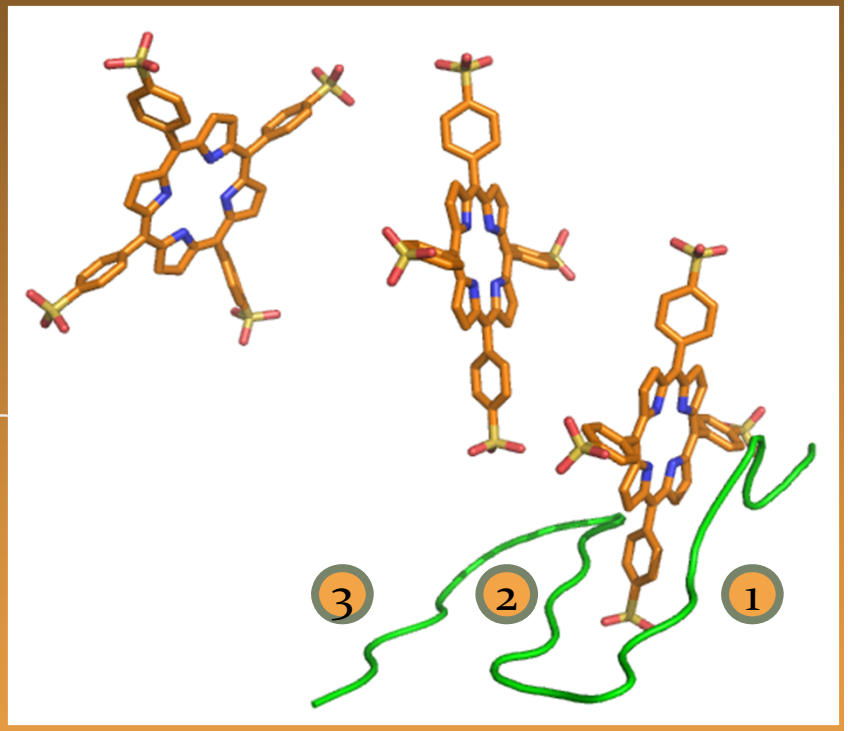
Porphyrin Nanostructures as Light Harvesting Antennas for Dye-Sensitized Solar Cells

Gregory A. Caputo, Department of Chemistry and Biochemistry, Rowan University

The development of new, cost-effective, and highly efficient materials for application to photovoltaic devices has far reaching impacts both on a industrial and societal levels. The model of dye-sensitized solar cells (DSSCs) inherently couples the light collection and electron transfer components within the solar cell itself. The approach we use to develop new DSSC materials combines the physical properties of porphyrin self-assembly into light-absorbing AND conductive aggregates with the malleable framework of peptide design and synthesis to create molecular scaffolds which promote porphyrin self-assembly.



Specifically we employ a highly absorptive porphyrin (Meso-tetra (4-sulfonatophenyl) porphine; $TPPS_4$) with a highly soluble, cationic peptide backbone. The $TPPS_4$ is known to form "J-aggregates" which can serve as a molecular wire, but only at very low pH. We have successfully designed peptides that promote $TPPS_4$ J-aggregate formation at higher pH conditions. These complexes have been shown to spontaneously form in solution and are capable of transferring electrons between $TPPS_4$ monomers within the aggregate 30x faster than non aggregated systems. We have also developed a series of next-generation peptides with greater solubility and flexibility in sequence. From this work we aim to:

- **Increase the pH range at which the complexes are stable**
- **Design new peptide scaffolds which can nucleate large excitonically coupled $TPPS_4$ aggregates**
- **Investigate the dynamics of the electron transfer in the aggregate state**
- **Develop nucleating peptides which promote aggregates larger than the peptide scaffold**