Supplement materials

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1 Neurons models

1.1 CA1 Pyramidal cell

Пирамидные нейроны описывались с помощью 19-ти компартментной модели. В модели принимались во внимание сома, базальные дендриты, проксимальная и дистальная часть апикального дендрита.

Уравнение баланса для соматического компартмента:

$$C\frac{dV_s}{dt} = -I_L - I_{Na} - I_{kdr} - I_A - I_M - I_h - I_{sAHP} - I_{mAHP} - I_{CaL} - \\ -I_{CaT} - I_{CaR} - I_{buff} - I_{syn} + I_{ext} \quad (1)$$

Уравнение баланса для аксона:

$$C\frac{dV_a}{dt} = -I_L - I_{Na} - I_{kdr} - I_M - I_{syn} \quad (2)$$

Уравнение баланса для базальных дендритов и проксимальной части апикального дендрита:

$$C\frac{dV_{rad,ori}}{dt} = -I_L - I_{Na} - I_{kdr} - I_A - I_M - I_h - I_{sAHP} - I_{mAHP} - \\ -I_{CaL} - I_{CaT} - I_{CaR} - I_{buff} - I_{syn} + I_{ext} \quad (3)$$

Уравнение баланса дистальной части апикального дендрита:

$$C\frac{dV_{LM}}{dt} = -I_L - I_{Na} - I_{kdr} - I_A - I_{syn} + I_{ext} \quad (4)$$

where I_L is the leak current, I_{Na} is the fast sodium current, I_{kdr} is the delayed rectifier potassium current, I_A is the A-type potassium current, I_M is the M-typepotassium current, I_h is a hyperpolarizing h-type current, I_{CaL}, I_{CaT} and I_{CaR} are the L-, T- and R-type Ca^{2+} currents, respectively, I_{sAHP} and I_{mAHP} are slow and medium Ca^{2+} activated K^+ currents, I_{buff} is a calcium pump/buffering mechanism and I_{syn} is the synaptic current. I_{ext} is the tonic current and noise. The parameters for all ionic currents are listed in Table 1.

The sodium current is described by:

$$I_{Na} = g_{max,Na} \cdot m^2 \cdot h \cdot s \cdot (V - E_{Na}) \tag{5}$$

where an additional variable s is introduced to account for dendritic location-dependent slow attenuation of the sodium current (Poirazzi et al., 2003a, b). Activation and inactivation kinetics for I_{Na} are given by:

$$m_{t+\Delta t} = m_t + (1 + exp(-\frac{\Delta t}{\tau_m})) \cdot (m_\infty - m_t) \ , \quad m_\infty = \frac{1}{1 + exp(-\frac{V+40}{3})} \tag{6}$$

$$h_{t+dt} = h_t + (1 - exp(-\frac{dt}{\tau_h})) \cdot (h_\infty - h_t) \ , h_\infty = \frac{1}{1 + exp(\frac{V+45}{3})} \tag{7}$$

$$s_{t+dt} = s_t + (1 + exp(-\frac{dt}{\tau_s})) \cdot (s_\infty - s_t), \ s_\infty = \frac{1 + Na_{att} \cdot exp(\frac{V+60}{2}))}{1 + exp(\frac{V+60}{2})} \tag{8}$$

with dt= 0.1 ms and time constants τ_{m}= 0.05 ms, τ_{h} = 0.5 ms, and

$$\tau_s = \frac{0.00333 \cdot exp(0.0024 \cdot (V + 60) \cdot Q(degC))}{1 + exp(0.0012 \cdot (V + 60) \cdot Q(degC))} \tag{9}$$

The function $Q(degC)$ is given by:

$$Q(degC) = \frac{F}{R \cdot (T + degC)} \tag{10}$$

where R = 8.315 *joule/degC*, F = 9.648 ^{4}Coul, T =*273.16* in degrees Kelvin and $degC$ is the temperature in degrees celsius. variable represents the degree of sodium current attenuation and varies linearly from soma to distal trunk $\mathrm{Na_{att}}$ η [0, 1]: 1 -maximum 0 - zero attenuation). The delayed rectifier current is given by:

$$I_{Kdr} = g_{Kdr} \cdot m^2 \cdot (V - E_K) \tag{11}$$

$$m_{t+dt} = m_t + (1 - exp(-dt/2.2)) \cdot m_\infty - m_t), \;\; m_\infty = \frac{1}{1 + exp(-\frac{V+42}{2})} \tag{12}$$

