Supplement materials

Mysin I.E.

Pyramidal neurons

Уравнение для сомы, радиатума и ориенса

$$C\frac{dV_s}{dt} = -I_l - I_{Kdr} - I_{Na} - I_A - I_M - I_H - I_{CaL} - I_{sAHP} - I_{mAHP} - I_{CaR} - I_{buff} - \\ -I_{syn} + I_{ext} \quad (1)$$

Уравнение для аксона

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

Уравнение для LM

$$C\frac{dV_LM}{dt} = -I_l - I_{Kdr} - I_{Na} - I_A - I_{syn} + I_{ext} \quad (3)$$

Натриевый каналы

$$I_{Na} = g_{max,Na} \cdot m^2 \cdot h \cdot s \cdot (V - E_{Na}) \quad (4)$$

For dendiritic compartments

$$m_\infty = \frac{1}{1 + exp(-\frac{V+40}{3})} \ \tau_m = 0.05ms \quad (5)$$

$$h_\infty = \frac{1}{1 + exp(-\frac{V+45}{3})} \; \tau_h = 0.5ms \tag{6}$$

For soma/axon compartments

$$m_\infty = \frac{1}{1 + exp(-\frac{V+44}{3})} \; \tau_m = 0.05ms \tag{7}$$

$$h_\infty = \frac{1}{1 + exp(-\frac{V+49}{3.5})} \; \tau_h = 1ms \tag{8}$$

For all compartments

$$s_\infty = \frac{1 + Na_{att} exp(0.5(V + 60))}{1 + exp(0.5(V + 60))} \tag{9}$$

$$\tau_s = \frac{0.00333 exp(0.0024(V + 60)Q)}{1 + exp(0.0012(V + 60)Q)} \tag{10}$$

$$Q = \frac{F}{RT} \tag{11}$$

The delayed rectifier current is given by:

$$I_{Kdr} = g_{max,Kdr} \cdot n^2 \cdot (V - E_K) \tag{12}$$

For dendiritic compartments

$$n_\infty = \frac{1}{1 + exp(-0.5(V + 42))} \; \tau_n = 2.2ms \tag{13}$$

For soma/axon compartments

$$n_\infty = \frac{1}{1 + exp(-0.3333(V + 46.3))} \ \tau_n = 3.5ms \tag{14}$$

The fast inactivating A-type K+ current is described by

$$I_A = g_{max,A} \cdot n_A \cdot l \cdot (V - E_K) \tag{15}$$

$$\alpha_{n_A} = \frac{-0.01(V + 21.3)}{exp(\frac{V+21.3}{-35}) - 1} \tag{16}$$

$$\beta_{n_A} = \frac{0.01(V + 21.3)}{exp(\frac{V+21.3}{35}) - 1} \tag{17}$$

$$\alpha_l = \frac{-0.01(V + 58)}{exp(\frac{V+58}{8.2}) - 1} \tag{18}$$

$$\beta_l = \frac{0.01(V + 58)}{exp(\frac{V+58}{-8.2}) - 1} \tag{19}$$

$$\tau_l = \ = \begin{cases} 5 + 0.26(V + 20) & \text{if } V > 20 \\ 5 & \text{otherwise} \end{cases} \tag{20}$$

The hyperpolarizing H-current is given by:

$$I_H = g_{max,H} \cdot H \cdot (V - E_H) \tag{21}$$

$$H_\infty = \frac{1}{1 + exp(0.125(V + 75))} \tag{22}$$

$$\tau_H = \frac{exp(0.033264(V + 75))}{0.35(1 + exp(0.0083(V + 75)))} \tag{23}$$

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

$$I_M = g_{max,M} \cdot T_{adj} \cdot q \cdot (V - E_K)\ T_{adj} = 10^{-4} \cdot 2.3^{0.1(T-296)} \tag{24}$$

$$\alpha_q = \frac{10^{-3}(V+30)}{1 - exp(\frac{V+30}{-9})} \tag{25}$$

$$\beta_q = \frac{-10^{-3}(V+30)}{1 - exp(\frac{V+30}{9})} \tag{26}$$

The slow after-hyperpolarizing current, IsAHP

$$I_{sAHP} = g_{max,sAHP} \cdot p^3 \cdot (V - E_K) \tag{27}$$

$$\frac{dp}{dt} = \frac{C_{Ca} - p(1 + C_{Ca})}{\tau_p(1 + C_{Ca})} \tag{28}$$

$$\tau_p = max(\frac{1}{0.003 \cdot (1 + C_{Ca})3(0.1(T - 295))},\ 0.5) \tag{29}$$

$$C_{Ca} = \Big(\frac{[Ca^{2+}]_{in}}{0.025}\Big)^2 \tag{30}$$

The medium after-hyperpolarizing current, I mAHP (Moczydlowski and Latorre, 1983), is given by:

$$I_{mAHP} = g_{max,mAHP} \cdot a \cdot (V - E_K) \tag{31}$$

$$\alpha_a = \frac{0.48}{1 + \frac{0.18 \cdot exp(-1.68VQ)}{[Ca^{2+}]_{in}}} \tag{32}$$

$$\beta_a = \frac{0.28}{1 + \frac{[Ca^{2+}]_{in}}{0.011 \cdot exp(-2VQ)}} \tag{33}$$

