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Dynamics of photosynthetic light harvesting: from conformational changes to excitation energy transfer

GABRIELA SCHLAU-COHEN, Massachusetts Institute of Technology

In photosynthetic light harvesting, absorbed energy migrates through a protein network to reach a dedicated location for conversion to chemical energy. This energy flow is efficient, directional, and, in oxygenic photosynthesis, regulated. The regulatory response, known as non-photochemical quenching (NPQ), safely dissipates excess energy to protect the system against deleterious photoproducts. In recent research, a protein within this network, light-harvesting complex stress related (LHCSR), has been implicated in dissipation in green algae and moss, yet the mechanisms of photoprotection remain poorly understood. We explore these mechanisms with single-molecule spectroscopy of LHCSR. By characterizing the conformational dynamics, we identify the extent of energy dissipation in single LHCSR proteins and how this changes under conditions that mimic high and low light. While this approach reveals the conformational dynamics of solubilized photosynthetic proteins, we also present experiments measuring ultrafast energy transfer dynamics within proteins held in their native membrane environment. Together, these experiments explore how the protein network produces an efficient and adaptable energy flow.