Hydrophobic Mismatch Molecular Model for Light State Transitions – Optimization of Photosynthetic Electron Transport under Light-Spectrum Changes

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Oxygen-evolving (oxygenic) photosynthesis is the most important light-induced biological process because it converts sunlight energy into chemical energy, and directly or indirectly sustains all the aerobic life on Earth. Its primary light reactions and their regulation are performed in the thylakoid membranes of cyanobacteria, algae and plants. Given the vital significance of oxygenic photosynthesis and its potential to provide bioinspired solutions in diverse membrane-related fields, it is important to understand its specific regulatory mechanisms.

From a membrane biophysical viewpoint, the most attractive seems to be the short-term adaptive regulatory mechanism light State Transitions (STs). STs are activated when one of the two photosystems (PSII and PSI) is preferentially excited by light-spectrum changes. The STs optimize photosynthesis by balancing the excitation energy supply to PSII and PSI via membrane structural reorganization. STs are unique not only because they are specific for oxygenic photosynthesis, but also because STs are the only regulatory mechanism which (i) optimizes the photosynthetic electron transport at low light and in dynamic environments, (ii) is reversible and occurs without energy losses, (iii) has characteristics of a perpetual mobile for membrane reorganizations, and (iv) is the reason for the recently proposed completely new molecular mechanism for induction and realization of membrane reorganizations without analog among the known regulatory/signaling mechanisms of biological membranes. The proposed mechanism has been termed hydrophobic mismatch molecular model for cytochrome b_6f governed STs [Vladkova (2016) *J. Biomol. Struct. Dyn.* 34: 824-854; Vladkova (2023) submitted and under revision].

This presentation will describe our model and the current stage of its confirmation. The proposed model provides for the first time not only a unified description of entire state transitions process in cyanobacteria, algae and plants, but also proposes the driving force for the induction of membrane reorganizations upon state transitions.