Unique List of ”Reactions”

Tim David

February 24, 2021

Abstract

1 Introduction

The list below is a unique list provided so as to generate a protocol for deleting ”reactions”. ”Reactions” are defined as distinct formulae forming the RHS of the relevant o.d.e. As a way of getting to a reduced system of NVC we have not altered the neuron model nor the ??

2 Synaptic Cleft and Astrocyte

THE LIST

Reaction	Description	
		Astrocyte and Synaptic Cleft.....
1	J_{K_k}	potassium (K^+) channel
2 Removing Coefficients	~~2~~J_{NaK_k}	K^+ sodium (Na^+)-ATPase pump
3	J_{NKCC1_k}	Na+, K+ and Cl flux through the NKCC1 channel
4	J_{KCC1_k}	Cl and K+ flux through the KCC1 channel
5	$J_{KNEtoSC}$	flux of K+ into the SC based on the extracellular K+
6	J_{Na_k}	Na+ flux through the Na+ channel
7	J_{NBC_k}	Na+ and HCO3 flux through the NBC channel
8	$J_{NaNEtoSC}$~~,~~	flux of K+ into the SC based on the extracellular K+ = $J_{KNEtoSC}$
9	J_{IP3_k}	flux of Ca2+ through the IP3R channel
10	J_{pump_k}	flux of Ca2+ through the uptake pump
11	J_{ERleak_k}	flux of Ca2+ through the leak channel
12 Removing Coefficients	~~$\frac{J_{TRPV_k}}{r_{buff}}$~~	flux of Ca2+ through TRPV4 channel
13	J_{CICR_k}	flux of Ca2+ through CICR into astrocytic cytosol
14 Removing Coefficients	~~r_h~~G	rate of IP3 production in astrocyte due to glutamate receptors
~~15~~	~~$k_{deg}IP3_k$~~	~~Rate constant for IP3 degradation in astrocyte~~
~~16~~	~~$V_{eet}\max(Ca_k - c_{k_{min}}, 0)$~~	~~production of astrocytic epoxyeicosatrienoic acid (EET) concentration~~
~~17~~	~~$k_{eet}eet_k$~~	~~degredation of astrocytic epoxyeicosatrienoic acid (EET) concentration~~
18	J_{BK_k}	
19	J_{Cl_k}	
~~20~~	~~$\phi_n w_\infty$~~	

I don't know exactly how to handle 15,16, and 17. Set the reactions to be just the parameters (k_deg, V_eet, and k_eet)?

Deleting reaction 20 and these changes to reaction 21 make it so that:
reaction 21 on = w_k changes with time
reaction 21 off = w_k is constant

Similarly removing reaction 23 and editing reaction 22 makes it so that:
reaction 22 on = h_k changes with time
reaction 22 off = h_k is constant

21	~~$=\phi_n w_k$~~	
22	$k_{on} K_{inh} - (Ca_k + K_{inh}) h_k$	inactivation variable h_k of the astrocytic IP_3R channel
~~23~~	~~$=k_{on}(Ca_k + K_{inh})h_k$~~	~~inactivation variable h_k of the astrocytic IP_3R channel~~
~~24~~	~~$\frac{m_{inf}}{\tau_{TRPV4}}$~~	~~TRPV4 channel open probability~~
~~25~~	~~$\frac{-m_k}{\tau_{TRPV4}}$~~	~~TRPV4 channel open probability~~
~~26~~	~~$\frac{(AA_i - AA_k)}{\tau_{AA}}$~~	~~concentration of arachidonic acid in the astrocyte AA_k.~~
~~27~~	~~$\frac{AA_m AA_{max}}{(AA_m + (Ca_k - Ca_0))^2 \frac{dCa_k}{dt}}$~~	~~concentration of arachidonic acid in the astrocyte AA_k.~~

if we add the parameter trpv_switch as a reaction, that reaction would control if m_k is constant in time or not, which is sort of what the (pre- my edits) reactions 24 and 25 do.

26 need to either be removed or VERY CAREFULLY coded - it appears in a slightly different form elsewhere

I'm not sure how to handle 27. If you change it to be just AA_m you might have a division by 0 error.

PVS.....

28 Removing Coefficients	~~$\frac{J_{BK_k}}{VR_{pk}}$~~	K^+ concentration in the perivascular space (PVS)
29 Removing Coefficients	~~$\frac{J_{KIR_i}}{VR_{pi}}$~~	K^+ concentration in the PVS
30 Removing Coefficients	~~$K_{decay_p}(K_p - K_{min_p})$~~	K^+ concentration in the PVS
31	~~$\frac{J_{TRPV_k}}{VR_{pk}}$~~	calcium (Ca^{2+}) concentration in the PVS
32	~~$\frac{J_{VOCC_i}}{VR_{pi}}$~~	Ca^{2+} concentration in the PVS
33 Removing Coefficients	~~$=Ca_{decay_p}(Ca_p - Ca_{min_p})$~~	Ca^{2+} concentration in the PVS
~~34~~	~~$\frac{m_{\infty_k}}{t_{TRPV_k}}$~~	~~The open probability of the transient receptor potential vanniloid-related 4 (TRPV4) channel~~
~~35~~	~~$\frac{-m_k}{t_{TRPV_k}}$~~	~~The open probability of the TRPV4 channel~~

34 and 35 are identical to 24 and 25

SMC .....