The sodium and delayed rectifier channel properties are slightly different in the soma, axis and dendritic arbor. To fit experimental data regarding the backpropagation of spike trains, soma and axon compartments have a lower threshold for $\mathrm{Na^+}$ spike initiation (-57 mV) than dendritic ones -50 mV. Thus, the m_∞ and h_∞ somatic/axonic HH channel kinetics as well as the time constants for both I^{sa}_{Na} and I^{sa}_{Kdr}, are modified as follows. For the sodium

$$m^{sa}_\infty = \frac{1}{1 + exp(-\frac{V+44}{3})}, \quad h^{sa}_\infty = \frac{1}{1 + exp(\frac{V+49}{3.5})} \tag{13}$$

while for the potassium delayed rectifier

$$m^{sa}_\infty = \frac{1}{1 + exp(-\frac{V+46.3}{3}))} \tag{14}$$

The somatic time constant for somatic/axonic Na^+ channel activation is kept the same τ_{m} = 0.05 ms while for inactivation is set to τ_{h}= 1 ms. The τ-value for the delayed rectifier channel activation is set to $\tau_m = 3.5ms$. In all of the following equations, τ values are given in ms.

The fast inactivating A-type $\mathrm{K^+}$ current is described by

$$I_A = g_A \cdot n_A \cdot l \cdot (V - E_K) \tag{15}$$

$$n_A(t+1) = n_A(t) + (n_{A_\infty} - n_A(t)) \cdot (1 - exp(-dt/\tau_n)), \;\; where \tau_n = 0.2ms \tag{16}$$

$$n_{A_\infty} = \frac{\alpha_{n_A}}{\alpha_{n_A} + \beta_{n_A}} \tag{17}$$

$$\alpha_{n_A} = \frac{-0.01(V+21.3)}{exp(-(V+21.3)/35)-1}, \quad \beta_{n_A} = \frac{0.01(V+21.3)}{exp((V+21.3)/35)-1} \tag{18}$$

$$l(t+1) = l(t) + (l_\infty - l(t)) \cdot (1 - exp(-dt/\tau_l)) \tag{19}$$

$$l_\infty = \frac{\alpha_l}{\alpha_l + \beta_l} \tag{20}$$

$$\alpha_l = \frac{-0.01(V+58)}{exp((V+58)/8.2)-1}, \quad \beta_l = \frac{0.01(V+58)}{exp(-(V+58)/8.2)-1} \tag{21}$$

where

$$\tau_l = 5 + 2.6(V+20)/10 \ , ifV > 20mV and \tau_l = 5, elsewhere. \tag{22}$$

The hyperpolarizing h-current is given by

$$I_h = g_h \cdot tt \cdot (V - E_h) \tag{23}$$

$$\frac{dtt}{dt} = \frac{tt_\infty - tt}{\tau_{tt}} \tag{24}$$

$$tt_\infty = \frac{1}{1 + exp(-(V - V_{half})/k_l)} \ , \ \tau_{tt} = \frac{exp(0.0378 \cdot \zeta \cdot gmt) \cdot (V - V_h alft}{qtl \cdot q10^{(T-33)/10} \cdot a0t \cdot (1 + a_{tt})} \tag{25}$$

$$a_{tt} = exp(0.00378 \cdot \zeta \cdot (V - V_{halft})) \tag{26}$$

where ζ *gmt*, *q10* and *qtl* are 2.2, 0.4, 4.5 and 1, respectively, *a0t* is 0.0111 1/ms,

V_{halft} = -75mV and k_l = -8.