The somatic high-voltage activated (HVA) L-type Ca2+ current is given by

$$I_{CaL} = g_{max,somaCaL} \cdot b \cdot \frac{0.001}{0.001 + [Ca^{2+}]_{in}} \cdot (V - E_{Ca})\ !!!??? \tag{34}$$

$$\alpha_b = \frac{-5.055\ (V + 27.01)}{exp(\frac{(V+27.01}{-3.8}) - 1} \tag{35}$$

$$\beta_b = 4.7\ exp\Big(\frac{V + 63.01}{-17}\Big) \tag{36}$$

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

$$I_{CaL} = g_{max,dendCaL} \cdot b^3 \cdot c \cdot (V - E_{Ca}) \tag{37}$$

$$\alpha_b = \frac{1}{1 + exp(-(V + 37))} \tag{38}$$

$$\beta_b = \frac{1}{1 + exp(2(V + 41))} \tag{39}$$

$$\alpha_c =? \tag{40}$$

$$\beta_c =? \tag{41}$$

$$\tau_b = 3.6 \tag{42}$$

$$\tau_c = 29 \tag{43}$$

The low-voltage activated (LVA) T-type Ca2+ channel kinetics are given by:

$$I_{CaT} = g_{max,somaCaT} \cdot d^2 \cdot r \cdot \frac{0.001}{0.001 + [Ca^{2+}]_{in}} \cdot (V - E_{Ca})\ !!!??? \tag{44}$$

$$\alpha_d = \frac{-0.196(V - 19.88)}{exp(-0.1(V - 19.88)) - 1} \tag{45}$$

$$\beta_d = 0.46 exp(-V/22.73) \tag{46}$$

$$\alpha_r = 0.00016 exp(\frac{V + 57}{-19}) \tag{47}$$

$$\beta_r = \frac{1}{1 + exp(-0.1(V - 15))} \tag{48}$$

The HVA R-type Ca2+ current is described by:

$$I_{CaR} = g_{max,CaR} \cdot w^3 \cdot j \cdot \cdot (V - E_{Ca}) \tag{49}$$

equations for dendritic CaR channels are:

$$w_\infty = \frac{1}{(1 + exp(-0.3333(V + 48)))} \quad \tau_w = 50ms \tag{50}$$

$$j_\infty = \frac{1}{1 + exp(V + 53)} \quad \tau_j = 5ms \tag{51}$$

while for the somatic CaR channels:

$$w_\infty = \frac{1}{(1 + exp(-0.3333(V + 60)))} \quad \tau_w = 100ms \tag{52}$$

$$j_\infty = \frac{1}{1 + exp(V + 62)} \quad \tau_j = 5ms \tag{53}$$

Dynamic of calcium concention

$$\frac{d[Ca^{2+}]_{in}}{dt} = \phi_{Ca} I_{sumCa} - \beta_{Ca}[Ca^{2+}]_{in} \tag{54}$$

Таблица 1: Parameters of pyramidal neurons

Parameter	**Soma**	**Axon**	**OriProx**	**Ori**
Cm, mF/cm2	1	1	1	
Rm, Ohm cm2	20000	20000	20000	20
Ra, cm	50	50	50	5
Leak conductance [S/cm2]	0.0002	0.000005	0.000005	0.00
Sodium conductance [S/cm2]	0.007	0.1	0.007	0.0
Delayed Rectifier K+ conductance [S/cm2]	0.0014	0.02	0.000868	0.00
Proximal A-type K+ conductance [S/cm2]	0.0025	—	0.0075	0.0
Distal A-type K+ conductance [S/cm2]	—	—	0	
M-type K+ conductance [S/cm2]	0.06	0.03	0.06	0.
Ih conductance [S/cm2]	0.00005	—	0.00005	0.0
Vhalf,h (mV)	-73	—	-81	-
L-type Ca2+ conductance [S/cm2]	0.0007	—	0.000031635	0.0000
T-type Ca2+ conductance [S/cm2]	0.00005	—	0.0001	0.0
R-type Ca2+ conductance [S/cm2]	0.0003	—	0.00003	0.00
Ca2+-dependent sAHP K+ conductance [S/cm2]	0.0005	—	0.0005	0.0
Ca2+-dependent mAHP K+ conductance [S/cm2]	0.09075	—	0.033	0.0
EL (mV)	-70	-70	-70	-
ENa (mV)	50	50	50	5
Eh, (mV)	-10	—	-10	-
ECa, (mV)	140	—	140	1
EK (mV)	-80	-80	-80	-