SBML Model Report

Model name: “Ratushny2012_ASSURE_I”

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: Vijayalakshmi Chelliah[1] and Alexander Ratushny[2] at May tenth 2012 at 5:52 p. m. and last time modified at July eleventh 2012 at 6:15 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	2
events	0	constraints	0
reactions	4	function definitions	0
global parameters	11	unit definitions	0
rules	2	initial assignments	0

Model Notes

This model is from the article:
Asymmetric positive feedback loops reliably control biological responses
Alexander V Ratushny, Ramsey A Saleem, Katherine Sitko, Stephen A Ramsey & John D Aitchison Mol Syst Biol. 2012 Apr 24;8:577. 22531117 ,
Abstract:

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Positive feedback is a common mechanism enabling biological systems to respond to stimuli in a switch-like manner. Such systems are often characterized by the requisite formation of a heterodimer where only one of the pair is subject to feedback. This ASymmetric Self-UpREgulation (ASSURE) motif is central to many biological systems, including cholesterol homeostasis (LXR/RXR), adipocyte differentiation (PPAR/RXR), development and differentiation (RAR/RXR), myogenesis (MyoD/E12) and cellular antiviral defense (IRF3/IRF7). To understand why this motif is so prevalent, we examined its properties in an evolutionarily conserved transcriptional regulatory network in yeast (Oaf1p/Pip2p). We demonstrate that the asymmetry in positive feedback confers a competitive advantage and allows the system to robustly increase its responsiveness while precisely tuning the response to a consistent level in the presence of varying stimuli. This study reveals evolutionary advantages for the ASSURE motif, and mechanisms for control, that are relevant to pharmacologic intervention and synthetic biology applications.

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
univ		0000290	3	1	litre	☑	

3.1 Compartment univ

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

SBO:0000290 physical compartment

4 Species

This model contains two species. Section 8 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
P2		univ	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Target		univ	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains eleven global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kd			10^{-5}		☑
Ksp			0.001		☑
P1			40.000		☑
dsp1ksp			0.000		☐
dsp1p2kd			0.000		☐
h			2.000		☑
k0			0.100		☑
ka			40.000		☑
ks			10.000		☑
ku			0.100		☑
s			1000.000		☑

6 Rules

This is an overview of two rules.

6.1 Rule dsp1ksp

Rule dsp1ksp is an assignment rule for parameter dsp1ksp:

$$\mathrm{dsp1ksp} = \frac{\mathrm{Ksp}}{2} \cdot \left(1 + \frac{\mathrm{s} + \mathrm{P1}}{\mathrm{Ksp}} - \left(\left(1 + \frac{\mathrm{s} + \mathrm{P1}}{\mathrm{Ksp}}\right)^2 - \frac{4 \cdot \mathrm{s} \cdot \mathrm{P1}}{\mathrm{Ksp}^2}\right)^{0.5}\right) \tag{1}$$

6.2 Rule dsp1p2kd

Rule dsp1p2kd is an assignment rule for parameter dsp1p2kd:

$$\begin{aligned}\mathrm{dsp1p2kd} = \frac{\mathrm{Kd}}{2} \cdot \Bigg(1 + \frac{\mathrm{dsp1ksp} + [\mathrm{P2}] \cdot \mathrm{vol}(\mathrm{univ})}{\mathrm{Kd}} \\ - \left(\left(1 + \frac{\mathrm{dsp1ksp} + [\mathrm{P2}] \cdot \mathrm{vol}(\mathrm{univ})}{\mathrm{Kd}}\right)^2 - \frac{4 \cdot \mathrm{dsp1ksp} \cdot [\mathrm{P2}] \cdot \mathrm{vol}(\mathrm{univ})}{\mathrm{Kd}^2}\right)^{0.5}\Bigg)\end{aligned} \tag{2}$$

7 Reactions

This model contains four reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	___r1		$\emptyset \longrightarrow$ P2	
2	___r2		P2 $\longrightarrow \emptyset$	
3	___r3		$\emptyset \longrightarrow$ Target	
4	___r4		Target $\longrightarrow \emptyset$	

7.1 Reaction ___r1

This is an irreversible reaction of no reactant forming one product.

Reaction equation

$$\emptyset \longrightarrow \mathrm{P2} \tag{3}$$

Product

Table 6: Properties of each product.

Id	Name	SBO
P2		

Kinetic Law

Derived unit not available

$$v_1 = \frac{\mathrm{ks} \cdot \left(\mathrm{k0} + \left(\frac{\mathrm{dsp1p2kd}}{\mathrm{ka}} \right)^{\mathrm{h}} \right)}{1 + \left(\frac{\mathrm{dsp1p2kd}}{\mathrm{ka}} \right)^{\mathrm{h}}} \tag{4}$$

7.2 Reaction ___r2

This is an irreversible reaction of one reactant forming no product.

Reaction equation

$$\mathrm{P2} \longrightarrow \emptyset \tag{5}$$

Reactant

Table 7: Properties of each reactant.

Id	Name	SBO
P2		

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \_\_\mathrm{RATE}\_\_ \cdot [\mathrm{P2}] \tag{6}$$

Table 8: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
__RATE__			0.1		☑

7.3 Reaction ___r3

This is an irreversible reaction of no reactant forming one product.

Reaction equation

$$\emptyset \longrightarrow \text{Target} \tag{7}$$

Product

Table 9: Properties of each product.

Id	Name	SBO
Target		

Kinetic Law

Derived unit not available

$$v_3 = \frac{\text{ks} \cdot \left(\text{k0} + \left(\frac{\text{dsp1p2kd}}{\text{ka}}\right)^{\text{h}}\right)}{1 + \left(\frac{\text{dsp1p2kd}}{\text{ka}}\right)^{\text{h}}} \tag{8}$$

7.4 Reaction ___r4

This is an irreversible reaction of one reactant forming no product.

Reaction equation

$$\text{Target} \longrightarrow \emptyset \tag{9}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
Target		

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \_\_\text{RATE}\_\_ \cdot [\text{Target}] \tag{10}$$

Table 11: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
__RATE__			0.1		☑

8 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.

Identifiers for kinetic laws highlighted in gray cannot be verified to evaluate to units of SBML `substance` per `time`. As a result, some SBML interpreters may not be able to verify the consistency of the units on quantities in the model. Please check if

- parameters without an unit definition are involved or
- volume correction is necessary because the `hasOnlySubstanceUnits` flag may be set to `false` and `spacialDimensions`> 0 for certain species.

8.1 Species P2

SBO:0000252 polypeptide chain

Initial amount 10 mol

This species takes part in two reactions (as a reactant in ___r2 and as a product in ___r1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{P2} = v_1 - v_2 \tag{11}$$

8.2 Species Target

SBO:0000011 product

Initial amount 10 mol

This species takes part in two reactions (as a reactant in ___r4 and as a product in ___r3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Target} = v_3 - v_4 \tag{12}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000011 product: Substance that is produced in a reaction. In a chemical equation the Products are the elements or compounds on the right hand side of the reaction equation. A product can be produced and consumed by the same reaction, its global quantity remaining unchanged

SBO:0000252 polypeptide chain: Naturally occurring macromolecule formed by the repetition of amino-acid residues linked by peptidic bonds. A polypeptide chain is synthesized by the ribosome. CHEBI:1654

SBO:0000290 physical compartment: Specific location of space, that can be bounded or not. A physical compartment can have 1, 2 or 3 dimensions

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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