The slowly activating voltage-dependent potassium current, I_M, is given by the equations:

$$I_m = 10^{-4} \cdot T_{adj}(degC) \cdot g_m \cdot m \cdot (V - E_K) \tag{27}$$

$$m_{t+dt} = m_t + (1 - exp(-\frac{dt \cdot T_a dj(degC)}{\tau}) \cdot (\frac{\alpha(V)}{(\alpha(V) + \beta(V)} - m_t),\ T_{adj}(degC) = 2.3^{degC-23)/10} \tag{28}$$

$$\alpha(V) = 10^{-3} \cdot \frac{(V+30)}{(1 - exp(-(V+30)/9))}\ , \beta(V) = -10^{-3} \cdot \frac{(V+30)}{(1 - exp((V+30)/9))}\ , \tau = \frac{1}{\alpha(V) + \beta(V} \tag{29}$$

The slow after-hyperpolarizing current, is given by:

$$I_{sAHP} = g_{sAHP} \cdot m^3 \cdot (V - E_K) \tag{30}$$

$$\frac{dm}{dt} = \frac{\frac{Cac}{(1+Cac)} - m}{\tau} \tag{31}$$

where $Cac = ([ca]_{in}/0.025)^2$.

The medium after-hyperpolarizing current, $\mathrm{I_{mAHP}}$ (Moczydlowski and Latorre, 1983), is given by:

$$I_{mAHP} = g_{mAHP} \cdot m \cdot (V - E_K) \tag{32}$$

$$m_{t+dt} = m_t + (1 + exp(-\frac{dt}{\tau_m})) \cdot (\frac{\alpha_m(V)}{\tau_m} - m_t) \tag{33}$$

$$\alpha_m(V) = \frac{0.48}{1 + \frac{0.18}{[Ca]_{in}} \cdot exp(-1.68 \cdot V \cdot Q(degC))} \tag{34}$$

$$\beta_m(V) = \frac{0.28}{1 + \frac{[ca]_{in}}{0.011 \cdot exp(-2 \cdot V \cdot Q(degC))}} \tag{35}$$

$$\tau_m = \frac{1}{\alpha_m(V) + \beta_m(V)} \tag{36}$$

The somatic high-voltage activated (HVA) L-type Ca^{2+} current is given by

$$I^s_{CaL} = g^s_{CaL} \cdot m \cdot \frac{0.001}{0.001 + [ca]_{in} \cdot ghk(V, [ca]_{in}, [Ca]_{out})} \tag{37}$$

$$\alpha_m(V) = -0.055 \cdot \frac{(V+27.01)}{exp(-(V+27.01)/3.8)-1},\ \beta_m(V) = 0.94 \cdot exp(-(V+63.01)/17) \tag{38}$$

$$\tau_m = \frac{1}{5 \cdot (\alpha_m(V) + \beta_m(V))} \tag{39}$$

whereas the dendritic L-type calcium channels have different kinetics:

$$I^d_{CaL} = g^d_{CaL} \cdot m^3 \cdot h \cdot (V - E_{Ca}) \tag{40}$$

$$\alpha(V) = \frac{1}{1 + exp(-(v+37))}, \beta(V) = \frac{1}{1 + exp((v+41)/0.5)} \tag{41}$$

Their time constants are equal to $\tau_m = 3.6ms$ and τ_h=29ms. The low-voltage activated (LVA) T-type Ca^{2+} channel kinetics are given by:

$$I_{CaT} = g_{CaT} \cdot m^2 \cdot h \frac{0.001}{0.001 + [ca]_{in} \cdot ghk(V, [ca]_{in}, [ca]_{out})} \tag{42}$$

$$ghk(V, [ca]_{in}, [ca]_{out}) = -x \cdot (1 - [ca]_{out}^{[ca]_{in}}) \cdot exp(\frac{V}{x}) \cdot f(\frac{V}{x})) \tag{43}$$

$$x = \frac{0.0853 \cdot (T + degC)}{2}, f(z) = \begin{cases} 1 - \frac{z}{2}, & if\ |z| < 10^{-4} \\ \frac{z}{e^z - 1}, & otherwise \end{cases} \tag{44}$$

