MODELING OF THE MOLECULAR MECHANISM OF NON-PHOTOCHEMICAL QUENCHING IN CYANOBACTERIA

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Cyanobacteria are among the ancient photosynthetic organisms. Despite the similarities with plants and algae, photosynthetic apparatus of cyanobacteria differ in the way light harvesting and photoprotection is organized. In particular, additional light harvesting pigments (phycobilins) of cyanobacteria are structured in the form of extramembrane light harvesting complexes – phycobilisomes (PBS). PBS effectively absorb light (in 500-650 nm) region and transfers it to the intramembrane chlorophyll-containing antenna. Recently it was shown that PBS are involved in the mechanism of photoprotection. The latter mechanism is induced by blue-green illumination and results in significant PBS fluorescence quenching. The key role in this process plays orange carotenoid protein (OCP). Blue-green light induces structural changes in the carotenoid that lead to conformational changes in the protein, leading to an effective quenching of the excited states of PBS pigments.

This work is aimed at clarifying and modeling of the molecular mechanisms involved in the quenching process. Blue-green light induced NPQ could be divided into two process: formation of the quenching center under actinic illumination and quenching of the excited states upon formation of the quenching state.In order to elucidate the mechanisms of quenching center formation Fluorescence induction and relaxation (FIRe) and Pulse Amplitude Modulation (PAM) techniques were implemented. Measurements of fluorescent parameters using named techniques revealed complex molecular dynamics of PBS-OCP interaction and allowed determination of characteristic times of structural transformations and excitation cross section of OCP. To investigate the mechanism of PBS excited states quenching we used Non-linear Laser Fluorimetry (NLF) that allows determination photophysical parameters of fluorescent pigments (excitation cross-sections, excited states lifetimes, rates of singlet-singlet annihilation) based on non-linear dependence of fluorescence photons on photon flux density of laser radiation (saturation curve). Changes in the values of photophysical parameters upon induction of NPQ suggest the possible site and mechanism of the excited states quenching.