Abstract

Potassium Channel Gating Mechanism Modeled by Harmonic Oscillators [†]

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Abstract: Potassium channels are integral membrane proteins that selectively transport K^+ ions across cell membranes. They function through a pair of gates, which work in tandem to allow the passage of the ions through the channel pore in a coupled system, to which I refer here as the “gate linker”. To closely examine the role of the gate linker in channel functioning, I mutated the amino acids in the cDNA of this region, either alone or together with amino acids of adjacent regions. The functional effects of these mutations suggest that the gate linker functions analogously to a triad of coiled springs arranged in series. Accordingly, I constructed a physical model of harmonic oscillators and analyzed it mechanically and mathematically. The operation of this model indeed corresponds to the phenomena observed in the mutations study. The harmonic oscillator model shows that the strength of the gate linker is crucial for gate coupling and may account for the velocity, direction, and efficiency of ion transfer through the channel. Such a physical perspective of the gating process suggests new lines of investigation regarding the coupling mode of potassium channels and may help to explain the importance of the gate linker to channel function.

Keywords: Potassium Channel; Harmonic Oscillator; Gating

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