SBML Model Report

Model name: "Bertram2004_PancreaticBetaCell_modelB"

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 10:04 p. m. and last time modified at April eighth 2016 at 5:06 p. m. Table 1 gives 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	7
events	0	constraints	0
reactions	0	function definitions	0
global parameters	113	unit definitions	0
rules	78	initial assignments	0

Model Notes

This a model from the article:
Calcium and glycolysis mediate multiple bursting modes in pancreatic islets.
Bertram R, Satin L, Zhang M, Smolen P, Sherman A. Biophys J2004 Nov;87(5):3074-87 15347584,
Abstract:

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Pancreatic islets of Langerhans produce bursts of electrical activity whenexposed to stimulatory glucose levels. These bursts often have a regularrepeating pattern, with a period of 10-60 s. In some cases, however, the burstsare episodic, clustered into bursts of bursts, which we call compound bursting.Consistent with this are recordings of free Ca2+ concentration, oxygenconsumption, mitochondrial membrane potential, and intraislet glucose levelsthat exhibit very slow oscillations, with faster oscillations superimposed. Wedescribe a new mathematical model of the pancreatic beta-cell that can accountfor these multimodal patterns. The model includes the feedback of cytosolic Ca2+onto ion channels that can account for bursting, and a metabolic subsystem thatis capable of producing slow oscillations driven by oscillations in glycolysis.This slow rhythm is responsible for the slow mode of compound bursting in themodel. We also show that it is possible for glycolytic oscillations alone todrive a very slow form of bursting, which we call „glycolytic bursting.„Finally, the model predicts that there is bistability between stationary andoscillatory glycolysis for a range of parameter values. We provide experimentalsupport for this model prediction. Overall, the model can account for adiversity of islet behaviors described in the literature over the past 20 years.

This model was taken from the CellML repository and automatically converted to SBML. The original model was:**Bertram R, Satin L, Zhang M, Smolen P, Sherman A. (2004) - version=1.0**
The original CellML model was created by:
Catherine Lloyd
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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 seven 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	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
n	n	COMpartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
c	c	COMpartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cer	cer	COMpartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
g6p	g6p	COMpartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
fbp	fbp	COMpartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
adp	adp	COMpartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 113 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
IK	IK		1012.500		⊟
ICa	ICa		−2927.842		⊟
IKCa	IKCa		1800.000		⊟
Cm	Cm	0000258	5300.000		☑
gK	gK	0000009	2700.000		☑
gKCa	gKCa	0000009	600.000		☑
kd	kd	0000009	0.500		☑
gCa	gCa	0000009	1000.000		☑
minf	minf		0.034		⊟
VCa	VCa	0000009	25.000		☑
taun	taun		20.000		☑
ninf	ninf		$1.50710358059757 \cdot 10^{-4}$		⊟
fcyt	fcyt	0000009	0.010		☑
Jmem	Jmem		−0.037		⊟
Jer	Jer		−0.063		⊟
fer	fer	0000009	0.010		☑
sigmaV	sigmaV	0000009	31.000		☑
pleak	pleak	0000009	$2 \cdot 10^{-4}$		☑
Kserca	Kserca	0000009	0.400		☑
lambdaer	lambdaer		1.000		☑
epser	epser	0000009	1.000		☑
alpha	alpha	0000009	$4.5 \cdot 10^{-6}$		☑
kpmca	kpmca	0000009	0.200		☑
Jserca	Jserca		0.100		⊟
Jleak	Jleak		0.037		⊟
rgpdh	rgpdh		1.265		⊟
Rgk	Rgk	0000009	0.200		☑
atot	atot		3000.000		☑
pfkbas	pfkbas	0000009	0.060		☑
f6p	f6p		60.000		⊟
lambda	lambda	0000009	0.005		☑
pfk	pfk		0.551		⊟
bottom1	bottom1		1.000		☑
topa1	topa1	0000009	0.000		☑
k1	k1	0000009	30.000		☑
k2	k2	0000009	1.000		☑
k3	k3	0000009	50000.000		☑

