VISUAL AND ARCHAEAL RHODOPSINS: SIMILARITIES, DIFFERENCES, AND CONTROVERSY

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Retinal is a chromophore that binds integral membrane proteins (opsins), via a protonated Schiff base, to form light-absorbing pigments called rhodopsins. Rhodopsins are currently known to belong to two distinct protein families. The visual rhodopsins, found in eyes throughout the animal kingdom, are photosensory pigments. Archaeal rhodopsins, found in extreme halophiles, function as light-driven proton pumps (bacteriorhodopsins), chloride ion pumps (halorhodopsins), or photosensory receptors (sensory rhodopsins). Light absorption (time of femtoseconds) by rhodopsins triggers characteristic photocycles extending into the millisecond time range. How rhodopsins translate femtosecond events into millisecond responses will be the main subject of this presentation. Attention will be paid to controversial problems, like the two paradigms of rhodopsin photophysics: (1) initiation of the trans-cis isomerization (11-cis-all-trans visual retinals or all-trans-13-cis archaeal retinals) is a primary consequence of light absorption and is a prerequisite for the initiation of the photocycle; and (2) rhodopsins store light energy via charge-separation – the charge of the Schiff base is separated from its counterion. We would like to question these paradigms. (1) It will be demonstrated that trans-cis isomerization is rather a secondary process and is not a prerequisite for the initiation of the photocycle. However, the lack of full trans-cis isomerization reduces rhodopsin biological activity. Mechanisms of the primary processes in rhodopsins will be suggested. (2) In vertebrate visual rhodopsins, a glutamic acid serves as a negative counterion to the protonated Schiff base. It will be shown that in invertebrate (e.g. octopus) rhodopsins, there is no group serving as a counterion. If there is no counterion, there can be no energy storage by charge-separation. Therefore, this hypothesis should be verified as a general one for all rhodopsins.