36	$J_{IP_{3i}}$	Cytosolic Ca^{2+} in the smooth muscle cell (SMC)
37 Removing Coefficients	~~$=J_{SR_{uptake_i}}$~~	Cytosolic Ca^{2+} in the SMC
38 Removing Coefficients	~~$+J_{CICR_i}$~~	Cytosolic Ca^{2+} in the SMC
39 Removing Coefficients	~~$=J_{extrusion_i}$~~	Cytosolic Ca^{2+} in the SMC
40	$J_{SR_{leak_i}}$	Cytosolic Ca^{2+} in the SMC
~~41~~ Now the same as 32	~~$=J_{VOCC_i}$~~	~~Cytosolic Ca^{2+} in the SMC~~
42	J_{Na/Ca_i}	Cytosolic Ca^{2+} in the SMC
43 Removing Coefficients	~~$=0.1J_{stretch_i}$~~	Cytosolic Ca^{2+} in the SMC
44	$J^{SMC-EC}_{Ca^{2+}-coupling_i}$	Cytosolic Ca^{2+} in the SMC
45 Removing Coefficients	~~$=\gamma_v J_{NaK_i}$~~	Membrane potential of the SMC
46 Removing Coefficients	~~$=\gamma_v J_{Cl_i}$~~	Membrane potential of the SMC
47 Removing Coefficients	~~$=\gamma_v J_{K_i}$~~	Membrane potential of the SMC
48 Removing Coefficients	~~$=\gamma_v J_{KIR_i}$~~	Membrane potential of the SMC
49	$V^{SMC-EC}_{coupling_i}$	Membrane potential of the SMC
50	~~$\lambda_i(K_{act_i})$~~	Open state probability of Ca^{2+}-activated K^+ channels
51	~~$=\lambda_i w_i$~~	Open state probability of Ca^{2+}-activated K^+ channels
		fluxes for K^+ in SMC are 45, 47, 48 divided by γ_v
52 Removing Coefficients	~~$=J_{degrad_i}$~~	inositol trisphosphate (IP_3) concentration in the SMC

50 and 51 (pre- my edits) combine to form one equation and I wasn't sure how to handle it. Right now my edits make it so that reaction 50 partially turns off the ODE and reaction 51 turns it off completely

53	$J^{SMC-EC}_{IP_3-coupling_i}$	IP_3 concentration in the SMC
~~54~~	~~$\frac{AA_k}{\tau_{AA}}$~~	~~Arachidonic acid in the SMC~~
~~55~~	~~$\frac{-AA_i}{\tau_{AA}}$~~	~~Arachidonic acid in the SMC~~
~~56~~	~~$\frac{1}{1+exp(\frac{(NO_i - NO_{rest})}{R_{NO}})} \frac{V_a AA_i}{K_a + AA_i}$~~	~~20-HETE in the SMC~~

I am not sure about how to handle 54, 55, and 56. It would be very easy for me to accidentally break something

~~57~~	$\frac{V_f AA_i}{K_f + AA_i}$	~~20-HETE in the SMC~~
58 Removing Coefficients	$= \lambda_h ~~H_i~~$	20-HETE in the SMC
EC		
59	$J_{IP_{3j}}$	Cytosolic Ca^{2+} concentration in the endothelial cell (EC)
60 Removing Coefficients	$= J_{ER_{uptake_j}}$	Cytosolic Ca^{2+} concentration in the EC
61	J_{CICR_j}	Cytosolic Ca^{2+} concentration in the EC
62 Removing Coefficients	$= J_{extrusion_j}$	Cytosolic Ca^{2+} concentration in the EC
63	$J_{ER_{leak_j}}$	Cytosolic Ca^{2+} concentration in the EC
64	J_{cation_j}	Cytosolic Ca^{2+} concentration in the EC
65	J_{0_j}	Cytosolic Ca^{2+} concentration in the EC
66 Removing Coefficients	$= J_{stretch_j}$	Cytosolic Ca^{2+} concentration in the EC
~~67~~	$~~-\frac{1}{C_{m_j}}(I_{K_j} + I_{R_j})~~$	~~Membrane potential of the EC~~
~~68~~	$~~= V^{SMC-EC}_{coupling_j}~~$	~~Membrane potential of the EC~~
69	J_{PLC}	IP_3 concentration of the EC
70 Removing Coefficients	$= J_{degrad_j}$	IP_3 concentration of the EC
71 Removing Coefficients	$= J^{SMC-EC}_{IP_3-coupling_j}$	IP_3 concentration of the EC

67 is another one I am not sure of how to handle without breaking something

we removed 68 previously because it was identical to an existing reaction. I think it was reaction 53