Id	Name	SBO	Value	Unit	Constant
k4	k4	0000009	1000.000		☑
cat	cat	0000009	2.000		☑
weight2	weight2		3609.038		⊟
topa2	topa2		0.000		⊟
bottom2	bottom2		3610.038		⊟
topa3	topa3		0.072		⊟
weight3	weight3		0.072		⊟
bottom3	bottom3		3610.110		⊟
famp	famp	0000009	0.020		☑
fatp	fatp	0000009	20.000		☑
ffbp	ffbp	0000009	0.200		☑
fbt	fbt	0000009	20.000		☑
fmt	fmt	0000009	20.000		☑
weight4	weight4		12.993		⊟
topa4	topa4		13.065		⊟
bottom4	bottom4		3623.102		⊟
weight5	weight5		40.000		⊟
topa5	topa5		13.065		⊟
bottom5	bottom5		3663.102		⊟
weight6	weight6		7218.076		⊟
topa6	topa6		13.065		⊟
bottom6	bottom6		10881.178		⊟
weight7	weight7		14.400		⊟
topa7	topa7		27.465		⊟
bottom7	bottom7		10895.578		⊟
weight8	weight8		129.925		⊟
topa8	topa8		157.390		⊟
bottom8	bottom8		11025.504		⊟
weight9	weight9		10.675		⊟
topa9	topa9		157.390		⊟
bottom9	bottom9		11036.179		⊟
weight10	weight10		1926.343		⊟
topa10	topa10		157.390		⊟
bottom10	bottom10		12962.522		⊟
weight11	weight11		38.430		⊟
topa11	topa11		195.820		⊟
bottom11	bottom11		13000.952		⊟
weight12	weight12		346.742		⊟
topa12	topa12		542.562		⊟
bottom12	bottom12		13347.694		⊟
weight13	weight13		427.004		⊟
topa13	topa13		542.562		⊟

Id	Name	SBO	Value	Unit	Constant
bottom13	bottom13		13774.698		☐
weight14	weight14		3852.686		☐
topa14	topa14		542.562		☐
bottom14	bottom14		17627.385		☐
weight15	weight15		7686.077		☐
topa15	topa15		542.562		☐
bottom15	bottom15		25313.462		☐
weight16	weight16		3467.418		☐
topa16	topa16		4009.980		☐
bottom16	bottom16		28780.880		☐
topb	topb		7686.077		☐
mgadp	mgadp		128.700		☐
adp3m	adp3m		105.300		☐
atp4m	atp4m		94.987		☐
topo	topo		52.301		☐
bottomo	bottomo		7348.241		☐
katpo	katpo		0.007		☐
IKATP	IKATP		2669.036		☐
VK	VK	0000009	−75.000		☑
gkatpbar	gkatpbar	0000009	25000.000		☑
kdd	kdd		17.000		☑
ktd	ktd	0000009	26.000		☑
ktt	ktt	0000009	1.000		☑
atp	atp		1899.747		☐
fback	fback		1.247		☐
taua	taua	0000009	300000.000		☑
r1	r1	0000009	0.350		☑
r	r	0000009	1.000		☑
y	y		0.247		☐
vg	vg		2.200		☑
kg	kg	0000009	10.000		☑
amp	amp		320.253		☐
rad	rad		1579.494		☐
ratio	ratio		2.436		☐

6 Rules

This is an overview of 78 rules.

6.1 Rule IK

Rule IK is an assignment rule for parameter IK:

$$\mathrm{IK} = \mathrm{gK} \cdot [\mathrm{n}] \cdot ([\mathrm{V}] - \mathrm{VK}) \tag{1}$$

6.2 Rule IKCa

Rule IKCa is an assignment rule for parameter IKCa:

$$\mathrm{IKCa} = \frac{\mathrm{gKCa}}{1 + \left(\frac{\mathrm{kd}}{[\mathrm{c}]}\right)^2} \cdot ([\mathrm{V}] - \mathrm{VK}) \tag{2}$$

6.3 Rule minf

Rule minf is an assignment rule for parameter minf:

$$\mathrm{minf} = \frac{1}{1 + \exp\left(\frac{\left(20 + \frac{[\mathrm{V}]}{1}\right)}{12}\right)} \tag{3}$$

6.4 Rule ICa

Rule ICa is an assignment rule for parameter ICa:

$$\mathrm{ICa} = \mathrm{gCa} \cdot \mathrm{minf} \cdot ([\mathrm{V}] - \mathrm{VCa}) \tag{4}$$

