SBML Model Report

Model name: "Plant1981_BurstingNerveCells"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by Vijayalakshmi Chelliah[1] at May 24th 2006 at 10:35 a. m. and last time modified at April first 2014 at 10:12 p. m. Table 1 shows an overview of the quantities of all components of this model.

Table 1: Number of components in this model, which are described in the following sections.

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	5
events	0	constraints	0
reactions	0	function definitions	0
global parameters	34	unit definitions	0
rules	23	initial assignments	0

Model Notes

This a model from the article:
Bifurcation and resonance in a model for bursting nerve cells.
Plant RE J Math Biol1981 Jan; 11(1): 15-32 7252375,
Abstract:
In this paper we consider a model for the phenomenon of bursting in nerve cells. Experimental

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evidence indicates that this phenomenon is due to the interaction of multiple conductances with very different kinetics, and the model incorporates this evidence. As a parameter is varied the model undergoes a transition between two oscillatory waveforms; a corresponding transition is observed experimentally. After establishing the periodicity of the subcritical oscillatory solution, the nature of the transition is studied. It is found to be a resonance bifurcation, with the solution branching at the critical point to another periodic solution of the same period. Using this result a comparison is made between the model and experimental observations. The model is found to predict and allow an interpretation of these observations.

Also, look athttp://www.scholarpedia.org/article/Plant_model

2 Unit Definitions

This is an overview of five unit definitions which are all predefined by SBML and not mentioned in the model.

2.1 Unit substance

Notes Mole is the predefined SBML unit for substance.

Definition mol

2.2 Unit volume

Notes Litre is the predefined SBML unit for volume.

Definition l

2.3 Unit area

Notes Square metre is the predefined SBML unit for area since SBML Level 2 Version 1.

Definition m^2

2.4 Unit length

Notes Metre is the predefined SBML unit for length since SBML Level 2 Version 1.

Definition m

2.5 Unit `time`

Notes Second is the predefined SBML unit for `time`.

Definition s

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`COMpartment`			3	1	litre	☑	

3.1 Compartment `COMpartment`

This is a three dimensional compartment with a constant size of one litre.

4 Species

This model contains five species. Section 7 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
`V_membrane`	V	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`h1`	h1	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`x1`	x1	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`n1`	n1	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`c`	c	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$

5 Parameters

This model contains 34 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
i_Na	i_Na		0.000		☐
V_I	V_I		30.000		☑
V_K	V_K		-75.000		☑
V_L	V_L		-40.000		☑
V_Ca	V_Ca		140.000		☑
g_I	g_I		4.000		☑
g_K	g_K		0.300		☑
g_T	g_T		0.010		☑
g_K_Ca	g_K_Ca		0.030		☑
g_L	g_L		0.003		☑
K_p	K_p		0.500		☑
K_c	K_c		0.009		☑
f	f		$3 \cdot 10^{-4}$		☑
tau_x	tau_x		235.000		☑
a	a		1.209		☑
b	b		78.714		☑
Vs	Vs		0.000		☐
m_infinity	m_infinity		0.000		☐
alpha_m	alpha_m		0.000		☐
beta_m	beta_m		0.000		☐
h_infinity	h_infinity		0.000		☐
alpha_h	alpha_h		0.000		☐
beta_h	beta_h		0.000		☐
tau_h	tau_h		0.000		☐
g_Ca	g_Ca		0.004		☐
x_infinity	x_infinity		0.000		☐
i_Ca	i_Ca		0.000		☐
n_infinity	n_infinity		0.000		☐
i_K	i_K		0.000		☐
alpha_n	alpha_n		0.000		☐
beta_n	beta_n		0.000		☐
tau_n	tau_n		0.000		☐
i_K_Ca	i_K_Ca		0.000		☐
i_L	i_L		0.000		☐

6 Rules

This is an overview of 23 rules.

6.1 Rule Vs

Rule Vs is an assignment rule for parameter Vs:

$$\mathrm{Vs} = \mathrm{a} \cdot [\mathrm{V\_membrane}] + \mathrm{b} \tag{1}$$

6.2 Rule alpha_m

Rule alpha_m is an assignment rule for parameter alpha_m:

$$\mathrm{alpha\_m} = \frac{0.1 \cdot (50 - \mathrm{Vs})}{\exp\left(\frac{50-\mathrm{Vs}}{10}\right) - 1} \tag{2}$$

6.3 Rule beta_m

Rule beta_m is an assignment rule for parameter beta_m:

$$\mathrm{beta\_m} = 4 \cdot \exp\left(\frac{25 - \mathrm{Vs}}{18}\right) \tag{3}$$

6.4 Rule m_infinity

Rule m_infinity is an assignment rule for parameter m_infinity:

$$\mathrm{m\_infinity} = \frac{\mathrm{alpha\_m}}{\mathrm{alpha\_m} + \mathrm{beta\_m}} \tag{4}$$

6.5 Rule alpha_h

Rule alpha_h is an assignment rule for parameter alpha_h:

$$\mathrm{alpha\_h} = 0.07 \cdot \exp\left(\frac{25 - \mathrm{Vs}}{20}\right) \tag{5}$$

6.6 Rule beta_h

Rule beta_h is an assignment rule for parameter beta_h:

$$\mathrm{beta\_h} = \frac{1}{\exp\left(\frac{55-\mathrm{Vs}}{10}\right) + 1} \tag{6}$$

6.7 Rule h_infinity

Rule h_infinity is an assignment rule for parameter h_infinity:

$$\text{h\_infinity} = \frac{\text{alpha\_h}}{\text{alpha\_h} + \text{beta\_h}} \tag{7}$$

