Plants and algae have versatile abilities to acclimate themselves to changing environments. We are interested in these acclimation processes, and how they efficiently yet safely harness sunlight for photosynthesis under fluctuating light conditions. Using a model green alga, we are studying the molecular mechanisms underlying photoacclimation of photosynthetic machinery. We are also applying knowledge obtained in the studies of this model green alga to various photosynthetic organisms, including phytoplankton and vascular plants, to explore how environmentally important photosynthetic organisms thrive in their ecological niche.


Photosynthesis is the process conducted by plants and algae to capture photons and store their energy in chemical forms. The light-harvesting, excitation transfer, charge separation and electron transfer in photosystem II (PSII) are the critical initial reactions of photosynthesis and thereby largely determine its overall efficiency. Knowledge about the architectures and assemblies of plant and green algal PSII–light harvesting complex II (LHCII) supercomplexes are rapidly accumulating (Figure 1). We made pair-wise comparative analyses between the supercomplexes from plants and green algae to gain insights about the evolution of the PSII–LHCII supercomplexes involving the peripheral small PSII subunits that might have been acquired during the evolution (Figure 1).
and about the energy transfer pathways that define their light-harvesting and photoprotective properties (Figure 3) (Sheng et al., Plant Cell Physiol., 62:1108-1120).

II. Structural basis of LhcbM5-mediated state transitions in green algae.

In green algae and plants, state transitions serve as a short-term light-acclimation process in the regulation of the light-harvesting capacity of photosystems I and II (PSI and PSII, respectively). During the process, a portion of light-harvesting complex II (LHCII) is phosphorylated, dissociated from PSII and binds with PSI to form the supercomplex PSI–LHCI–LHCII. We reported high-resolution structures of PSI–LHCI–LHCII from Chlamydomonas reinhardtii, revealing the mechanism of assembly between the PSI–LHCI complex and two phosphorylated LHCII trimers containing all four types of LhcbM protein (Figure 4). Two specific LhcbM isoforms, namely LhcbM1 and LhcbM5, directly interact with the PSI core through their phosphorylated amino terminal regions. Furthermore, biochemical and functional studies on mutant strains lacking either LhcbM1 or LhcbM5 indicate that only LhcbM5 is indispensable in supercomplex formation. The results unravel the specific interactions and potential excitation energy transfer routes between green algal PSI and two phosphorylated LHCIIIs (Pan et al., Nat. Plants, 7:1119-1131).
Publication List:

Original Papers


Review Article