1

$$c_m \frac{dV}{dt} = -i_m + \frac{I_e}{A} \qquad c_m = 10\,\mathrm{nF}/\mathrm{mm}^2$$

$$i_{\mathrm{m}} = \overline{g}_{\mathrm{L}}(V - E_{\mathrm{L}}) + \overline{g}_{\mathrm{K}} n^4 (V - E_{\mathrm{K}}) + \overline{g}_{\mathrm{Na}} m^3 h (V - E_{\mathrm{Na}}) \,.$$

The maximal conductances and reversal potentials used in the model are $\overline{g}_{\mathrm{L}} = 0.003$ mS/mm^2, $\overline{g}_{\mathrm{K}} = 0.36$ mS/mm^2, $\overline{g}_{\mathrm{Na}} = 1.2$ mS/mm^2, $E_{\mathrm{L}} = -54.387$ mV, $E_{\mathrm{K}} = -77$ mV and $E_{\mathrm{Na}} = 50$ mV. The full model consists of equation 5.6

$$\frac{dn}{dt} = \alpha_n(V)(1-n) - \beta_n(V)\,n$$

$$\tau_n(V)\frac{dn}{dt} = n_\infty(V) - n\,,$$

$$\tau_n(V) = \frac{1}{\alpha_n(V) + \beta_n(V)}$$

$$n_\infty(V) = \frac{\alpha_n(V)}{\alpha_n(V) + \beta_n(V)}\,.$$

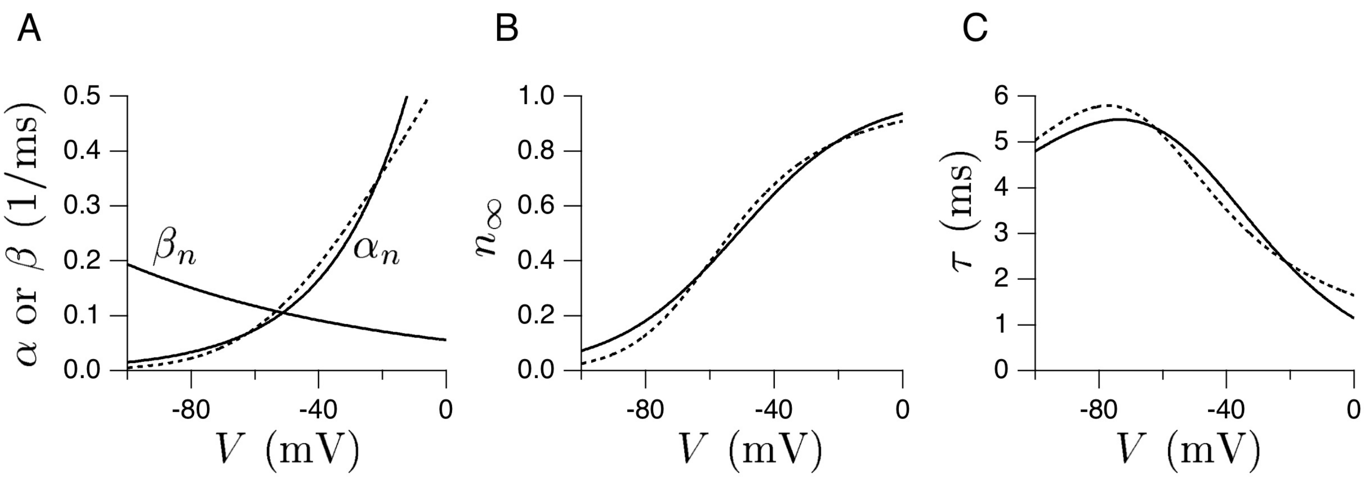
$$\alpha_n(V) = A_\alpha \exp(-qB_\alpha V/k_{\mathrm{B}}T) = A_\alpha \exp(-B_\alpha V/V_T)$$

