SBML Model Report

Model name: "Vilar2006_TGFbeta"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by Harish Dharuri[1] at November 28th 2006 at 6:39 p. m. and last time modified at July fifth 2012 at 2:45 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	2
species types	0	species	6
events	1	constraints	0
reactions	13	function definitions	0
global parameters	9	unit definitions	3
rules	0	initial assignments	0

Model Notes

The model reproduces Fig 5A of the paper. The ligand concentration is increased from 3E-5 to 0.01 at time t=2500 to ensure that the system reaches steady state. Hence, the time t=0 of the paper corresponds to t=2500 in the model. The peak value of the active ligand receptor complex is off by a value of 1.25, the authors have stated that this discrepancy is due to the fact that the figure in the paper corresponds to a slightly different parameter set. The model was successfully tested on MathSBML.

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2 Unit Definitions

This is an overview of six unit definitions of which three are predefined by SBML and not mentioned in the model.

2.1 Unit `substance`

Name substance

Definition item

2.2 Unit `time`

Name minutes

Definition 3600 s

2.3 Unit `min_inv`

Name min_inv

Definition $(3600\ \mathrm{s})^{-1}$

2.4 Unit `volume`

Notes Litre is the predefined SBML unit for `volume`.

Definition l

2.5 Unit `area`

Notes Square metre is the predefined SBML unit for `area` since SBML Level 2 Version 1.

Definition m^2

2.6 Unit `length`

Notes Metre is the predefined SBML unit for `length` since SBML Level 2 Version 1.

Definition m

3 Compartments

This model contains two compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`PM`	Plasma membrane		3	1	litre	☑	
`Endosome`	Endosome		3	1	litre	☑	`PM`

3.1 Compartment `PM`

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

Name Plasma membrane

3.2 Compartment `Endosome`

This is a three dimensional compartment with a constant size of one litre, which is surrounded by `PM` (Plasma membrane).

Name Endosome

4 Species

This model contains six 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
RI	Receptor 1	PM	item	⊟	⊟
RII	Receptor 2	PM	item	⊟	⊟
lRIRII	ligand receptor complex-plasma membrane	PM	item	⊟	⊟
lRIRII_endo	ligand receptor complex-endosome	Endosome	item	⊟	⊟
RI_endo	Receptor 1-endosome	Endosome	item	⊟	⊟
RII_endo	Receptor 2 endosome	Endosome	item	⊟	⊟

5 Parameters

This model contains nine global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
ka			1.000		☑
ligand			$3 \cdot 10^{-5}$		☐
kcd			0.028		☑
klid			0.250		☑
ki			0.333		☑
pRI			8.000		☑
kr			0.033		☑
alpha			1.000		☑
pRII			4.000		☑

6 Event

This is an overview of one event. Each event is initiated whenever its trigger condition switches from `false` to `true`. A delay function postpones the effects of an event to a later time point. At the time of execution, an event can assign values to species, parameters or compartments if these are not set to constant.

6.1 Event `event_0000001`

Trigger condition

$$t \geq 2500 \tag{1}$$

Assignment

$$\text{ligand} = 0.01 \tag{2}$$

7 Reactions

This model contains 13 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	v1	Ligand receptor complex formation	$RII + RI \longrightarrow lRIRII$	
2	v2	Ligand receptor complex constitutive degradation	$lRIRII \longrightarrow \emptyset$	
3	v3	Ligand independent complex degradation	$lRIRII \longrightarrow \emptyset$	
4	v4	Ligand receptor complex internalization	$lRIRII \longrightarrow lRIRII\_endo$	
5	v5	RI synthesis	$\emptyset \longrightarrow RI$	
6	v6	RI constitutive degradation	$RI \longrightarrow \emptyset$	
7	v7	RI internalization	$RI \longrightarrow RI\_endo$	
8	v8	RI recycling	$RI\_endo \longrightarrow RI$	
9	v9	Ligand Receptor complex recycling	$lRIRII\_endo \longrightarrow RI + RII$	
10	v10	RII synthesis	$\emptyset \longrightarrow RII$	
11	v11	RII constitutive degradation	$RII \longrightarrow \emptyset$	
12	v12	RII internalization	$RII \longrightarrow RII\_endo$	
13	v13	RII recycling	$RII\_endo \longrightarrow RII$	

7.1 Reaction v1

This is an irreversible reaction of two reactants forming one product.

Name Ligand receptor complex formation

Reaction equation

$$\mathrm{RII} + \mathrm{RI} \longrightarrow \mathrm{lRIRII} \tag{3}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
RII	Receptor 2	
RI	Receptor 1	

Product

Table 7: Properties of each product.

Id	Name	SBO
lRIRII	ligand receptor complex-plasma membrane	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{ka} \cdot \mathrm{ligand} \cdot \mathrm{RI} \cdot \mathrm{RII} \tag{4}$$

7.2 Reaction v2

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

Name Ligand receptor complex constitutive degradation

Reaction equation

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

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
lRIRII	ligand receptor complex-plasma membrane	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{kcd} \cdot \text{lRIRII} \tag{6}$$

7.3 Reaction v3

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

Name Ligand independent complex degradation

Reaction equation

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

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
lRIRII	ligand receptor complex-plasma membrane	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{klid} \cdot \text{lRIRII} \tag{8}$$

7.4 Reaction v4

This is an irreversible reaction of one reactant forming one product.