6.5 Rule ninf

Rule ninf is an assignment rule for parameter ninf:

$$\mathrm{ninf} = \frac{1}{1 + \exp\left(\frac{\left(16 + \frac{[\mathrm{V}]}{1}\right)}{5}\right)} \tag{5}$$

6.6 Rule Jmem

Rule Jmem is an assignment rule for parameter Jmem:

$$\mathrm{Jmem} = (\mathrm{alpha} \cdot \mathrm{ICa} + \mathrm{kpmca} \cdot [\mathrm{c}]) \tag{6}$$

Derived unit $\mathrm{mol} \cdot \mathrm{l}^{-1}$

6.7 Rule Jserca

Rule Jserca is an assignment rule for parameter Jserca:

$$\mathrm{Jserca} = \mathrm{Kserca} \cdot [\mathrm{c}] \tag{7}$$

6.8 Rule `Jleak`

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

$$\text{Jleak} = \text{pleak} \cdot ([\text{cer}] - [\text{c}]) \tag{8}$$

6.9 Rule `Jer`

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

$$\text{Jer} = \frac{\text{epser} \cdot (\text{Jleak} - \text{Jserca})}{\text{lambdaer}} \tag{9}$$

6.10 Rule `rgpdh`

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

$$\text{rgpdh} = 0.2 \cdot \left(\left| \frac{[\text{fbp}] \cdot 1}{1^2} \right| \right)^{\frac{1}{2}} \tag{10}$$

6.11 Rule `f6p`

Rule `f6p` is an assignment rule for parameter `f6p`:

$$\text{f6p} = 0.3 \cdot [\text{g6p}] \tag{11}$$

6.12 Rule `topa2`

Rule `topa2` is an assignment rule for parameter `topa2`:

$$\text{topa2} = \text{topa1} \tag{12}$$

6.13 Rule `weight3`

Rule `weight3` is an assignment rule for parameter `weight3`:

$$\text{weight3} = \frac{\text{f6p}^2}{\text{k3} \cdot 1} \tag{13}$$

6.14 Rule `topa3`

Rule `topa3` is an assignment rule for parameter `topa3`:

$$\text{topa3} = \text{topa2} + \text{weight3} \tag{14}$$

6.15 Rule `weight5`

Rule `weight5` is an assignment rule for parameter `weight5`:

$$\text{weight5} = \frac{[\text{fbp}]}{\text{k2}} \tag{15}$$

6.16 Rule weight7

Rule weight7 is an assignment rule for parameter weight7:

$$\text{weight7} = \frac{[\text{fbp}] \cdot \text{f6p}^2}{\text{k2} \cdot \text{k3} \cdot \text{ffbp} \cdot 1} \tag{16}$$

6.17 Rule mgadp

Rule mgadp is an assignment rule for parameter mgadp:

$$\text{mgadp} = 0.165 \cdot [\text{adp}] \tag{17}$$

6.18 Rule adp3m

Rule adp3m is an assignment rule for parameter adp3m:

$$\text{adp3m} = 0.135 \cdot [\text{adp}] \tag{18}$$

6.19 Rule topo

Rule topo is an assignment rule for parameter topo:

$$\text{topo} = 0.08 \cdot \left(1 + \frac{2 \cdot \text{mgadp}}{\text{kdd} \cdot 1}\right) + 0.89 \cdot \left(\frac{\text{mgadp}}{\text{kdd} \cdot 1}\right)^2 \tag{19}$$

6.20 Rule y

Rule y is an assignment rule for parameter y:

$$\text{y} = \text{vg} \cdot \frac{\text{rgpdh}}{\text{kg} + \text{rgpdh}} \tag{20}$$

6.21 Rule fback

Rule fback is an assignment rule for parameter fback:

$$\text{fback} = \text{r} + \text{y} \tag{21}$$

6.22 Rule rad

Rule rad is an assignment rule for parameter rad:

$$\text{rad} = \frac{\left(\left|([\text{adp}] - \text{atot})^2 - 4 \cdot [\text{adp}]^2\right|\right)^{\frac{1}{2}}}{1} \tag{22}$$

6.23 Rule atp

Rule atp is an assignment rule for parameter atp:

$$\text{atp} = 0.5 \cdot (\text{atot} - [\text{adp}] + \text{rad} \cdot 1) \tag{23}$$

