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Light Dependent Energy Regulation in Phycobilisomes of Cyanobacteria

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Synechocystis PCC6803 (Synechocystis) are species of Cyanobacteria capable of oxygenic photosynthesis. Phycobilisomes (PBs) are large peripheral light-harvesting antenna complexes located on the thylakoid membrane. PBs absorb light and transfer the energy to the reaction centers of Photosystem I and II. An intact PB contains a total of 396 pigment-protein complexes. A single pigment-protein complex is made of a phycocyanobilin pigment attached to a polypeptide chain with a covalent bond. In Synechocystis, the PBs have a hemi-discoidal shape with six phycocyanin (PC) cylindrical rods radiating outwards from an allophycocyanin (APC) core. The energy absorbed by pigment-protein complexes of the PBs is transmitted to special core pigment complexes, ApcE and ApcD, known as terminal emitters. ApcE is a pigmented core-membrane linker that stabilizes the complete structure of the PBs. Recent Single Molecule Spectroscopy (SMS) studies on PBs (Gwizdala et al., 2016; Krüger et al., 2019) have shown the existence of energy regulation related to blinking. Upon illumination, the PBs switch reversibly between 'bright' emissive, unquenched states and 'dark' quenched states. As the intensity of excitation light increases, the frequency of switching between unquenched and quenched states increases. However, the switching to quenched states dominates at higher intensities and the PBs dissipate excess energy as heat in a quenched state. The exact mechanisms underlying the energy regulation are still unknown. Here we present the first single-molecule investigation of PBs from mutant Synechocystis that lack the terminal emitter pigments ApcD or ApcE to reveal the origins of light-dependent energy regulation.

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