1 Sodium and Potassium Channels

1.1 Sodium Channels

- Drosophila genome has two genes predicted to encode Na_v proteins: para, and 60E (NaCP60E). However, NaCP60E null mutants showed no loss in inward sodium current, suggesting that para is the putative Na_v channel [4].
- para has 60 predicted isoforms via alternative splicing [4]
- Para is only expressed in active neurons [4]
- Currently I chose vales from [5] where $DmNa_v$ was expressed in Xenopus ooscyte (frog). The similar was done in [3], but the values are different.
- "heterologous expression indicates that the inclusion of specific exons imparts characteristic gating properties to individual splice variants of $DmNa_v$ channels. These differences likely contribute to, and may even explain, the diversity in action potential firing between different neurons observed in the Drosophila CNS"
- [4] stated in Fig. 5 that 4th power exponential fit for activation resutled in time constant equal to 2.1. This means, that for one gate it should be 8.4.

The model and parameters for the transient and persistent Na channels, as well as fast and slow K currents were taken from [1]. All currents are modelled according to Ohm's law:

$$I_c(V, m, h) = g_c m_c^{p_c}(V) h_c(V)(V - V_c)$$

where c denotes the current type ($c \in NaT, NaP, Kf, Ks$), where T, P, f, and s stand for 'Transient', 'Persistent', 'fast', and 'slow' correspondingly, p is the number of activation gates.

Activation and inactivation variables are governed by ($x \in m, h$):

$$\frac{dx}{dt}(V) = \frac{x_{c,\infty}(V) - x}{\tau_c(V)}$$

where the steady states $x_{c,\infty}$ are defined as:

$$x_{c,\infty}(V) = \frac{1}{1 + \exp\left([V - V_{c,x,1/2}]/k_{c,x,1/2}\right)}$$

The parameters are given in Table 1.

	Activation				**Inactivation**		
Current	p	$V_{1/2,m}$ (mV)	k_m (mV)	τ_m (ms)	$V_{1/2,h}$ (mV)	k_h (mV)	τ_h (ms)
NaT	3	-29.13	-8.92	$0.13 + \frac{3.43}{1+\exp((V+45.35)/5.98)}$	-47	5	$0.36 + \exp(\frac{V+20.65}{-10.47})$
NaP	1	-48.77	-3.68	1	–	–	–
Ks	4	-12.85	-19.91	$2.03 + \frac{1.96}{1+\exp((V-29.83)/3.32)}$	-	-	-
Kf	4	-17.55	-7.27	$1.94 + \frac{2.66}{1+\exp((V-8.12)/7.96)}$	-45	6	$1.79 + \frac{515.8}{1+\exp((V+147.4)/28.66)}$

Table 1: Channel parameters for activation and inactivation of sodium and potassium channels.

Note 1. Similar parameters (small differences) is also given in [2].