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We developed a biophysical model of the unusual calcium-dependent chloride channel (Kurahashi and Yau, 1994) of the olfactory sensory neurons:

This model channel (Simoes-de-Souza and Roque, 2002) is based in the experimental results of Hallani et al. (1998), Reuter et al. (1998) and Larson et al. (1997).

From Hallani et al.(1998) we got the equation (with Hill coefficient=1) that describes the calcium concentration versus chloride current behavior of the channel

$$gCl = gCl_{\max}\left({[Ca^{2+}]^1}\Big/{([Ca^{2+}]^1 + 26\mu M)}\right)$$

From Reuter et al. (1998) we got the reverse potential of the channel (6± 12,5 mV).
From Larson et al. (1997) we got the unitary conductance of the channel (0,8pS) and the channel density (70 channels/mm2). Therefore, the calculated conductance density of the channel is 56pS/mm2.
The Hodgkin-Huxley m¥ activation state variable is

$$m\infty = {[Ca^{2+}]}\Big/{([Ca^{2+}] + 26\mu M)}$$

and the temporal variable tm is zero, because the response delay of the channel to calcium is depressible.
The final equation of the chloride channel is

$$ICl = gCl_{\max}\left(\frac{[Ca^{2+}]}{[Ca^{2+}] + 26\mu M}\right)(Em - 6mV)$$

Where, ICl is the chloride current, gClmax= 56pS/mm2 is the conductance density,
$m\infty = {[Ca^{2+}]}\Big/{([Ca^{2+}] + 26\mu M)}$ is the activation state variable, Em is the compartment membrane potential, and ECl = +6mV is the reverse potential of the channel.

References:

Kurahashi, T. and Yau, K. (1994) Tale of an unusual chloride current. Current Biology, 4: 256-258.

Simoes-de-Souza, F.M. and Roque, A.C. (2002) Simulation of a vertebrate receptor cell of the olfactory epithelium for use in network models. Neurocomputing, 44-46: 177-182.

Hallani, M.; Lynch, J.W.; Barry, P.H. (1998) characterization of calcium-activated chloride channels in patches excised from the dendritic knob of mammalian olfactory receptor neurons. J. Membrane Biology, 161: 163-171.

Reuter,D.; Zierold, K.; Schröder, W.H.; Frings, S. (1998) A depolarizing chloride current contributes to chemoelectrical tranduction in olfactory sensory neurons in situ. J. Neuroscience, 18: 6623-6630.

Larson, H.P.; Kleene, S.J.; Lecar, H. (1997) Noise analyses of ion channels in non-space-clamped cables: estimates of channel parameters in olfactory cilia. Biophysical J., 72: 1193-1203.