SBML Model Report

Model name: "Clarke2006_Smad_signalling"

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1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by the following two authors: Harish Dharuri[1] and Katja Wegner[2] at November 29th 2006 at 11:35 a. m. and last time modified at October 29th 2010 at 1:55 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	2
species types	0	species	10
events	0	constraints	0
reactions	8	function definitions	0
global parameters	4	unit definitions	5
rules	4	initial assignments	0

Model Notes

The model reproduces the temporal evolution of four variables depicted in Fig 2a. The solution is generated for median parameter values as given in Table 3. Result shown was generated by MathSBML.

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2 Unit Definitions

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

2.1 Unit `time`

Name minutes

Definition 60 s

2.2 Unit `substance`

Definition item

2.3 Unit `min_inv`

Name min_inv

Definition $(60\ \mathrm{s})^{-1}$

2.4 Unit `items_per_min`

Name items per min

Definition $\mathrm{item} \cdot (60\ \mathrm{s})^{-1}$

2.5 Unit `per_item_min`

Name per item per min

Definition $\mathrm{item}^{-1} \cdot (60\ \mathrm{s})^{-1}$

2.6 Unit `volume`

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

Definition l

2.7 Unit area

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

Definition m^2

2.8 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
cytoplasm	cytoplasm		3	1	litre	☑	
nucleus	nucleus		3	1	litre	☑	cytoplasm

3.1 Compartment cytoplasm

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

Name cytoplasm

3.2 Compartment nucleus

This is a three dimensional compartment with a constant size of one litre, which is surrounded by cytoplasm (cytoplasm).

Name nucleus

4 Species

This model contains ten 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
receptor	receptors	cytoplasm	item	⊟	⊟
R_smad_cyt	R-Smad_cyt	cytoplasm	item	⊟	⊟
R_smad_P_cyt	R-Smad-P_cyt	cytoplasm	item	⊟	⊟
smad4_cyt	Smad4_cyt	cytoplasm	item	⊟	⊟
R_smad_P_smad4_cyt	R-Smad-P-Smad4_cyt	cytoplasm	item	⊟	⊟
R_smad_P_smad4_nuc	R-Smad-P-Smad4_nuc	nucleus	item	⊟	⊟
R_smad_nuc	R-Smad_nuc	nucleus	item	⊟	⊟
R_smad_P_nuc	R-Smad-P_nuc	nucleus	item	⊟	⊟
smad4_nuc	Smad4_nuc	nucleus	item	⊟	⊟
Pi	Pi	nucleus	item	⊟	⊟

5 Parameters

This model contains four global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
sum_R_smad_cyt	sum_R_smad_cyt		0.0		⊟
sum_R_smad_nuc	sum_R_smad_nuc		0.0		⊟
sum_smad4_cyt	sum_Smad4_cyt		0.0		⊟
sum_smad4_nuc	sum_Smad4_nuc		0.0		⊟

6 Rules

This is an overview of four rules.

6.1 Rule sum_R_smad_nuc

Rule sum_R_smad_nuc is an assignment rule for parameter sum_R_smad_nuc:

$$\text{sum\_R\_smad\_nuc} = \text{R\_smad\_nuc} + \text{R\_smad\_P\_nuc} + \text{R\_smad\_P\_smad4\_nuc} \quad (1)$$

Derived unit item

6.2 Rule sum_smad4_nuc

Rule sum_smad4_nuc is an assignment rule for parameter sum_smad4_nuc:

$$\text{sum\_smad4\_nuc} = \text{smad4\_nuc} + \text{R\_smad\_P\_smad4\_nuc} \quad (2)$$

Derived unit item

6.3 Rule sum_R_smad_cyt

Rule sum_R_smad_cyt is an assignment rule for parameter sum_R_smad_cyt:

$$\text{sum\_R\_smad\_cyt} = \text{R\_smad\_cyt} + \text{R\_smad\_P\_cyt} + \text{R\_smad\_P\_smad4\_cyt} \quad (3)$$

Derived unit item

6.4 Rule sum_smad4_cyt

Rule sum_smad4_cyt is an assignment rule for parameter sum_smad4_cyt:

$$\text{sum\_smad4\_cyt} = \text{smad4\_cyt} + \text{R\_smad\_P\_smad4\_cyt} \tag{4}$$