6.24 Rule weight2

Rule weight2 is an assignment rule for parameter weight2:

$$\text{weight2} = \frac{\text{atp}^2}{\text{k4} \cdot 1} \tag{24}$$

6.25 Rule bottom2

Rule bottom2 is an assignment rule for parameter bottom2:

$$\text{bottom2} = \text{bottom1} + \text{weight2} \tag{25}$$

6.26 Rule bottom3

Rule bottom3 is an assignment rule for parameter bottom3:

$$\text{bottom3} = \text{bottom2} + \text{weight3} \tag{26}$$

6.27 Rule weight4

Rule weight4 is an assignment rule for parameter weight4:

$$\text{weight4} = \frac{(\text{f6p} \cdot \text{atp})^2}{\text{fatp} \cdot \text{k3} \cdot \text{k4} \cdot 1^2} \tag{27}$$

6.28 Rule topa4

Rule topa4 is an assignment rule for parameter topa4:

$$\text{topa4} = \text{topa3} + \text{weight4} \tag{28}$$

6.29 Rule bottom4

Rule bottom4 is an assignment rule for parameter bottom4:

$$\text{bottom4} = \text{bottom3} + \text{weight4} \tag{29}$$

6.30 Rule topa5

Rule topa5 is an assignment rule for parameter topa5:

$$\text{topa5} = \text{topa4} \tag{30}$$

6.31 Rule bottom5

Rule bottom5 is an assignment rule for parameter bottom5:

$$\text{bottom5} = \text{bottom4} + \text{weight5} \tag{31}$$

6.32 Rule weight6

Rule weight6 is an assignment rule for parameter weight6:

$$\text{weight6} = \frac{[\text{fbp}] \cdot \text{atp}^2}{\text{k2} \cdot \text{k4} \cdot \text{fbt} \cdot 1} \tag{32}$$

6.33 Rule topa6

Rule topa6 is an assignment rule for parameter topa6:

$$\text{topa6} = \text{topa5} \tag{33}$$

6.34 Rule bottom6

Rule bottom6 is an assignment rule for parameter bottom6:

$$\text{bottom6} = \text{bottom5} + \text{weight6} \tag{34}$$

6.35 Rule topa7

Rule topa7 is an assignment rule for parameter topa7:

$$\text{topa7} = \text{topa6} + \text{weight7} \tag{35}$$

6.36 Rule bottom7

Rule bottom7 is an assignment rule for parameter bottom7:

$$\text{bottom7} = \text{bottom6} + \text{weight7} \tag{36}$$

6.37 Rule weight8

Rule weight8 is an assignment rule for parameter weight8:

$$\text{weight8} = \frac{[\text{fbp}] \cdot \text{f6p}^2 \cdot \text{atp}^2}{\text{k2} \cdot \text{k3} \cdot \text{k4} \cdot \text{ffbp} \cdot \text{fbt} \cdot \text{fatp} \cdot 1^2} \tag{37}$$

6.38 Rule topa8

Rule topa8 is an assignment rule for parameter topa8:

$$\text{topa8} = \text{topa7} + \text{weight8} \tag{38}$$

6.39 Rule topa9

Rule topa9 is an assignment rule for parameter topa9:

$$\text{topa9} = \text{topa8} \tag{39}$$

6.40 Rule bottom8

Rule bottom8 is an assignment rule for parameter bottom8:

$$\text{bottom8} = \text{bottom7} + \text{weight8} \tag{40}$$

6.41 Rule topa10

Rule topa10 is an assignment rule for parameter topa10:

$$\text{topa10} = \text{topa9} \tag{41}$$

6.42 Rule atp4m

Rule atp4m is an assignment rule for parameter atp4m:

$$\text{atp4m} = 0.05 \cdot \text{atp} \tag{42}$$

6.43 Rule bottomo

Rule bottomo is an assignment rule for parameter bottomo:

$$\text{bottomo} = \left(1 + \frac{\text{mgadp}}{\text{kdd} \cdot 1}\right)^2 \cdot \left(1 + \frac{\text{adp3m}}{\text{ktd} \cdot 1} + \frac{\text{atp4m}}{\text{ktt} \cdot 1}\right) \tag{43}$$

