SBML Model Report

Model name: "Bertram2000-_PancreaticBetaCells_Oscillations"

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 29th 2011 at 10:15 p. m. and last time modified at May 28th 2014 at 8:48 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	4
events	0	constraints	0
reactions	0	function definitions	0
global parameters	32	unit definitions	0
rules	15	initial assignments	0

Model Notes

This a model from the article:
The phantom burster model for pancreatic beta-cells.
Bertram R, Previte J, Sherman A, Kinard TA, Satin LS. Biophys J2000 Dec;79(6):2880-92 11106596,

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Abstract:
Pancreatic beta-cells exhibit bursting oscillations with a wide range ofperiods. Whereas periods in isolated cells are generally either a few seconds ora few minutes, in intact islets of Langerhans they are intermediate (10-60 s).We develop a mathematical model for beta-cell electrical activity capable ofgenerating this wide range of bursting oscillations. Unlike previous models,bursting is driven by the interaction of two slow processes, one with arelatively small time constant (1-5 s) and the other with a much larger timeconstant (1-2 min). Bursting on the intermediate time scale is generated withoutneed for a slow process having an intermediate time constant, hence phantombursting. The model suggests that isolated cells exhibiting a fast pattern maynonetheless possess slower processes that can be brought out by injectingsuitable exogenous currents. Guided by this, we devise an experimental protocolusing the dynamic clamp technique that reliably elicits islet-like, mediumperiod oscillations from isolated cells. Finally, we show that strong electricalcoupling between a fast burster and a slow burster can produce synchronizedmedium bursting, suggesting that islets may be composed of cells that areintrinsically either fast or slow, with few or none that are intrinsicallymedium.

This model was taken from the CellML repository and automatically converted to SBML.
The original model was: **Bertram R, Previte J, Sherman A, Kinard TA, Satin LS. (2000) - version02**

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 four 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`	V	`Compartment`	$\text{mol} \cdot \text{l}^{-1}$	$\boxminus$	$\boxminus$
`n`	n	`Compartment`	$\text{mol} \cdot \text{l}^{-1}$	$\boxminus$	$\boxminus$
`s1`	s1	`Compartment`	$\text{mol} \cdot \text{l}^{-1}$	$\boxminus$	$\boxminus$
`s2`	s2	`Compartment`	$\text{mol} \cdot \text{l}^{-1}$	$\boxminus$	$\boxminus$

5 Parameters

This model contains 32 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Cm	Cm	0000258	4524.000		☑
Vm	Vm	0000009	−22.000		☑
VCa	VCa	0000009	100.000		☑
gCa	gCa	0000009	280.000		☑
minf	minf		0.057		☐
sm	sm	0000009	7.500		☑
ICa	ICa		−2295.260		☐
IK	IK		1443.000		☐
VK	VK	0000009	−80.000		☑
gK	gK		1300.000		☑
lambda	lambda	0000009	1.100		☑
tnbar	tnbar	0000009	8.300		☑
Vn	Vn	0000009	−9.000		☑
sn	sn	0000009	10.000		☑
taun	taun		8.032		☐
ninf	ninf		0.032		☐
Is1	Is1		74.000		☐
gs1	gs1	0000009	20.000		☑
s1inf	s1inf		0.002		☐
Vs1	Vs1	0000009	−40.000		☑
ss1	ss1	0000009	0.500		☑
taus1	taus1	0000009	1000.000		☑
Vs2	Vs2	0000009	−42.000		☑
s2inf	s2inf		0.076		☐
ss2	ss2	0000009	0.400		☑
gs2	gs2	0000009	32.000		☑
taus2	taus2	0000009	120000.000		☑
Is2	Is2		513.856		☐
Il	Il		−75.000		☐
gl	gl	0000009	25.000		☑
Vl	Vl	0000009	−40.000		☑
parameter_1	I1+I2		587.856		☐

6 Rules

This is an overview of 15 rules.

