevent or repair malfunctions in existing enzymes, but would also lead to the creation of enzymes with novel functions. Keeping this in mind and considering the growing concern regarding the increase in CO_e levels in our current atmosphere, in this project we aim to combine the design of a membrane soluble enzyme engineered to bind heme, ME1, with the need for a catalyst able to reduce CO_2 to usable fuels. To do this, we've employed a scaffold of self-assembled monolayers on gold electrodes with heme optimally placed so that ME1 will be isotropically "wired" to our electrode upon reassembly. We then plan on employing cyclic voltammetry, both catalytic and non-catalytic, chronoamperometry, and electrolysis to ascertain the overpotential required for the reduction of CO_2 and the suite of products generated. From there, a library of rationally designed mutants and a pentacoordinate ME1 will be used in attempt to lower the overpotential required and to control the products formed. By doing so, we hope not only to discover greater understanding of membrane soluble enzymes and oxidoreductases in general, but also hope to advance the knowledge of CO_2 reduction in order to rid our society of an ever-looming problem.

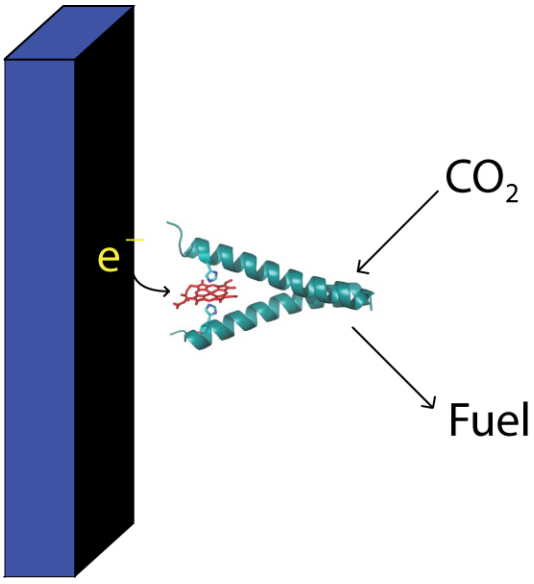

Fig.1 Schematic representation of proposed research.