SBML Model Report

Model name: "Tolic2000_InsulinGlucoseFeedback"

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 28$^{\text{th}}$ 2011 at 9:30 p. m. and last time modified at October tenth 2014 at 10:30 a. 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	6
events	0	constraints	0
reactions	0	function definitions	0
global parameters	29	unit definitions	0
rules	14	initial assignments	0

Model Notes

This a model from the article:
Modeling the insulin-glucose feedback system: the significance of pulsatileinsulin secretion.
Tolic IM, Mosekilde E, Sturis J. J Theor Biol2000 Dec 7;207(3):361-75 11082306,

[1]EMBL-EBI, ajmera@ebi.ac.uk
[2]The University of Auckland,The Bioengineering Institute, c.lloyd@aukland.ac.nz

Abstract:
A mathematical model of the insulin-glucose feedback regulation in man is usedto examine the effects of an oscillatory supply of insulin compared to aconstant supply at the same average rate. We show that interactions between theoscillatory insulin supply and the receptor dynamics can be of minutesignificance only. It is possible, however, to interpret seemingly conflictingresults of clinical studies in terms of their different experimental conditionswith respect to the hepatic glucose release. If this release is operating nearan upper limit, an oscillatory insulin supply will be more efficient in loweringthe blood glucose level than a constant supply. If the insulin level is highenough for the hepatic release of glucose to nearly vanish, the opposite effectis observed. For insulin concentrations close to the point of inflection of theinsulin-glucose dose-response curve an oscillatory and a constant insulininfusion produce similar effects. Copyright 2000 Academic Press.

This model was taken from the CellML repository and automatically converted to SBML.
The original model was:**Tolic IM, Mosekilde E, Sturis J. (2000) - version=1.0**

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 six 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
`x1`	x1	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`x2`	x2	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`x3`	x3	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`G`	G	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`Ii`	Ii	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$
`Ip`	Ip	`COMpartment`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$

5 Parameters

This model contains 29 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Vp	Vp	0000468	3.000		☑
Vi	Vi	0000468	11.000		☑
Vg	Vg	0000468	10.000		☑
E	E	0000009	0.200		☑
Ip_conc	Ip_conc	0000196	31.121		☐
tp	tp	0000345	6.000		☑
td	td	0000345	36.000		☑
f1_G	f1_G		15.175		☐
Rm	Rm	0000009	210.000		☑
C1	C1	0000009	2000.000		☑
a1	a1	0000009	300.000		☑
Ii_conc	Ii_conc		22.117		☐
ti	ti	0000345	100.000		☑
G_conc	G_conc		123.426		☐
Gin	Gin	0000009	216.000		☑
f2_G	f2_G		71.986		☐
f3_G	f3_G		1.234		☐
f4_Ii	f4_Ii		204.190		☐
f5_x3	f5_x3		12.795		☐
C2	C2	0000009	144.000		☑
C3	C3	0000009	1000.000		☑
C4	C4	0000009	80.000		☑
C5	C5	0000009	26.000		☑
U0	U0	0000009	40.000		☑
Um	Um	0000009	940.000		☑
Ub	Ub	0000009	72.000		☑
beta	beta	0000009	1.770		☑
Rg	Rg	0000009	180.000		☑
alpha	alpha	0000009	0.290		☑

6 Rules

This is an overview of 14 rules.

6.1 Rule f1_G

Rule f1_G is an assignment rule for parameter f1_G:

$$\mathrm{f1\_G} = \frac{\mathrm{Rm}}{1 + \exp\left(\frac{\mathrm{C1} - \frac{[\mathrm{G}]}{\mathrm{Vg}}}{\mathrm{a1}}\right)} \tag{1}$$

6.2 Rule Ip_conc

Rule Ip_conc is an assignment rule for parameter Ip_conc:

$$\mathrm{Ip\_conc} = \frac{[\mathrm{Ip}]}{\mathrm{Vp}} \tag{2}$$

6.3 Rule Ii_conc

Rule Ii_conc is an assignment rule for parameter Ii_conc:

$$\mathrm{Ii\_conc} = \frac{[\mathrm{Ii}]}{\mathrm{Vi}} \tag{3}$$

6.4 Rule G_conc

Rule G_conc is an assignment rule for parameter G_conc:

$$\mathrm{G\_conc} = \frac{[\mathrm{G}]}{\mathrm{Vg} \cdot 10} \tag{4}$$

6.5 Rule f2_G

Rule f2_G is an assignment rule for parameter f2_G:

$$\mathrm{f2\_G} = \mathrm{Ub} \cdot \left(1 - \exp\left(\frac{[\mathrm{G}]}{\mathrm{C2} \cdot \mathrm{Vg}}\right)\right) \tag{5}$$

