Editorial

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Editorial Note on Chlorophyll biosynthesis, crucial to life on Earth

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Editorial

Chlorophyll biosynthesis, crucial to life on Earth, is tightly regulated because its precursors are phototoxic1. In flowering plants, the enzyme light-dependent protochlorophyllide oxidoreductase (LPOR) captures photons to catalyse the penultimate reaction: the reduction of a double bond within protochlorophyllide (Pchlide) to generate chlorophyllide (Chlide)2,3. In darkness, LPOR oligomerizes to facilitate photon energy transfer and catalysis4,5. However, the complete three-dimensional structure of LPOR, the higher-order architecture of LPOR oligomers and the implications of these self-assembled states for catalysis, including how LPOR positions Pchlide and the co-factor NADPH, remain unknown. Here, we report the atomic structure of LPOR assemblies by electron cryo-microscopy. LPOR polymerizes with its substrates into helical filaments around constricted lipid bilayer tubes. Portions of LPOR and Pchlide insert into the outer membrane leaflet, targeting the product, Chlide, to the membrane for the final reaction site of chlorophyll biosynthesis. In addition to its crucial photocatalytic role, we show that in darkness LPOR filaments directly shape membranes into high-curvature tubules with the spectral properties of the prolamellar body, whose light-triggered disassembly provides lipids for thylakoid assembly. Moreover, our structure of the catalytic site challenges previously proposed reaction mechanisms6. Together, our results reveal a new and unexpected synergy between photosynthetic membrane biogenesis and chlorophyll synthesis in plants, orchestrated by LPOR.