1 Generic PDE Model 04 v15.04.16

class II, negative feedback, RyR, closed cell, four variables

$$\frac{\partial c}{\partial t} = D_{\mathrm{c}}\nabla^2 c + (J_{\mathrm{IPR}} + k_{\mathrm{leak}} + k_{\mathrm{RyR}}P_{\mathrm{RyR}})(c_{\mathrm{e}} - c) - J_{\mathrm{serca}} \tag{1}$$

$$\frac{\partial p}{\partial t} = D_{\mathrm{p}}\nabla^2 p + V_{\mathrm{PLC}}(\vec{x}) - V_{\mathrm{deg}}\left(\frac{c^2}{K_{\mathrm{3K}}^2 + c^2}\right)p \tag{2}$$

$$\frac{\partial h}{\partial t} = \frac{h_\infty - h}{\tau} \tag{3}$$

$$\frac{\partial c_{\mathrm{e}}}{\partial t} = D_{\mathrm{e}}\nabla^2 c_{\mathrm{e}} - \big((J_{\mathrm{IPR}} + k_{\mathrm{leak}} + k_{\mathrm{RyR}}P_{\mathrm{RyR}})(c_{\mathrm{e}} - c) - J_{\mathrm{serca}}\big)/\gamma \tag{4}$$

$$J_{\mathrm{serca}} = V_{\mathrm{s}}\frac{c^2}{K_{\mathrm{s}}^2 + c^2} \tag{5}$$

$$J_{\mathrm{IPR}} = k_{\mathrm{IPR}}(\vec{x})P_O \tag{6}$$

$$P_{\mathrm{RyR}} = \frac{c^2}{K_{\mathrm{RyR}}^2 + c^2} \tag{7}$$

$$P_O = \phi_c\phi_p h \tag{8}$$

$$\phi_c = \frac{c^3}{K_{\mathrm{a}}^3 + c^3} \tag{9}$$

$$\phi_p = \frac{p^4}{K_{\mathrm{p}}^4 + p^4} \tag{10}$$

$$h_\infty = \frac{K_{\mathrm{i}}^2}{K_{\mathrm{i}}^2 + c^2} \tag{11}$$

c	0.06(init)	μM	cytosolic Ca^{2+} concentration
p	0.26(init)	μM	IP_3 concentration
h	0.334(init)	-	IPR modelling variable
c_{e}	26.7(init)	μM	ER Ca^{2+} concentration
γ	0.185	-	ratio of ER volume to cystolic volume
t		s	time
J_{IPR}		s^{-1}	calcium from ER
$k_{\mathrm{IPR}}(\vec{x})$	7.4(max)	s^{-1}	parameter (highest near apical region)
P_{RyR}			calcium from ER
k_{RyR}	0.01	s^{-1}	parameter
K_{RyR}	0.42	μM	parameter
P_O		-	open probability of IPR (range: 0.0 - 1.0)
ϕ_c		-	function of Ca^{2+} concentration
K_{a}	0.3	μM	parameter
ϕ_p		-	function of IP_3 concentration
K_{p}	0.5	μM	parameter
h_∞		-	function of Ca^{2+} concentration
K_{i}	0.06	μM	parameter
τ	0.5	s^{-1}	parameter
D_{c}	5.0	$\mu m^2\ s^{-1}$	systolic Ca^{2+} diffusion coefficient
D_{e}	1.0	$\mu m^2\ s^{-1}$	ER Ca^{2+} diffusion coefficient
J_{serca}		$\mu M\ s^{-1}$	calcium flux into ER
V_{s}	0.25	$\mu M\ s^{-1}$	parameter
K_{s}	0.1	μM	parameter
k_{leak}	0.00148	s^{-1}	calcium from ER (to balance J_{serca} at rest)
$V_{\mathrm{PLC}}(\vec{x})$	0.03(max)	$\mu M\ s^{-1}$	parameter (highest near basal membrane)
V_{deg}	0.16	s^{-1}	parameter
K_{3K}	0.4	μM	parameter
D_{p}	283	$\mu m^2\ s^{-1}$	IP_3 diffusion coefficient