6.6 Rule f3_G

Rule f3_G is an assignment rule for parameter f3_G:

$$\mathrm{f3\_G} = \frac{[\mathrm{G}]}{\mathrm{C3} \cdot \mathrm{Vg}} \tag{6}$$

6.7 Rule f4_Ii

Rule f4_Ii is an assignment rule for parameter f4_Ii:

$$\mathrm{f4\_Ii} = \mathrm{U0} + \frac{\mathrm{Um} - \mathrm{U0}}{1 + \exp\left(\mathrm{beta} \cdot \left(\frac{[\mathrm{Ii}]}{\mathrm{C4}} \cdot \left(\frac{1}{\mathrm{Vi}} + \frac{1}{\mathrm{E} \cdot \mathrm{ti}}\right)\right)\right)} \tag{7}$$

6.8 Rule f5_x3

Rule f5_x3 is an assignment rule for parameter f5_x3:

$$\mathrm{f5\_x3} = \frac{\mathrm{Rg}}{1 + \exp\left(\mathrm{alpha} \cdot \left(\frac{[\mathrm{x3}] \cdot 1}{\mathrm{Vp}} - \mathrm{C5}\right)\right)} \tag{8}$$

6.9 Rule Ip

Rule Ip is a rate rule for species Ip:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ip} = \mathrm{f1\_G} - \left(\mathrm{E} \cdot \left(\frac{[\mathrm{Ip}]}{\mathrm{Vp}} - \frac{[\mathrm{Ii}]}{\mathrm{Vi}}\right) + \frac{[\mathrm{Ip}]}{\mathrm{tp}}\right) \tag{9}$$

6.10 Rule Ii

Rule Ii is a rate rule for species Ii:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ii} = \mathrm{E} \cdot \left(\frac{[\mathrm{Ip}]}{\mathrm{Vp}} - \frac{[\mathrm{Ii}]}{\mathrm{Vi}}\right) - \frac{[\mathrm{Ii}]}{\mathrm{ti}} \tag{10}$$

6.11 Rule G

Rule G is a rate rule for species G:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{G} = \mathrm{Gin} + \mathrm{f5\_x3} + ((\mathrm{f2\_G} + \mathrm{f3\_G} \cdot \mathrm{f4\_Ii})) \tag{11}$$

6.12 Rule x3

Rule x3 is a rate rule for species x3:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{x3} = \frac{3}{\mathrm{td}} \cdot ([\mathrm{x2}] - [\mathrm{x3}]) \tag{12}$$

6.13 Rule x1

Rule x1 is a rate rule for species x1:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{x1} = \frac{3}{\mathrm{td}} \cdot \left(\frac{[\mathrm{Ip}]}{1} - [\mathrm{x1}]\right) \tag{13}$$

6.14 Rule x2

Rule x2 is a rate rule for species x2:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{x2} = \frac{3}{\mathrm{td}} \cdot ([\mathrm{x1}] - [\mathrm{x2}]) \tag{14}$$

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 x1

Name x1

SBO:0000225 delay

Initial amount 110.420253 mol

Involved in rule x1

One rule which determines this species' quantity.

7.2 Species x2

Name x2

SBO:0000225 delay

Initial amount 112.7601171 mol

Involved in rule x2

One rule which determines this species' quantity.

7.3 Species x3

Name x3

SBO:0000225 delay

Initial amount 104.5878705 mol

Involved in rule x3

One rule which determines this species' quantity.

7.4 Species G

Name G

Initial amount 12342.61665 mol

Involved in rule G

One rule which determines this species' quantity.

7.5 Species `Ii`

Name Ii

Initial amount 243.2865183 mol

Involved in rule `Ii`

One rule which determines this species' quantity.

7.6 Species `Ip`

Name Ip

Initial amount 93.36441699 mol

Involved in rule `Ip`

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:0000196 **concentration of an entity pool:** The amount of an entity per unit of volume.

SBO:0000225 **delay:** Time during which some action is awaited

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

SBO:0000468 **volume:** A quantity representing the three-dimensional space occupied by all or part of an object

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.

[a]Center for Bioinformatics Tübingen (ZBIT), Germany
[b]California Institute of Technology, Beckman Institute BNMC, Pasadena, United States
[c]European Bioinformatics Institute, Wellcome Trust Genome Campus, Hinxton, United Kingdom
[d]EML Research gGmbH, Heidelberg, Germany