$$m_{t+dt} = m_t + (1 + exp(-\frac{dt}{\tau_m})) \cdot (\frac{\alpha_{m(V)}}{\alpha_m(V) + \beta_m(V)} - m_t) \tag{45}$$

$$h_{t+dt} = h_t + (1 - exp(-\frac{dt}{\tau_h})) \cdot (\frac{\alpha_h(V)}{\alpha_h(V) + \beta_h(V)} - h_t) \tag{46}$$

$$\alpha_m(V) = -0.196 \cdot \frac{(V-19.88)}{exp(-(V-19.88)/10)-1},\ \beta_m(V) = 0.046 \cdot exp(-(V/22.73)) \tag{47}$$

$$\alpha_h(V) = 0.00016 \cdot exp(-(V+57)/19), \beta_h(V) = \frac{1}{exp(-(V-15)/10)+1} \tag{48}$$

$$tau_m = \frac{1}{\alpha_m(V) + \beta_m(V)}, \tau_h = \frac{1}{0.68 \cdot (\alpha_h(V) + \beta_h(V)} \quad (49)$$

where $[Ca]_{in}$ and $[Ca]_{out}$ are the internal and external calcium concentrations. The HVA R-type Ca2+ current is described by:

$$I_{CaR} = \bar{g}_{CaR} \cdot m^3 \cdot h \cdot (V - E_{Ca}) \quad (50)$$

$$m_{t+dt} = m_t + (1 + exp(-\frac{dt}{\tau_m}) \cdot (\alpha(V) - m_t) \quad (51)$$

$$h_{t+dt} = h_t + (1 - exp(-\frac{dt}{\tau_h})) \cdot (\beta(V) - h_t) \quad (52)$$

The difference between somatic and dendritic CaR currents lies in the $\alpha(V)$, $\beta(V)$ and τ parameter values. For the somatic current, $\tau_m = 100ms$ and $\tau_h = 5ms$ while for the dendritic current $\tau_m = 50ms$ and τ_h=5 ms. The $\alpha(V)$ and $\beta(V)$ equations for dendritic CaR channels are:

$$\alpha(V) = \frac{1}{1 + exp(-(V + 48.5)/3)}, \beta(V) = \frac{1}{1 + exp(V + 53)} \quad (53)$$

while for the somatic CaR channels:

$$\alpha(V) = \frac{1}{1 + exp(-(V + 60)/3)}, \beta(V) = \frac{1}{1 + exp(V + 62)} \quad (54)$$

Finally, a calcium pump/buffering mechanism is inserted at the cell body and along the apical and basal trunk. The mechanism is taken from (Destexhe, Mainen, & Sejnowski, 1994). The factor for Ca_{2+} entry was changed from f_e = 10,000 to f_e = 10,000/18 and the rate of calcium removal was made 7 times faster. The kinetic equations are given by:

$$drivechannel = \begin{cases} -f_e \frac{I_{Ca}}{0.2F}, & if\ drivechannel > 0 \\ 0, & otherwise \end{cases} \quad (55)$$

$$\frac{dCa}{dt} = drivechannel + \frac{10^{-4} - Ca}{7 \cdot 200ms} \quad (56)$$

1.1.1 Bistratified cells

All compartments obey the following current balance equation, which was adapted from Cutsuridis et al. (2010):

$$C\frac{dV}{dt} = I_{ext} - I_L - I_{Na} - I_{Kdr,fast} - I_A - I_{CaL} - I_{CaN} - I_{AHP} - I_C - I_{syn} \quad (57)$$

where C is the membrane capacitance, V is the membrane potential, I_L is the leak current, I_{Na} is the sodium current, $I_{Kdr,fast}$ is the fast delayed rectifier K^+ current, I_A is the A-type K^+ current, I_{CaL} is the L-type Ca^{2+} current, I_{CaN} is the N-type Ca^{2+} current, I_{AHP} is the Ca^{2+}-dependent K^+ (SK) current, I_C is the Ca^{2+} and voltage-dependent K^+ (BK) current and I_{syn} is the synaptic current. The conductance and reversal potential values of all ionic currents are listed in Table 8.

