The Dependence of the Rate of Flash Induced Photopigment Reconversion on Membrane Potential in Photoreceptor Cells

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Barnacle photoreceptors have two stable species of photopigment (1). The two species give early receptor potentials (ERP's) of opposite polarity (1). The rate of ERP decay is determined by the time constant RC of the cell (2;3;4). The present study reports data about the change of flash induced reconversion rate of photopigment using bathing solutions which depolarize the photoreceptor cells.

Extracellular measurements of the ERP's of median and lateral photoreceptor of the barnacle are carried out in physiological saline (artificial seawater, ASW) and in ASW in which sodium is exchanged by potassium. After steady adaptation with chromatic light one bright flash converts the photopigment and a second test flash of varying delay serves to monitor ERP's of the appearing photopigment species with the ERP of opposite polarity.

It is observed that in cells which are depolarized by K^+ solution the rate of photopigment reconversion decreases by the same amount as the electric time constant. Since the two time constants have the same dependence on membrane potential it is inferred that in both processes charge transfer is involved. Previous models of the RC equivalent of barnacle photoreceptor cells (4) gave an indication that the smooth membrane of the perikaryon has a specific resistance of approximately 1 kOhm cm^2 and the microvilli contribute the major cell capacity with a specific capacitance $C^* = 1\ \mu F/cm^2$. The specific resistance R^*_m of the microvilli can therefore be calculated if the charge transfer reaction associated with the photopigment reconversion in the microvillar membrane is assumed to determine the rate. With the reconversion time constant in ASW $\tau_{rec} = 90 - 180$ ms one calculates the specific resistance of the microvillar membrane $R^*_m = \tau_{rec}/C^*$ to 90 - 180 kOhm cm^2.

This microvillar membrane system has the relatively high specific resistance which would be needed of an electrogenic pump mechanism (5) was involved in the transduction reaction.

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