

Structure, Function & Engineering of Photoreceptors

Andreas Möglich, Humboldt-Universität zu Berlin, Institut für Biologie, AG Biophysikalische Chemie.

Excitability, i. e. the ability to perceive and respond to signals, is a basic hallmark of life. Our work aims at quantitatively understanding (analyzing) and at controlling (synthesizing) the underlying signal-transduction systems, specifically those engaged in the detection of light. At the molecular level, light perception is mediated by sensory photoreceptor proteins which comprise photosensor modules that absorb light and effector modules that exert a certain downstream biological activity. Based on structural and sequence data, we have constructed the blue-light-regulated histidine kinase YF1 by recombining a light-oxygen-voltage (LOV) photosensor with an effector module. On the basis of YF1, gene expression in prokaryotes can be up- or down-regulated as a function of blue light, thus affording spatiotemporally precise, reversible and non-invasive control. A crystal structure of YF1 we recently determined at 2.3 Å resolution reveals that the dimeric LOV photosensor module is linked to the catalytic effector modules via coiled-coil connectors. Functional assays pinpoint this region of the structure as crucial for activity and regulation by light; even single amino-acid mutations suffice to completely invert the signal response of gene expression. Structural motifs identified in YF1 widely recur in signal receptors, and the underlying signaling principles and mechanisms may be widely shared between soluble and transmembrane, prokaryotic and eukaryotic signal receptors of diverse biological activity. In a second project, we exemplify this notion by subjecting under red-light control the activity of a eukaryotic enzyme.