SPECIAL SEMINAR:

Spectrum, Form, Function: Structural Tuning Mechanisms in Photosynthetic Light Harvesting

Biological photosynthesis offers a tantalizing glimpse of the clean-energy opportunities at the interface of synthetic biology, chemical catalysis, molecular excitonics, and soft-matter physics. However, this sophisticated system is optimized in nature for biological objectives (competitive fitness) that are often at odds with human concerns such as energy-storage efficiency. While some progress has been made in reconfiguring native photosystems for biofuel production, advances are limited by gaps in our understanding of the "structure-spectrum-function" relationship, i.e., of the mechanisms by which protein structures tune pigment optical and excitonic properties and, in turn, how these properties translate into biological function. In this talk, I will describe recent efforts in my group to build a quantitative approach to structure-based tuning using site-directed mutagenesis, optical spectroscopy, and molecular and quantum dynamics simulations. Electrostatic effects are found to provide a relatively simple and predictable control knob for tuning electronic transitions, while steric ring-deformation (although likely to be important) is more difficult to predict and control. Single point mutations are found to produce surprisingly large changes in vibrational sidebands in low-temperature electronic spectra, suggesting interplay between excitonic and vibrational coupling. I will close with preliminary results on tuning the lowest-energy fluorescent state of Photosystem II in cyanobacterial cells, opening the door both to characterizing the functional relevance of these states in native systems and to tuning their properties for new applications.

Host: Paul Stevenson

Speaker

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