Identification of Cl(Ca) Channel Distributions in Olfactory Cilia

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ABSTRACT

Identification of detailed features of neuronal systems is an important challenge in the biosciences today. Cilia are long thin structures that extend from the olfactory receptor neurons into the nasal mucus. Transduction of an odor into an electrical signal occurs in the membranes of the cilia. The $Cl(Ca)$ channels which reside in the ciliary membrane are activated by calcium and allow a depolarizing efflux of Cl^- and are thought to amplify the electrical signal to the brain.

A mathematical model consisting of primarily partial differential equations is developed to model experiments within olfactory cilia, one involving interplay between CNG and $Cl(Ca)$ channels and the other involving the diffusion of Ca^{2+} into cilia and the resulting electrical activity. The unknowns in the problem are the concentration of calcium, a buffer, the membrane potential and, the quantity of most interest in this work, the distribution of $Cl(Ca)$ ion channels along the length of a cilium. A simple numerical method is derived that can be used to obtain estimates of the spatial distribution of $Cl(Ca)$ ion channels along the length of a cilium.