6.8 Rule tau_h

Rule tau_h is an assignment rule for parameter tau_h:

$$\text{tau\_h} = \frac{12.5}{\text{alpha\_h} + \text{beta\_h}} \tag{8}$$

6.9 Rule h1

Rule h1 is a rate rule for species h1:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{h1} = \frac{\text{h\_infinity} - [\text{h1}]}{\text{tau\_h}} \tag{9}$$

6.10 Rule i_Na

Rule i_Na is an assignment rule for parameter i_Na:

$$\text{i\_Na} = \text{g\_I} \cdot \text{m\_infinity}^3 \cdot [\text{h1}] \cdot (\text{V\_I} - [\text{V\_membrane}]) \tag{10}$$

6.11 Rule x_infinity

Rule x_infinity is an assignment rule for parameter x_infinity:

$$\text{x\_infinity} = \frac{1}{\exp\left(0.15 \cdot ([\text{V\_membrane}] - 50)\right) + 1} \tag{11}$$

6.12 Rule x1

Rule x1 is a rate rule for species x1:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{x1} = \frac{\text{x\_infinity} - [\text{x1}]}{\text{tau\_x}} \tag{12}$$

6.13 Rule i_Ca

Rule i_Ca is an assignment rule for parameter i_Ca:

$$\text{i\_Ca} = \text{g\_T} \cdot [\text{x1}] \cdot (\text{V\_I} - [\text{V\_membrane}]) \tag{13}$$

6.14 Rule alpha_n

Rule alpha_n is an assignment rule for parameter alpha_n:

$$\text{alpha\_n} = \frac{0.01 \cdot (55 - \text{Vs})}{\exp\left(\frac{55-\text{Vs}}{10}\right) - 1} \tag{14}$$

6.15 Rule beta_n

Rule beta_n is an assignment rule for parameter beta_n:

$$\text{beta\_n} = 0.125 \cdot \exp\left(\frac{45 - \text{Vs}}{80}\right) \tag{15}$$

6.16 Rule n_infinity

Rule n_infinity is an assignment rule for parameter n_infinity:

$$\text{n\_infinity} = \frac{\text{alpha\_n}}{\text{alpha\_n} + \text{beta\_n}} \tag{16}$$

6.17 Rule tau_n

Rule tau_n is an assignment rule for parameter tau_n:

$$\text{tau\_n} = \frac{12.5}{\text{alpha\_n} + \text{beta\_n}} \tag{17}$$

6.18 Rule n1

Rule n1 is a rate rule for species n1:

$$\frac{\text{d}}{\text{d}t}\text{n1} = \frac{\text{n\_infinity} - [\text{n1}]}{\text{tau\_n}} \tag{18}$$

6.19 Rule i_K

Rule i_K is an assignment rule for parameter i_K:

$$\text{i\_K} = \text{g\_K} \cdot [\text{n1}]^4 \cdot (\text{V\_K} - [\text{V\_membrane}]) \tag{19}$$

6.20 Rule c

Rule c is a rate rule for species c:

$$\frac{\text{d}}{\text{d}t}\text{c} = \text{f} \cdot (\text{K\_c} \cdot [\text{x1}] \cdot (\text{V\_Ca} - [\text{V\_membrane}]) - [\text{c}]) \tag{20}$$

6.21 Rule i_K_Ca

Rule i_K_Ca is an assignment rule for parameter i_K_Ca:

$$\mathrm{i\_K\_Ca} = \frac{\mathrm{g\_K\_Ca} \cdot [\mathrm{c}]}{\mathrm{K\_p} + [\mathrm{c}]} \cdot (\mathrm{V\_K} - [\mathrm{V\_membrane}]) \tag{21}$$

6.22 Rule i_L

Rule i_L is an assignment rule for parameter i_L:

$$\mathrm{i\_L} = \mathrm{g\_L} \cdot (\mathrm{V\_L} - [\mathrm{V\_membrane}]) \tag{22}$$

6.23 Rule V_membrane

Rule V_membrane is a rate rule for species V_membrane:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{V\_membrane} = \mathrm{i\_Na} + \mathrm{i\_Ca} + \mathrm{i\_K} + \mathrm{i\_K\_Ca} + \mathrm{i\_L} \tag{23}$$

7 Derived Rate Equations

When interpreted as an ordinary differential equation framework, this model implies the following set of equations for the rates of change of each species.

7.1 Species V_membrane

Name V

SBO:0000259 voltage

Initial concentration $-55 \ \mathrm{mol} \cdot \mathrm{l}^{-1}$

Involved in rule V_membrane

One rule which determines this species' quantity.

7.2 Species h1

Name h1

SBO:0000247 simple chemical

Initial concentration $0.9 \ \mathrm{mol} \cdot \mathrm{l}^{-1}$

Involved in rule h1

One rule which determines this species' quantity.

7.3 Species x1

Name x1

SBO:0000247 simple chemical

Initial concentration $0.27\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

Involved in rule x1

One rule which determines this species' quantity.

7.4 Species n1

Name n1

SBO:0000247 simple chemical

Initial concentration $0.03\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

Involved in rule n1

One rule which determines this species' quantity.

7.5 Species c

Name c

SBO:0000247 simple chemical

Initial concentration $0.4\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

Involved in rule c

One rule which determines this species' quantity.

A Glossary of Systems Biology Ontology Terms

SBO:0000247 **simple chemical:** Simple, non-repetitive chemical entity

SBO:0000259 **voltage:** Difference of electrical potential between two points of an electrical network, expressed in volts

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