6.44 Rule katpo

Rule katpo is an assignment rule for parameter katpo:

$$\text{katpo} = \frac{\text{topo}}{\text{bottomo}} \tag{44}$$

6.45 Rule IKATP

Rule IKATP is an assignment rule for parameter IKATP:

$$\text{IKATP} = \text{gkatpbar} \cdot \text{katpo} \cdot ([\text{V}] - \text{VK}) \tag{45}$$

6.46 Rule amp

Rule amp is an assignment rule for parameter amp:

$$\text{amp} = \frac{[\text{adp}] \cdot [\text{adp}]}{\text{atp}} \tag{46}$$

6.47 Rule weight9

Rule weight9 is an assignment rule for parameter weight9:

$$\text{weight9} = \frac{\text{amp}}{\text{k1}} \tag{47}$$

6.48 Rule bottom9

Rule bottom9 is an assignment rule for parameter bottom9:

$$\text{bottom9} = \text{bottom8} + \text{weight9} \tag{48}$$

6.49 Rule weight10

Rule weight10 is an assignment rule for parameter weight10:

$$\text{weight10} = \frac{\text{amp} \cdot \text{atp}^2}{\text{k1} \cdot \text{k4} \cdot \text{fmt} \cdot 1} \tag{49}$$

6.50 Rule bottom10

Rule bottom10 is an assignment rule for parameter bottom10:

$$\text{bottom10} = \text{bottom9} + \text{weight10} \tag{50}$$

6.51 Rule weight11

Rule weight11 is an assignment rule for parameter weight11:

$$\text{weight11} = \frac{\text{amp} \cdot \text{f6p}^2}{\text{k1} \cdot \text{k3} \cdot \text{famp} \cdot 1} \tag{51}$$

6.52 Rule topa11

Rule topa11 is an assignment rule for parameter topa11:

$$\text{topa11} = \text{topa10} + \text{weight11} \tag{52}$$

6.53 Rule bottom11

Rule bottom11 is an assignment rule for parameter bottom11:

$$\text{bottom11} = \text{bottom10} + \text{weight11} \tag{53}$$

6.54 Rule weight12

Rule weight12 is an assignment rule for parameter weight12:

$$\text{weight12} = \frac{\text{amp} \cdot \text{f6p}^2 \cdot \text{atp}^2}{\text{k1} \cdot \text{k3} \cdot \text{k4} \cdot \text{famp} \cdot \text{fmt} \cdot \text{fatp} \cdot 1^2} \tag{54}$$

6.55 Rule topa12

Rule topa12 is an assignment rule for parameter topa12:

$$\text{topa12} = \text{topa11} + \text{weight12} \tag{55}$$

6.56 Rule bottom12

Rule bottom12 is an assignment rule for parameter bottom12:

$$\text{bottom12} = \text{bottom11} + \text{weight12} \tag{56}$$

6.57 Rule weight13

Rule weight13 is an assignment rule for parameter weight13:

$$\text{weight13} = \frac{\text{amp} \cdot [\text{fbp}]}{\text{k1} \cdot \text{k2}} \tag{57}$$

6.58 Rule topa13

Rule topa13 is an assignment rule for parameter topa13:

$$\text{topa13} = \text{topa12} \tag{58}$$

6.59 Rule bottom13

Rule bottom13 is an assignment rule for parameter bottom13:

$$\text{bottom13} = \text{bottom12} + \text{weight13} \tag{59}$$

6.60 Rule weight14

Rule weight14 is an assignment rule for parameter weight14:

$$\text{weight14} = \frac{\text{amp} \cdot [\text{fbp}] \cdot \text{atp}^2}{\text{k1} \cdot \text{k2} \cdot \text{k4} \cdot \text{fbt} \cdot \text{fmt} \cdot 1} \tag{60}$$

6.61 Rule topa14

Rule topa14 is an assignment rule for parameter topa14:

$$\text{topa14} = \text{topa13} \tag{61}$$

6.62 Rule bottom14

Rule bottom14 is an assignment rule for parameter bottom14:

$$\text{bottom14} = \text{bottom13} + \text{weight14} \tag{62}$$

6.63 Rule weight15

Rule weight15 is an assignment rule for parameter weight15:

$$\text{weight15} = \frac{\text{amp} \cdot [\text{fbp}] \cdot \text{f6p}^2}{\text{k1} \cdot \text{k2} \cdot \text{k3} \cdot \text{ffbp} \cdot \text{famp} \cdot 1} \tag{63}$$