The sodium current and its kinetics are described by,

$$I_{Na} = g_{Na}m^3h(V - E_{Na}) \quad (58)$$

$$\frac{dm}{dt} = \alpha_m(1-m) - \beta_m m,\ \alpha_m = \frac{-0.3(V-25)}{(1 - exp((V-25)/-5))},\ \beta_m = \frac{0.3(V-53)}{(1 - exp((V-53)/5))} \quad (59)$$

$$\frac{dh}{dt} = \alpha_h(1-h) - \beta_h h,\ \alpha_h = \frac{0.23}{exp((V-3)/20)},\ \beta_h = \frac{3.33}{(1 + exp((V-55.5)/-10))} \quad (60)$$

The fast delayed rectifier K^+ current, $I_{Kdr,fast}$ is given by

$$I_{Kdr,fast} = g_{Kdr,fast}n_f^4(V - E_K) \quad (61)$$

$$\frac{dn_f}{dt} = \alpha_{n_f}(1-n_f) - \beta_{n_f}n_f, \alpha_{n_f} = \frac{-0.07(V-47)}{(1 - exp((V-47)/-6))}\beta_{n_f} = 0.264exp((v-22)/4) \quad (62)$$

The N-type Ca^{2+} current, I_{CaN}, is given by

$$I_{CaN} = g_{CaN}c^2d(V - E_Ca) \quad (63)$$

$$\frac{dc}{dt} = \alpha_c(1-c) - \beta_c c,\ \alpha_c = \frac{0.19(19.88 - V)}{(exp(19.88 - V)/10) - 1)},\ \beta_c = 0.046 \cdot exp(-V/20.73) \tag{64}$$

$$\frac{dd}{dt} = \alpha_d(1-d) - \beta_d d,\ \alpha_d = 1.6 \cdot 10^{-4} exp(-V/48.4),\ \beta_d = \frac{1}{(1 + exp(39 - V)/10))} \tag{65}$$

The Ca^{2+}-dependent K^+ (SK) current, I_{AHP}, is described by

$$I_{AHP} = g_{AHP} q^2 (V - E_K) \tag{66}$$

$$\frac{dq}{dt} = \alpha_q(1 - q) - \beta_q q \tag{67}$$

$$\alpha_q = \frac{0.00246}{exp(12 \cdot log_{10}([Ca^{2+}]) + 28.48)/ - 4.5)}\ ,\ \beta_q = \frac{0.006}{exp(12 \cdot log_{10}([Ca^{2+}]) + 60.4)/35)} \tag{68}$$

$$\frac{d[Ca^{2+}]_i}{dt} = B \sum_{T,N,L} I_{Ca} - \frac{[Ca^{2+}]_i - [Ca^{2+}]_0}{\tau} \tag{69}$$

where

$$B = 5.2 \cdot 10^{-6}/Ad \tag{70}$$

in units of mol/(C m^3) for a shell of surface area A and thickness d (0.2 μm) and $\tau = 10$;ms was the calcium removal rate. $[Ca^{2+}]_0 = 5$ μM was the resting calcium concentration.

The Ca^{2+} and voltage-dependent K^+ (BK) current, I_c, is

$$I_C = g_c o(v - E_K) \tag{71}$$

where activation variable, o, is described in Migliore et al., (1995). The A-type K^+ current, I_A, is described by

$$I_A = g_A ab(V - E_k) \tag{72}$$

$$\frac{da}{dt} = \alpha_a(1-a) - \beta_a a, \alpha_a = \frac{0.02(13.1-V)}{exp(\frac{13.1-V}{10}))-1},\ \beta_a = \frac{0.0175(V-40.1)}{exp(\frac{V-40.1}{10}))-1} \quad (73)$$

$$\frac{db}{dt} = \alpha_b(1-b) - \beta_b b,\ \alpha_b = 0.0016 \cdot exp(\frac{-13-V}{18})),\ \beta_b = \frac{0.05}{1+exp(\frac{10.1-V}{5}))} \quad (74)$$