Name Ligand receptor complex internalization

Reaction equation

$$\text{lRIRII} \longrightarrow \text{lRIRII\_endo} \tag{9}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
lRIRII	ligand receptor complex-plasma membrane	

Product

Table 11: Properties of each product.

Id	Name	SBO
lRIRII_endo	ligand receptor complex-endosome	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{ki} \cdot \mathrm{lRIRII} \tag{10}$$

7.5 Reaction v5

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

Name RI synthesis

Reaction equation

$$\emptyset \longrightarrow \mathrm{RI} \tag{11}$$

Product

Table 12: Properties of each product.

Id	Name	SBO
RI	Receptor 1	

Kinetic Law

Derived unit not available

$$v_5 = \mathrm{pRI} \tag{12}$$

7.6 Reaction v6

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

Name RI constitutive degradation

Reaction equation

$$\mathrm{RI} \longrightarrow \emptyset \tag{13}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
RI	Receptor 1	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{kcd} \cdot \mathrm{RI} \tag{14}$$

7.7 Reaction v7

This is an irreversible reaction of one reactant forming one product.

Name RI internalization

Reaction equation

$$\mathrm{RI} \longrightarrow \mathrm{RI\_endo} \tag{15}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
RI	Receptor 1	

Product

Table 15: Properties of each product.

Id	Name	SBO
RI_endo	Receptor 1-endosome	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{ki} \cdot \mathrm{RI} \tag{16}$$

7.8 Reaction v8

This is an irreversible reaction of one reactant forming one product.

Name RI recycling

Reaction equation

$$\mathrm{RI\_endo} \longrightarrow \mathrm{RI} \tag{17}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
RI_endo	Receptor 1-endosome	

Product

Table 17: Properties of each product.

Id	Name	SBO
RI	Receptor 1	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{kr} \cdot \mathrm{RI\_endo} \tag{18}$$

7.9 Reaction v9

This is an irreversible reaction of one reactant forming two products.

Name Ligand Receptor complex recycling

Reaction equation

$$\text{lRIRII\_endo} \longrightarrow \text{RI} + \text{RII} \tag{19}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
lRIRII_endo	ligand receptor complex-endosome	

Products

Table 19: Properties of each product.

Id	Name	SBO
RI	Receptor 1	
RII	Receptor 2	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{kr} \cdot \text{lRIRII\_endo} \tag{20}$$

7.10 Reaction v10

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

Name RII synthesis

Reaction equation

$$\emptyset \longrightarrow \text{RII} \tag{21}$$

Product

Table 20: Properties of each product.

Id	Name	SBO
RII	Receptor 2	

Kinetic Law

Derived unit not available

$$v_{10} = \text{pRII} \tag{22}$$

7.11 Reaction v11

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

Name RII constitutive degradation

Reaction equation

$$\text{RII} \longrightarrow \emptyset \tag{23}$$

Reactant

Table 21: Properties of each reactant.

Id	Name	SBO
RII	Receptor 2	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{kcd} \cdot \text{RII} \tag{24}$$

7.12 Reaction v12

This is an irreversible reaction of one reactant forming one product.

Name RII internalization

Reaction equation

$$\text{RII} \longrightarrow \text{RII\_endo} \tag{25}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
RII	Receptor 2	

Product

Table 23: Properties of each product.

Id	Name	SBO
RII_endo	Receptor 2 endosome	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{ki} \cdot \mathrm{RII} \tag{26}$$

7.13 Reaction v13

This is an irreversible reaction of one reactant forming one product.

Name RII recycling

Reaction equation

$$\mathrm{RII\_endo} \longrightarrow \mathrm{RII} \tag{27}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
RII_endo	Receptor 2 endosome	

Product

Table 25: Properties of each product.

Id	Name	SBO
RII	Receptor 2	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \mathrm{kr} \cdot \mathrm{RII\_endo} \tag{28}$$

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 `RI`

Name Receptor 1

Initial amount 20 item

This species takes part in six reactions (as a reactant in `v1`, `v6`, `v7` and as a product in `v5`, `v8`, `v9`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RI} = v_5 + v_8 + v_9 - v_1 - v_6 - v_7 \tag{29}$$

8.2 Species `RII`

Name Receptor 2

Initial amount 20 item

This species takes part in six reactions (as a reactant in `v1`, `v11`, `v12` and as a product in `v9`, `v10`, `v13`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RII} = v_9 + v_{10} + v_{13} - v_1 - v_{11} - v_{12} \tag{30}$$

8.3 Species lRIRII

Name ligand receptor complex-plasma membrane

Initial amount 0 item

This species takes part in four reactions (as a reactant in v2, v3, v4 and as a product in v1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{lRIRII} = v_1 - v_2 - v_3 - v_4 \tag{31}$$

8.4 Species lRIRII_endo

Name ligand receptor complex-endosome

Initial amount 40 item

This species takes part in two reactions (as a reactant in v9 and as a product in v4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{lRIRII\_endo} = v_4 - v_9 \tag{32}$$

8.5 Species RI_endo

Name Receptor 1-endosome

Initial amount 0 item

This species takes part in two reactions (as a reactant in v8 and as a product in v7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RI\_endo} = v_7 - v_8 \tag{33}$$

8.6 Species RII_endo

Name Receptor 2 endosome

Initial amount 0 item

This species takes part in two reactions (as a reactant in v13 and as a product in v12).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RII\_endo} = v_{12} - v_{13} \tag{34}$$

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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