Derived unit item

7 Reactions

This model contains eight 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	`reaction_1`	Phosphorylation	$\text{R\_smad\_cyt} \xrightarrow{\text{receptor}} \text{R\_smad\_P\_cyt}$	
2	`reaction_5`	R-Smad translocation	$\text{R\_smad\_nuc} \rightleftharpoons \text{R\_smad\_cyt}$	
3	`reaction_4`	Smad4 translocation	$\text{smad4\_nuc} \rightleftharpoons \text{smad4\_cyt}$	
4	`reaction_2`	Complex formation	$\text{R\_smad\_P\_cyt} + \text{smad4\_cyt} \rightleftharpoons \text{R\_smad\_P\_smad4\_cyt}$	
5	`reaction_3`	Complex translocation	$\text{R\_smad\_P\_smad4\_cyt} \longrightarrow \text{R\_smad\_P\_smad4\_nuc}$	
6	`reaction_6`	Complex in nucleus	$\text{R\_smad\_P\_smad4\_nuc} \rightleftharpoons \text{smad4\_nuc} + \text{R\_smad\_P\_nuc}$	
7	`reaction_7`	Dephosphorylation	$\text{R\_smad\_P\_nuc} \longrightarrow \text{R\_smad\_nuc} + \text{Pi}$	
8	`reaction_0`	Receptor degradation	$\text{receptor} \longrightarrow \emptyset$	

7.1 Reaction `reaction_1`

This is an irreversible reaction of one reactant forming one product influenced by one modifier.

Name Phosphorylation

Reaction equation

$$\text{R\_smad\_cyt} \xrightarrow{\text{receptor}} \text{R\_smad\_P\_cyt} \tag{5}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
`R_smad_cyt`	R-Smad_cyt	

Modifier

Table 7: Properties of each modifier.

Id	Name	SBO
`receptor`	receptors	

Product

Table 8: Properties of each product.

Id	Name	SBO
`R_smad_P_cyt`	R-Smad-P_cyt	

Kinetic Law

Derived unit $(60\,\mathrm{s})^{-1} \cdot \mathrm{item}$

$$v_1 = \frac{\mathrm{KCAT} \cdot \mathrm{receptor} \cdot \mathrm{R\_smad\_cyt}}{\mathrm{K1} + \mathrm{R\_smad\_cyt}} \tag{6}$$

Table 9: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KCAT			3.51	$(60\ \mathrm{s})^{-1}$	☑
K1			289000.00	item	☑

7.2 Reaction reaction_5

This is a reversible reaction of one reactant forming one product.

Name R-Smad translocation

Reaction equation

$$\mathrm{R\_smad\_nuc} \rightleftharpoons \mathrm{R\_smad\_cyt} \tag{7}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
R_smad_nuc	R-Smad_nuc	

Product

Table 11: Properties of each product.

Id	Name	SBO
R_smad_cyt	R-Smad_cyt	

Kinetic Law

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{item}$

$$v_2 = \mathrm{k5nc} \cdot \mathrm{R\_smad\_nuc} - \mathrm{k5cn} \cdot \mathrm{R\_smad\_cyt} \tag{8}$$

Table 12: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k5nc			5.630	$(60\ \mathrm{s})^{-1}$	☑
k5cn			0.563	$(60\ \mathrm{s})^{-1}$	☑

7.3 Reaction reaction_4

This is a reversible reaction of one reactant forming one product.

Name Smad4 translocation

Reaction equation

$$\text{smad4\_nuc} \rightleftharpoons \text{smad4\_cyt} \tag{9}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
smad4_nuc	Smad4_nuc	

Product

Table 14: Properties of each product.

Id	Name	SBO
smad4_cyt	Smad4_cyt	

Kinetic Law

Derived unit $(60\ \text{s})^{-1} \cdot \text{item}$

$$v_3 = \text{k4nc} \cdot \text{smad4\_nuc} - \text{k4cn} \cdot \text{smad4\_cyt} \tag{10}$$

Table 15: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k4nc			0.783	$(60\ \text{s})^{-1}$	☑
k4cn			0.005	$(60\ \text{s})^{-1}$	☑

7.4 Reaction reaction_2

This is a reversible reaction of two reactants forming one product.

Name Complex formation

Reaction equation

$$\text{R\_smad\_P\_cyt} + \text{smad4\_cyt} \rightleftharpoons \text{R\_smad\_P\_smad4\_cyt} \tag{11}$$

Reactants

Table 16: Properties of each reactant.

Id	Name	SBO
`R_smad_P_cyt`	R-Smad-P_cyt	
`smad4_cyt`	Smad4_cyt	

Product

Table 17: Properties of each product.

Id	Name	SBO
`R_smad_P_smad4_cyt`	R-Smad-P-Smad4_cyt	

Kinetic Law

Derived unit $(60\ \text{s})^{-1} \cdot \text{item}$

$$v_4 = \text{k2a} \cdot \text{R\_smad\_P\_cyt} \cdot \text{smad4\_cyt} - \text{k2d} \cdot \text{R\_smad\_P\_smad4\_cyt} \tag{12}$$

Table 18: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
`k2a`			$6.5 \cdot 10^{-5}$	$\text{item}^{-1} \cdot (60\ \text{s})^{-1}$	☑
`k2d`			0.040	$(60\ \text{s})^{-1}$	☑

7.5 Reaction `reaction_3`

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

Name Complex translocation

Reaction equation

$$\text{R\_smad\_P\_smad4\_cyt} \longrightarrow \text{R\_smad\_P\_smad4\_nuc} \tag{13}$$

Reactant

Table 19: Properties of each reactant.

