Biomimetic Membranes for Energy and the Environment

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Date and Time: October 9, 2013; 11:30 am – 1:00 pm
Location: 212/213 Stinson-Remick Hall
Pizza and soft drinks will be served at 11:30 am. Seminar starts at 12:00 pm.

Biology provides excellent paradigms for engineering materials and processes that are efficient and sustainable. A “reverse engineering” approach to mining biological paradigms can also increase our understanding of biological phenomena. This talk will provide a short overview of such ideas and focus on two projects inspired by the cell membrane relevant to energy efficient separations and energy production.

Biological water channel proteins, called aquaporins, provide selective and rapid transport of water across cell membranes. They utilize an elegant mechanism distinct from and more efficient than that used in commercial solute separation polymeric membranes. By incorporating a bacterial and mammalian Aquaporins into synthetic biomimetic membranes, we have shown that orders of magnitude improvement in productivity of synthetic membranes is possible. This talk will discuss approaches to most productively address fundamental and practical challenges to realization of such membranes.

The light harvesting complex, photosystem 1 (PSI), is a robust membrane protein with the ability to provide the chemical potential energy needed to produce protons for reducing substrates. Hydrogenase enzymes have already been successfully wired to PSI to generate significant amounts of hydrogen. Studies to increase hydrogen rates by attachment of PSI constructs to electrodes have focused on single particle approaches. A challenge to maximum electron transfer to PSI is high protein density and correct orientation. Incorporating PSI in a membrane environment mimics the native state of PSI and provides favorable conditions for electrochemical transfer since the electron acceptor site of the protein is accessible normal to the membrane and all proteins could be oriented in this way. An update on approaches being explored in our group towards developing a stable hydrogen producing membranes will be provided.

Biosketch of Prof. Kumar

Manish Kumar has a BTech Degree in Chemical Engineering from the National Institute of Technology in Trichy, India. He has masters and doctoral degrees in environmental engineering from the University of Illinois at Urbana Champaign. Between his masters and PhD degrees he spent ~ 7 years in applied research and consulting primarily on membrane treatment of water and wastewater. His current research interests focus on developing biomimetic membranes for energy, environmental and biomedical applications. His group utilizes membrane proteins, block copolymers and synthetic protein analogs to develop these membranes. The methods used rely heavily on understanding the self-assembly of these molecules and methods to direct self-assembly.