SBML Model Report

Model name: "DeVries2000-_PancreaticBetaCells_InsulinSecretion"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Ishan Ajmera[1] and Catherine Lloyd[2] at September 28th 2011 at 9:16 p. m. and last time modified at April eighth 2016 at 5:05 p. m. Table 1 provides 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	3
events	0	constraints	0
reactions	0	function definitions	0
global parameters	24	unit definitions	0
rules	10	initial assignments	0

Model Notes

This a model from the article:
Channel sharing in pancreatic beta -cells revisited: enhancement of emergentbursting by noise.
De Vries G, Sherman A. J Theor Biol2000 Dec 21;207(4):513-30 11093836,

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Abstract:
Secretion of insulin by electrically coupled populations of pancreatic beta-cells is governed by bursting electrical activity. Isolated beta -cells,however, exhibit atypical bursting or continuous spike activity. We studybursting as an emergent property of the population, focussing on interactionsamong the subclass of spiking cells. These are modelled by equipping the fastsubsystem with a saddle-node-loop bifurcation, which makes it monostable. Suchcells can only spike tonically or remain silent when isolated, but can beinduced to burst with weak diffusive coupling. With stronger coupling, the cellsrevert to tonic spiking. We demonstrate that the addition of noise dramaticallyincreases, via a phenomenon like stochastic resonance, the coupling range overwhich bursting is seen. Copyright 2000 Academic Press.

This model was taken from the CellML repository and automatically converted to SBML.
The original model was: **De Vries G, Sherman A. (2000) - version01**

To cite BioModels Database, please use: Li C, Donizelli M, Rodriguez N, Dharuri H, Endler L, Chelliah V, Li L, He E, Henry A, Stefan MI, Snoep JL, Hucka M, Le Novre N, Laibe C (2010) BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models. BMC Syst Biol., 4:92.

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`	Compartment		3	1	litre	☑	

3.1 Compartment `Compartment`

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

Name Compartment

4 Species

This model contains three 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_membrane	`Compartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`n`	n	`Compartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`s`	s	`Compartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 24 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
tau_membrane	tau	0000345	20.000		☑
i_Ca	i_Ca		-7.445		☐
g_Ca	g_Ca	0000009	3.600		☑
V_Ca	V_Ca	0000009	25.000		☑
m_infinity	m_infinity		0.023		☐
V_m	V_m	0000009	-20.000		☑
theta_m	theta_m	0000009	12.000		☑
i_K	i_K		5.000		☐
V_K	V_K	0000009	-75.000		☑
g_K	g_K	0000009	10.000		☑
n_infinity	n_infinity		$1.89405943825186 \cdot 10^{-4}$		☐
V_n	V_n	0000009	-17.000		☑
theta_n	theta_n	0000009	5.600		☑
lamda	lamda	0000009	0.800		☑
tau-_potassium-_current_n-_gate	tau_2	0000345	20.000		☑
i_s	i_s		1.000		☐
g_s	g_s	0000009	4.000		☑
s_infinity	s_infinity		0.005		☐
V_s	V_s	0000009	-22.000		☑
theta_s	theta_s	0000009	8.000		☑
tau_s	tau_s	0000345	20000.000		☑
i_K_ATP	i_K_ATP		6.000		☐
g_K_ATP	g_K_ATP		1.200		☑
p	p	0000009	0.500		☑

6 Rules

This is an overview of ten rules.

6.1 Rule m_infinity

Rule m_infinity is an assignment rule for parameter m_infinity:

$$\mathrm{m\_infinity} = \frac{1}{1+\exp\left(\frac{\mathrm{V\_m}-[\mathrm{V\_membrane}]}{\mathrm{theta\_m}}\right)} \tag{1}$$

6.2 Rule i_Ca

Rule i_Ca is an assignment rule for parameter i_Ca:

$$\mathrm{i\_Ca} = \mathrm{g\_Ca} \cdot \mathrm{m\_infinity} \cdot ([\mathrm{V\_membrane}] - \mathrm{V\_Ca}) \tag{2}$$

6.3 Rule i_K

Rule i_K is an assignment rule for parameter i_K:

$$\mathrm{i\_K} = \mathrm{g\_K} \cdot [\mathrm{n}] \cdot ([\mathrm{V\_membrane}] - \mathrm{V\_K}) \tag{3}$$

6.4 Rule n_infinity

Rule n_infinity is an assignment rule for parameter n_infinity:

$$\mathrm{n\_infinity} = \frac{1}{1+\exp\left(\frac{\mathrm{V\_n}-[\mathrm{V\_membrane}]}{\mathrm{theta\_n}}\right)} \tag{4}$$

6.5 Rule i_s

Rule i_s is an assignment rule for parameter i_s:

$$\mathrm{i\_s} = \mathrm{g\_s} \cdot [\mathrm{s}] \cdot ([\mathrm{V\_membrane}] - \mathrm{V\_K}) \tag{5}$$

6.6 Rule s_infinity

Rule s_infinity is an assignment rule for parameter s_infinity:

$$\mathrm{s\_infinity} = \frac{1}{1+\exp\left(\frac{\mathrm{V\_s}-[\mathrm{V\_membrane}]}{\mathrm{theta\_s}}\right)} \tag{6}$$

6.7 Rule i_K_ATP

Rule i_K_ATP is an assignment rule for parameter i_K_ATP:

$$\mathrm{i\_K\_ATP} = \mathrm{g\_K\_ATP} \cdot \mathrm{p} \cdot ([\mathrm{V\_membrane}] - \mathrm{V\_K}) \tag{7}$$

6.8 Rule V_membrane

Rule V_membrane is a rate rule for species V_membrane:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{V\_membrane} = \frac{(\text{i\_Ca} + \text{i\_K} + \text{i\_K\_ATP} + \text{i\_s})}{\text{tau\_membrane}} \tag{8}$$

6.9 Rule n

Rule n is a rate rule for species n:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{n} = \frac{\text{lamda} \cdot (\text{n\_infinity} - [\text{n}])}{\text{tau\_potassium\_current\_n\_gate}} \tag{9}$$

6.10 Rule s

Rule s is a rate rule for species s:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{s} = \frac{\text{s\_infinity} - [\text{s}]}{\text{tau\_s}} \tag{10}$$

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_membrane

Initial amount -65 mol

Involved in rule V_membrane

One rule which determines this species' quantity.

7.2 Species n

Name n

Initial amount 0.05 mol

Involved in rule n

One rule which determines this species' quantity.

7.3 Species s

Name s

Initial amount 0.025 mol

Involved in rule s

One rule which determines this species' quantity.

A Glossary of Systems Biology Ontology Terms

SBO:0000009 kinetic constant: Numerical parameter that quantifies the velocity of a chemical reaction

SBO:0000345 time: Fundmental quantity of the measuring system used to sequence events, to compare the durations of events and the intervals between them, and to quantify the motions or the transformation of entities. The SI base unit for time is the SI second. The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom

SBML2LaTeX was developed by Andreas Dräger[a], Hannes Planatscher[a], Dieudonné M Wouamba[a], Adrian Schröder[a], Michael Hucka[b], Lukas Endler[c], Martin Golebiewski[d] and Andreas Zell[a]. Please see http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX for more information.

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