$$TheL-typeCa^{2+}current, I_{CaL}, isdescribedby \quad (75)$$

$$I_{CaL} = g_{CaL} \cdot s_\infty^2 \cdot V \cdot \quad (76)$$

where g_{CaL} is the maximal conductance, s_∞ is the steady-state activation variable, F is Faraday's constant, T is the temperature, k is Boltzmann's constant, $[Ca^{2+}]_0$ is the equilibrium calcium concentration and $[Ca^{2+}]_i$ is described in equation 49. The activation variable, s_∞, is then

$$s_\infty = \frac{\alpha_s}{\alpha_s+\beta_s}, \alpha_s = \frac{15.69(-V+81.5)}{exp(\frac{-V+81.5}{10})-1}, \beta_s = 0.29 \cdot exp(-V/10.86) \quad (77)$$

1.2 Интернейроны

1.2.1 CavL

$$I_{CavL} = g_{max,CavL} \cdot m^2 \cdot h \cdot ghk(V, [[Ca_{2+}]_{in}, Ca_{2+}]_{out}) \quad (78)$$

$$h = \frac{0.001}{0.001 + [[Ca_{2+}]_{in}} \quad (79)$$

$$\alpha_m = \frac{15.69 \cdot (81.5-V)}{exp(0.1(81.5-V))-1} \quad (80)$$

$$\beta_m = 0.29 \cdot exp\Big(\frac{-V}{10.86}\Big) \quad (81)$$

$$ghk = -f \cdot \Big(1 - \Big(\frac{[[Ca_{2+}]_{in}}{Ca_{2+}]_{out}}\Big) \cdot exp\Big(\frac{V}{f}\Big)\Big) \frac{V}{f \cdot exp(V/f) - 1} \quad (82)$$

1.2.2 CavN

$$I_{CavN} = g_{max,CavN} \cdot c^2 \cdot c \cdot (V - E_{Ca}) \tag{83}$$

$$\alpha_c = \frac{-0.19 \cdot (V - 19.88)}{exp(0.1(V - 19.88)) - 1} \tag{84}$$

$$\beta_c = 0.046 \cdot exp\Big(\frac{-V}{20.73}\Big) \tag{85}$$

$$\alpha_d = 0.00016 \cdot exp\Big(\frac{-V}{48.4}\Big) \tag{86}$$

$$\beta_d = \frac{1}{exp(0.1(39 - V)) + 1} exp\Big(\frac{-V}{20.73}\Big) \tag{87}$$

$$x_{t+\Delta t} = x_t + (1 - exp(\Delta t / \tau_x)) \cdot (x_\infty - x_t) \tag{88}$$

1.2.3 HCN

$$I_H = g_{max,H} \cdot h^2 \cdot (V - E_H) \tag{89}$$

$$\tau_h = \frac{1}{q_{10}} \cdot \left(120 + \frac{129.5}{1 + exp(1.2\ (V + 59.3))}\right) \tag{90}$$

$$h_\infty = \frac{1}{1 + exp(0.1\ (V + 91))} \tag{91}$$

1.2.4 HCNolm

$$I_{Holm} = g_{max,Holm} \cdot r \cdot (V - E_H) \tag{92}$$

$$r_\infty = \frac{1}{1 + exp(0.98\ (V + 84.1))} \tag{93}$$

$$\tau_r = 100 + \frac{1}{exp(-(17.9 + 0.116V)) + exp(0.09V - 1.84)} \tag{94}$$

1.2.5 KCaS

$$I_{KCaS} = g_{max,KCaS} \cdot q^2 \cdot (V - E_K) \tag{95}$$

$$\alpha_q = q_{10} \cdot 15 \cdot ([Ca^{2+}]_{in})^2 \ \beta_q = q_{10} \cdot 0.00025 \tag{96}$$

