48. Ion channels

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Voltage-dependent potassium channels: voltage sensing and pore conformational changes

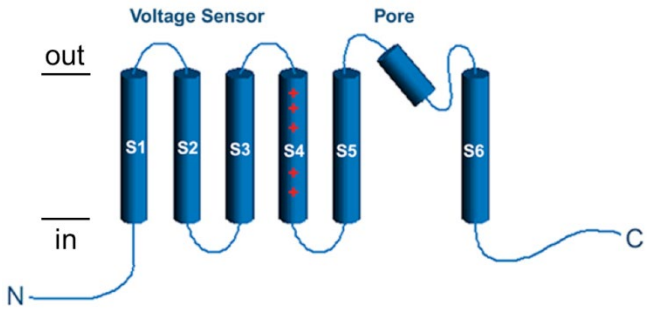
Background information:

Voltage-dependent potassium (Kv) channels are tetramers of four identical subunits. Each subunit contains 6 transmembrane helices. The last two of these helices (S5 and S6) and a short intervening "pore helix" come together from the four subunits to form a single ion conduction pore. The pore architecture is conserved in eukaryotic and prokaryotic potassium ion channels. The S1-S4 helices form voltage sensors, giving rise to four voltage sensors per channel.

Kv channels open and close the pore in response to changes in the voltage across the membrane, which are felt by the voltage sensors. In the "resting state" of a cell, the inside of the cell is negatively charged (with respect to the outside of the cell) and the Kv channels are closed. When the inside becomes more positive (known as depolarization), Kv channels open. When the cell returns to its resting negative charge (repolarization), Kv channels close.

The discussion paper is concerning the contributions of positively charged residues within the S4 helix of the voltage sensor to channel gating. "Gating currents" are currents arising from these residues, because when a charged particle moves, it produces a current. This should not be confused with ionic currents from the flow of potassium ions through the pore. AgTx blocks the ionic currents.

Left. Topology of a Kv channel subunit.



Right. Crystal structure of a Kv channel, viewed from the outside of the cell. There are four voltage sensors and a single ion conduction pore. Each subunit is colored uniquely.

Discussion

Aggarwal et al. Contribution of the S4 segment to gating charge in the Shaker K+ channel. Neuron (1996) vol. 16 (6) pp. 1169-77

Review:

MacKinnon. Potassium channels. FEBS Lett (2003) vol. 555 (1) pp. 62-5

Background:

Long et al. Crystal structure of a mammalian voltage-dependent Shaker family K+ channel. Science (2005) vol. 309 (5736) pp. 897-903

Long et al. Voltage sensor of Kv1.2: structural basis of electromechanical coupling. Science (2005) vol. 309 (5736) pp. 903-8