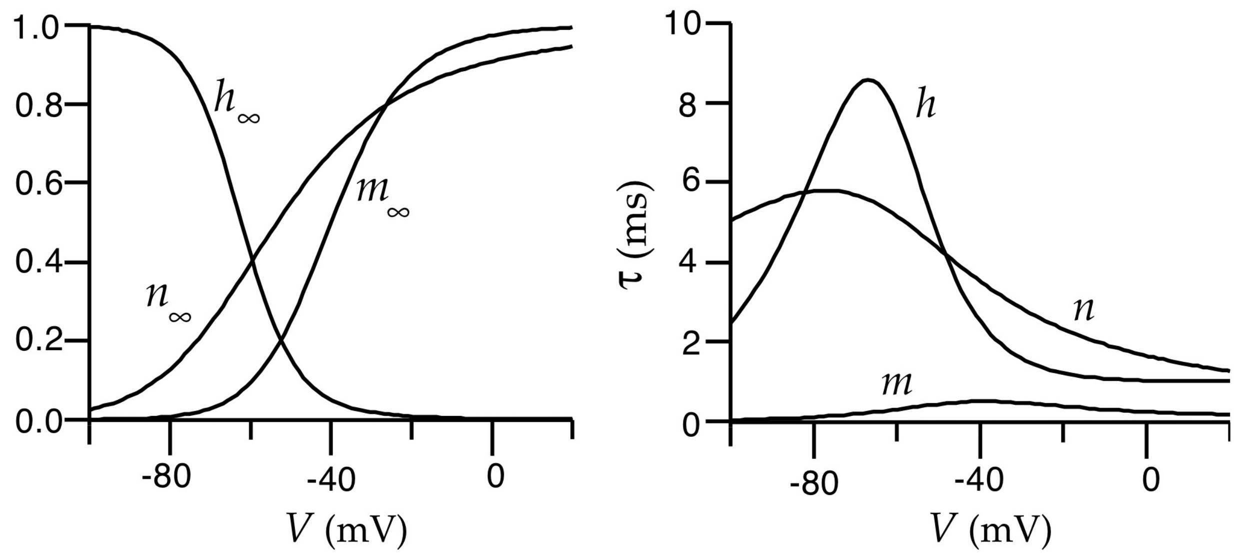
$$n_\infty(V) = \frac{1}{1 + (A_\beta/A_\alpha)\exp((B_\alpha - B_\beta)V/V_T)}\,.$$

$$\alpha_n = \frac{.01\,(V+55)}{1-\exp(-.1\,(V+55))} \quad \text{and} \quad \beta_n = 0.125\exp(-0.0125\,(V+65))\,, \tag{5.22}$$

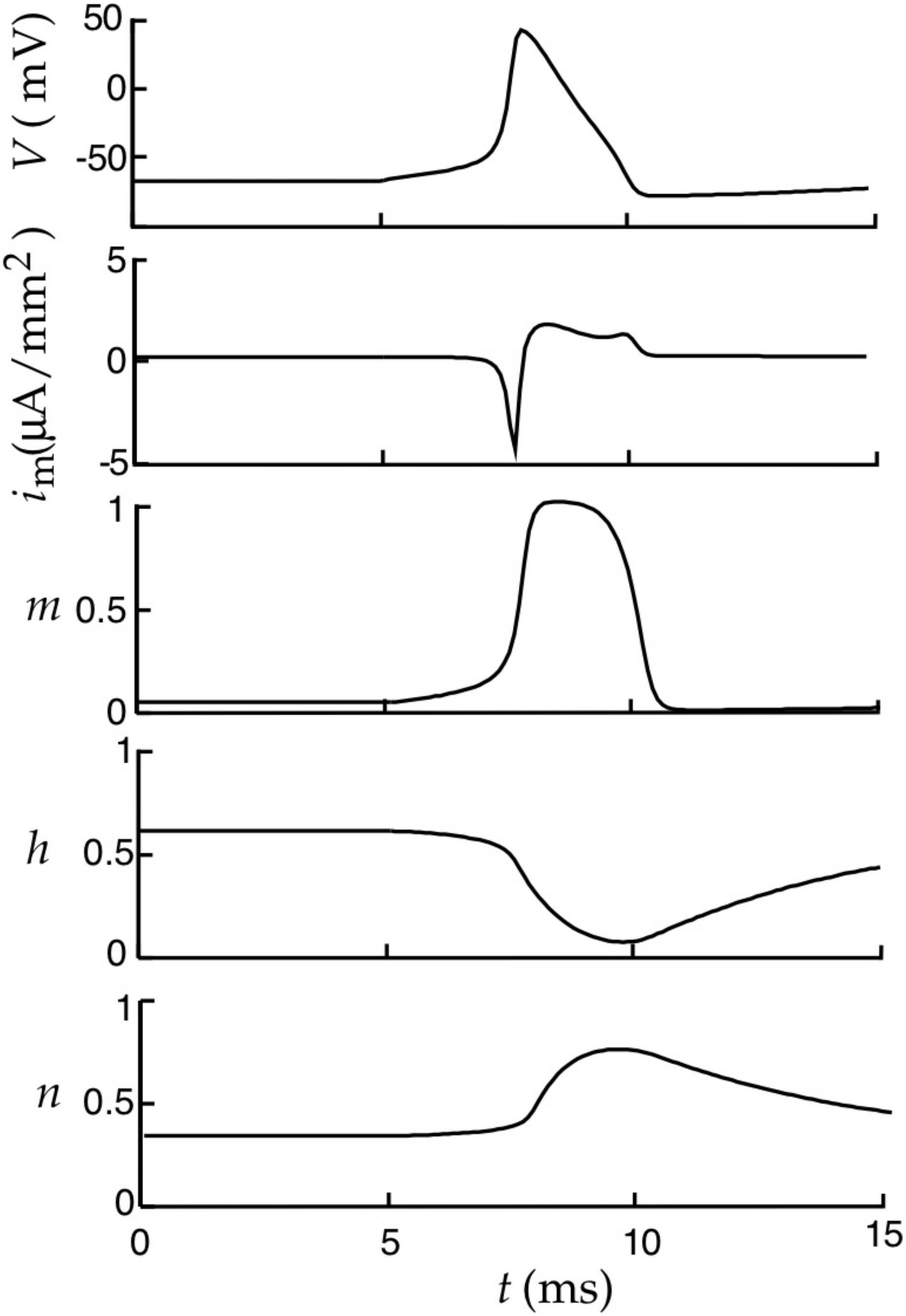
$$\frac{x}{1-\exp(-x)} = \frac{x}{1-(1-x)} = \frac{x}{x} = 1$$