6.64 Rule topa15

Rule topa15 is an assignment rule for parameter topa15:

$$\text{topa15} = \text{topa14} \tag{64}$$

6.65 Rule bottom15

Rule bottom15 is an assignment rule for parameter bottom15:

$$\text{bottom15} = \text{bottom14} + \text{weight15} \tag{65}$$

6.66 Rule weight16

Rule weight16 is an assignment rule for parameter weight16:

$$\text{weight16} = \frac{\text{amp} \cdot [\text{fbp}] \cdot \text{f6p}^2 \cdot \text{atp}^2}{\text{k1} \cdot \text{k2} \cdot \text{k3} \cdot \text{k4} \cdot \text{ffbp} \cdot \text{famp} \cdot \text{fbt} \cdot \text{fmt} \cdot \text{fatp} \cdot 1^2} \tag{66}$$

6.67 Rule topa16

Rule topa16 is an assignment rule for parameter topa16:

$$\text{topa16} = \text{topa15} + \text{weight16} \tag{67}$$

6.68 Rule bottom16

Rule bottom16 is an assignment rule for parameter bottom16:

$$\text{bottom16} = \text{bottom15} + \text{weight16} \tag{68}$$

6.69 Rule topb

Rule topb is an assignment rule for parameter topb:

$$\text{topb} = \text{weight15} \tag{69}$$

6.70 Rule pfk

Rule pfk is an assignment rule for parameter pfk:

$$\text{pfk} = 1 \cdot \frac{\text{pfkbas} \cdot \text{cat} \cdot \text{topa16} + \text{cat} \cdot \text{topb}}{\text{bottom16}} \tag{70}$$

6.71 Rule `ratio`

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

$$\text{ratio} = \frac{\text{atp}}{[\text{adp}]} \tag{71}$$

6.72 Rule `V`

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{V} = \frac{(\text{IK} + \text{ICa} + \text{IKCa} + \text{IKATP})}{\text{Cm}} \tag{72}$$

6.73 Rule `n`

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{n} = \frac{\text{ninf} - [\text{n}]}{\text{taun}} \tag{73}$$

6.74 Rule `c`

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{c} = \text{fcyt} \cdot (\text{Jmem} + \text{Jer}) \tag{74}$$

6.75 Rule `cer`

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cer} = \text{fer} \cdot \text{sigmaV} \cdot \text{Jer} \tag{75}$$

6.76 Rule `g6p`

Rule `g6p` is a rate rule for species `g6p`:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{g6p} = \text{lambda} \cdot (\text{Rgk} - \text{pfk}) \tag{76}$$

6.77 Rule `fbp`

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{fbp} = \text{lambda} \cdot \left(\frac{\text{pfk}}{1} - 0.5 \cdot \text{rgpdh}\right) \tag{77}$$

6.78 Rule adp

Rule adp is a rate rule for species adp:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{adp} = \frac{\mathrm{atp} - [\mathrm{adp}] \cdot \exp\left(\mathrm{fback} \cdot \left(1 - \frac{[\mathrm{c}]}{\mathrm{r1}}\right)\right)}{\mathrm{taua} \cdot 1} \tag{78}$$

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 −60 mol

Involved in rule V

One rule which determines this species' quantity.

7.2 Species n

Name n

Initial amount 0.025 mol

Involved in rule n

One rule which determines this species' quantity.

7.3 Species c

Name c

Initial amount 0.25 mol

Involved in rule c

One rule which determines this species' quantity.

7.4 Species `cer`

Name cer

Initial amount 185 mol

Involved in rule `cer`

One rule which determines this species' quantity.

7.5 Species `g6p`

Name g6p

Initial amount 200 mol

Involved in rule `g6p`

One rule which determines this species' quantity.

7.6 Species `fbp`

Name fbp

Initial amount 40 mol

Involved in rule `fbp`

One rule which determines this species' quantity.

7.7 Species `adp`

Name adp

Initial amount 780 mol

Involved in rule `adp`

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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