A mathematical modeling toolbox for ion channels and transporters across cell membranes

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The following supplementary material is from " A mathematical modeling toolbox for ion channels and transporters across cell membranes" manuscript. It contains an overview of all equations related to Ion channels, Pumps, Cotransporters, and Symporters, organized in a table form. The detailed transporters along with the descriptions of their equatuons can be found from here.

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1.3.2. *T-type voltage- gated calcium channels*

T-type Voltage- Gated Calcium Channels	Ref
	[19–22]

$$I_{Ca,Ca_t}^{M-N} = \overline{P}_{Ca,CaL}^{M-N} m_{Ca_t}^3 h_{Ca_t} \frac{z_{Ca}^2 F^2 V_m^{M-N}}{RT} \frac{[Ca]_i - [Ca]_o exp\left(\frac{-z_{Ca} F V_m^{M-N}}{RT}\right)}{1 - exp\left(\frac{-z_{Ca} F V_m^{M-N}}{RT}\right)} \tag{64}$$

where:

$$\frac{dm_{Ca_t}}{dt} = \frac{\bar{m}_{Ca_t} - m_{Ca_t}}{\tau_m^{Ca_t}} \tag{65}$$

$$\frac{dh}{dt} = \frac{\bar{h} - h}{\tau_h} \tag{66}$$

$$\bar{m}_{Ca_t} = \frac{1}{1 + exp\left(\frac{-(V_m^{M-N} + V_{1/2,m\,Ca_v}^{M-N})}{k_{m\,Ca_v}}\right)} \tag{67}$$

$$\bar{h}_{Ca_t} = \frac{1}{1 + exp\left(\frac{(V_m^{M-N} + V_{1/2,h\,Ca_t}^{M-N})}{k_{h\,Ca_t}}\right)} \tag{68}$$

$$For\ all\ range\ of\ V_m : \left\{ \tau_m^{Ca_t} = \frac{A_{\tau_m^{Ca_t}}}{exp\left(\frac{-(V_m^{M-N} + V_{1\tau_m})}{k_{1\tau_m}}\right) + exp\left(\frac{(V_m^{M-N} + V_{2\tau_m})}{k_{2\tau_m}}\right)} + B_{\tau_m^{Ca_t}} \right. \tag{69}$$

$$For\ \ V_m \geq -80mV : \left\{ \tau_h^{Ca_t} = A_{\tau_h^{Ca_t}}\ exp\left[\frac{-(V_m + V_{\tau_h^{Ca_t}})}{k_{\tau_h^{Ca_t}}}\right] + B_{\tau_h^{Ca_t}} \right. \tag{70}$$

$$For\ \ V_m < -80mV : \left\{ \tau_h^{Ca_t} = A_{\tau_h^{Ca_t}}\ exp\frac{(V_m + V_{\tau_h^{Ca_t}})}{k_{\tau_h^{Ca_t}}} \right.$$

Table 5: The corresponding equations describing the flux and current transported via T-type voltage- gated calcium channels across the cell membrane