In chlorophyll biosynthesis, the light-activated enzyme protochlorophyllide oxidoreductase (POR) catalyses trans addition of hydrogen across the C17-C18 double bond of the chlorophyll precursor protochlorophyllide (Pchlide). This unique light-driven reaction leads to profound changes in the morphological development of photosynthetic organisms through modification and reorganisation of plastid membranes and has proven to be an excellent model system for studying the role of protein dynamics and thermodynamics in enzyme catalysis. During the reaction a hydride is transferred from the pro-S face of the nicotinamide ring of NADPH to the C17 position of the Pchlide molecule and a conserved Tyr residue has been proposed to donate a proton to the C18 position. By using laser activation of the reaction cycle it is possible to trigger these two sequential enzymatic H-transfer reactions in a pre-formed enzyme-substrate complex with a single pulse of light. This has not only provided a unique opportunity to study the reaction at cryogenic temperatures and on very fast timescales that are generally experimentally inaccessible for most other enzymes, but also revealed that both H-transfer reactions proceed by using quantum mechanical tunneling coupled to specific motions (vibrations) in the protein.