1.2.6 Kdrfast

$$I_{Kdrfast} = g_{max,Kdrfast} \cdot n^4 \cdot (V - E_K) \tag{97}$$

$$\alpha_n = \frac{-0.07(V + 18)}{exp(\frac{V+18}{-6}) - 1} \tag{98}$$

$$\beta_n = 0.264 \cdot exp\left(\frac{V + 43}{40}\right) \tag{99}$$

1.2.7 Kdrfastngf

$$I_{Kdrfastngf} = g_{max,Kdrfastngf} \cdot n^4 \cdot (V - E_K) \tag{100}$$

$$\alpha_n = \frac{-0.07(V + 8)}{exp(\frac{V+8}{-6}) - 1} \tag{101}$$

$$\beta_n = 0.264 \cdot exp\left(\frac{V + 33}{40}\right) \tag{102}$$

1.2.8 Kdrslow

$$I_{Kdrslow} = g_{max,Kdrslow} \cdot n^4 \cdot (V - E_K) \tag{103}$$

$$\alpha_n = \frac{-0.028(V + 30)}{exp(\frac{V+30}{-6}) - 1} \tag{104}$$

$$\beta_n = 0.1056 \cdot exp\left(\frac{V + 55}{40}\right) \tag{105}$$

1.2.9 KvA

$$I_{kvA} = g_{max,kvA} \cdot n \cdot l \cdot (V - E_K) \tag{106}$$

$$n_\infty = \frac{1}{1 + exp(-21(V + 33.6)/T} \tag{107}$$

$$\tau_n = \frac{exp(-21(V + 33.6)/T)}{q_{10} \cdot 0.02 \cdot (1 + exp(-21(V + 33.6)/T))} \tag{108}$$

$$l_\infty = \frac{1}{1 + exp(46.41(V + 83)/T)} \tag{109}$$

$$\tau_l = \frac{exp(46.41(V + 83)/T)}{q_{10} \cdot 0.08 \cdot (1 + exp(46.41(V + 83)/T))} \tag{110}$$

1.2.10 KvAngf

$$I_{KvAngf} = g_{max,KvAngf} \cdot n \cdot l \cdot (V - E_K) \tag{111}$$

$$n_\infty = \frac{1}{1 + exp(-34.8(V + 23.6)/T} \tag{112}$$

$$\tau_n = \frac{exp(-34.8(V + 23.6))}{q_{10} \cdot 0.02 \cdot (1 + exp(-34.8(V + 23.6)/T))} \tag{113}$$

$$l_\infty = \frac{1}{1 + exp(46.41(V + 83)/T)} \tag{114}$$

$$\tau_l = \frac{exp(46.41(V + 83))}{q_{10} \cdot 0.08 \cdot (1 + exp(46.41(V + 83)/T))} \tag{115}$$

1.2.11 KvAolm

Таблица 1: Parameters of pyramidal neurons

Parameter	**Soma**	**Axon**	**OriProx**	**OriDist**	**RadProx**	**RadMed**	**RadDist**	**LM**
Cm, mF/cm2	1	1	1	1	1	1	1	1
Rm, Ohm cm2	20000	20000	20000	20000	20000	20000	20000	20000
Ra, Ω cm	50	50	50	50	50	50	50	50
Leak conductance (S/cm2)	0.0002	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005
Sodium conductance (S/cm2)	0.007	0.1	0.007	0.007	0.007	0.007	0.007	0.007
Delayed Rectifier K+ conductance (S/cm2)	0.0014	0.02	0.000868	0.000868	0.000868	0.000868	0.000868	0.000868
Proximal A-type K+ conductance (S/cm2)	0.0025	—	0.0075	0.0075	0.015	0	0	—
Distal A-type K+ conductance (S/cm2)	—	—	0	0	0	0.03	0.045	0.049
M-type K+ conductance (S/cm2)	0.06	0.03	0.06	0.06	0.06	0.06	0.06	—
Ih conductance [S/cm2]	0.00005	—	0.00005	0.0001	0.0001	0.0002	0.00035	—
Vhalf,h (mV)	-73	—	-81	-81	-82	-81	-81	—
L-type Ca2+ conductance (S/cm2)	0.0007	—	0.000031635	0.000031635	0.000031635	0.0031635	0.0031635	—
T-type Ca2+ conductance (S/cm2)	0.00005	—	0.0001	0.0001	0.0001	0.0001	0.0001	—
R-type Ca2+ conductance (S/cm2)	0.0003	—	0.00003	0.00003	0.00003	0.00003	0.00003	—