$$\begin{aligned} \alpha_m &= \frac{.1\,(V+40)}{1-\exp(-.1\,(V+40))} & \beta_m &= 4\exp(-.0556\,(V+65)) \\ \alpha_h &= .07\exp(-.05\,(V+65)) & \beta_h &= 1/(1+\exp(-.1\,(V+35)))\,. \end{aligned} \tag{5.24}$$

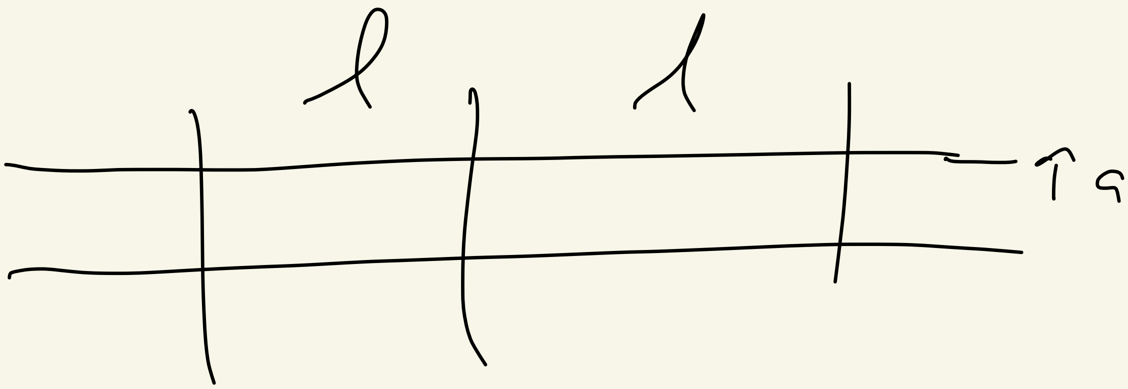

A
B
C
α or β (1/ms)
β_n
α_n
n_∞
τ (ms)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1.0
0
1
2
3
4
5
6
-80
-40
0
V (mV)

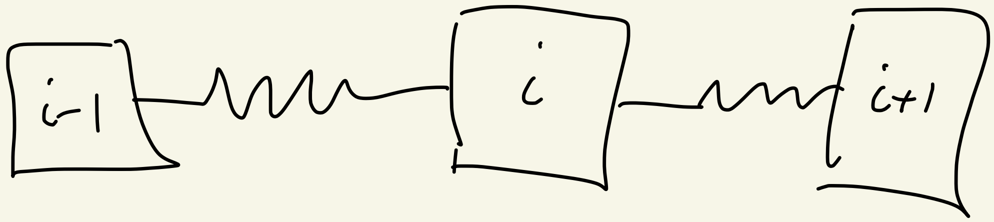

1.0
0.8
0.6
0.4
0.2
0.0
h_∞
m_∞
n_∞
-80
-40
0
V (mV)
10
8
6
4
2
0
τ (ms)
h
n
m

4



5





$$c_m \frac{dV_i}{dt} = i_m + \frac{I_e}{A} + g_c\left(V_{i-1} - V_i\right) + g_c\left(V_{i+1} - V_i\right)$$

$$g_c = \frac{1}{R_c} \frac{1}{2\pi a l}$$

$$R_c = \frac{r_L l}{\pi a^2}$$

$$g_c = \frac{\pi a^2}{r_L l} \frac{1}{2\pi a l} = \boxed{\frac{a}{2 r_L l^2}}$$