6.1 Rule `s1inf`

Rule `s1inf` is an assignment rule for parameter `s1inf`:

$$\mathrm{s1inf} = \frac{1}{1+\exp\left(\frac{\mathrm{Vs1}-[\mathrm{V}]}{\mathrm{ss1}}\right)} \tag{1}$$

6.2 Rule `minf`

Rule `minf` is an assignment rule for parameter `minf`:

$$\mathrm{minf} = \frac{1}{1+\exp\left(\frac{\mathrm{Vm}-[\mathrm{V}]}{\mathrm{sm}}\right)} \tag{2}$$

6.3 Rule `ICa`

Rule `ICa` is an assignment rule for parameter `ICa`:

$$\mathrm{ICa} = \mathrm{gCa}\cdot\mathrm{minf}\cdot([\mathrm{V}]-\mathrm{VCa}) \tag{3}$$

6.4 Rule `IK`

Rule `IK` is an assignment rule for parameter `IK`:

$$\mathrm{IK} = \mathrm{gK}\cdot[\mathrm{n}]\cdot([\mathrm{V}]-\mathrm{VK}) \tag{4}$$

6.5 Rule `taun`

Rule `taun` is an assignment rule for parameter `taun`:

$$\mathrm{taun} = \frac{\mathrm{tnbar}}{1+\exp\left(\frac{[\mathrm{V}]-\mathrm{Vn}}{\mathrm{sn}}\right)} \tag{5}$$

6.6 Rule `ninf`

Rule `ninf` is an assignment rule for parameter `ninf`:

$$\mathrm{ninf} = \frac{1}{1+\exp\left(\frac{\mathrm{Vn}-[\mathrm{V}]}{\mathrm{sn}}\right)} \tag{6}$$

6.7 Rule Is1

Rule Is1 is an assignment rule for parameter Is1:

$$\mathrm{Is1} = \mathrm{gs1} \cdot [\mathrm{s1}] \cdot ([\mathrm{V}] - \mathrm{VK}) \tag{7}$$

6.8 Rule s2inf

Rule s2inf is an assignment rule for parameter s2inf:

$$\mathrm{s2inf} = \frac{1}{1 + \exp\left(\frac{\mathrm{Vs2} - [\mathrm{V}]}{\mathrm{ss2}}\right)} \tag{8}$$

6.9 Rule Is2

Rule Is2 is an assignment rule for parameter Is2:

$$\mathrm{Is2} = \mathrm{gs2} \cdot [\mathrm{s2}] \cdot ([\mathrm{V}] - \mathrm{VK}) \tag{9}$$

6.10 Rule Il

Rule Il is an assignment rule for parameter Il:

$$\mathrm{Il} = \mathrm{gl} \cdot ([\mathrm{V}] - \mathrm{Vl}) \tag{10}$$

6.11 Rule parameter_1

Rule parameter_1 is an assignment rule for parameter parameter_1:

$$\mathrm{parameter\_1} = \mathrm{Is1} + \mathrm{Is2} \tag{11}$$

6.12 Rule V

Rule V is a rate rule for species V:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{V} = \frac{(\mathrm{ICa} + \mathrm{IK} + \mathrm{Il} + \mathrm{Is1} + \mathrm{Is2})}{\mathrm{Cm}} \tag{12}$$

6.13 Rule n

Rule n is a rate rule for species n:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{n} = \frac{\mathrm{ninf} - [\mathrm{n}]}{\mathrm{taun}} \tag{13}$$

6.14 Rule s1

Rule s1 is a rate rule for species s1:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s1} = \frac{\mathrm{s1inf} - [\mathrm{s1}]}{\mathrm{taus1}} \tag{14}$$

6.15 Rule `s2`

Rule `s2` is a rate rule for species `s2`:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s2} = \frac{\mathrm{s2inf} - [\mathrm{s2}]}{\mathrm{taus2}} \tag{15}$$

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`

Name V

SBO:0000259 voltage

Initial amount -43 mol

Involved in rule `V`

One rule which determines this species' quantity.

7.2 Species `n`

Name n

Initial amount 0.03 mol

Involved in rule `n`

One rule which determines this species' quantity.

7.3 Species `s1`

Name s1

Initial amount 0.1 mol

Involved in rule `s1`

One rule which determines this species' quantity.

7.4 Species s2

Name s2

Initial amount 0.434 mol

Involved in rule s2

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:0000258 **capacitance:** Measure of the amount of electric charge stored (or separated) for a given electric potential. The unit of capacitance id the Farad

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

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