Id	Name	SBO
R_smad_P_smad4_cyt	R-Smad-P-Smad4_cyt	

Product

Table 20: Properties of each product.

Id	Name	SBO
R_smad_P_smad4_nuc	R-Smad-P-Smad4_nuc	

Kinetic Law

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{item}$

$$v_5 = \mathrm{k3} \cdot \mathrm{R\_smad\_P\_smad4\_cyt} \tag{14}$$

Table 21: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k3			16.6	$(60\ \mathrm{s})^{-1}$	☑

7.6 Reaction reaction_6

This is a reversible reaction of one reactant forming two products.

Name Complex in nucleus

Reaction equation

$$\mathrm{R\_smad\_P\_smad4\_nuc} \rightleftharpoons \mathrm{smad4\_nuc} + \mathrm{R\_smad\_P\_nuc} \tag{15}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
R_smad_P_smad4_nuc	R-Smad-P-Smad4_nuc	

Products

Table 23: Properties of each product.

Id	Name	SBO
smad4_nuc	Smad4_nuc	
R_smad_P_nuc	R-Smad-P_nuc	

Kinetic Law

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{item}$

$$v_6 = \mathrm{k6d} \cdot \mathrm{R\_smad\_P\_smad4\_nuc} - \mathrm{k6a} \cdot \mathrm{smad4\_nuc} \cdot \mathrm{R\_smad\_P\_nuc} \tag{16}$$

Table 24: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k6d			0.049	$(60\ \mathrm{s})^{-1}$	☑
k6a			$1.44 \cdot 10^{-4}$	$\mathrm{item}^{-1} \cdot (60\ \mathrm{s})^{-1}$	☑

7.7 Reaction reaction_7

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

Name Dephosphorylation

Reaction equation

$$\mathrm{R\_smad\_P\_nuc} \longrightarrow \mathrm{R\_smad\_nuc} + \mathrm{Pi} \tag{17}$$

Reactant

Table 25: Properties of each reactant.

Id	Name	SBO
R_smad_P_nuc	R-Smad-P_nuc	

Products

Table 26: Properties of each product.

Id	Name	SBO
R_smad_nuc	R-Smad_nuc	
Pi	Pi	

Kinetic Law

Derived unit $\text{item} \cdot (60\ \text{s})^{-1}$

$$v_7 = \frac{\text{Vmax7} \cdot \text{R\_smad\_P\_nuc}}{\text{K7} + \text{R\_smad\_P\_nuc}} \tag{18}$$

Table 27: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Vmax7			17100.0	$\text{item} \cdot (60\ \text{s})^{-1}$	☑
K7			8950.0	item	☑

7.8 Reaction reaction_0

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

Name Receptor degradation

Reaction equation

$$\text{receptor} \longrightarrow \emptyset \tag{19}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
receptor	receptors	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = 100 \cdot \exp\left(\frac{\text{time}}{90}\right) \tag{20}$$

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 `receptor`

Name receptors

Initial amount 10000 item

This species takes part in two reactions (as a reactant in `reaction_0` and as a modifier in `reaction_1`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{receptor} = -v_8 \tag{21}$$

8.2 Species `R_smad_cyt`

Name R-Smad_cyt

Initial amount 162000 item

This species takes part in two reactions (as a reactant in `reaction_1` and as a product in `reaction_5`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_smad\_cyt} = v_2 - v_1 \tag{22}$$

8.3 Species `R_smad_P_cyt`

Name R-Smad-P_cyt

Initial amount 0 item

This species takes part in two reactions (as a reactant in `reaction_2` and as a product in `reaction_1`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_smad\_P\_cyt} = v_1 - v_4 \tag{23}$$

8.4 Species smad4_cyt

Name Smad4_cyt

Initial amount 120000 item

This species takes part in two reactions (as a reactant in reaction_2 and as a product in reaction_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{smad4\_cyt} = v_3 - v_4 \tag{24}$$

8.5 Species R_smad_P_smad4_cyt

Name R-Smad-P-Smad4_cyt

Initial amount 0 item

This species takes part in two reactions (as a reactant in reaction_3 and as a product in reaction_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_smad\_P\_smad4\_cyt} = v_4 - v_5 \tag{25}$$

8.6 Species R_smad_P_smad4_nuc

Name R-Smad-P-Smad4_nuc

Initial amount 0 item

This species takes part in two reactions (as a reactant in reaction_6 and as a product in reaction_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_smad\_P\_smad4\_nuc} = v_5 - v_6 \tag{26}$$

8.7 Species R_smad_nuc

Name R-Smad_nuc

Initial amount 18000 item

This species takes part in two reactions (as a reactant in reaction_5 and as a product in reaction_7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_smad\_nuc} = v_7 - v_2 \tag{27}$$

8.8 Species R_smad_P_nuc

Name R-Smad-P_nuc

Initial amount 0 item

This species takes part in two reactions (as a reactant in reaction_7 and as a product in reaction_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_smad\_P\_nuc} = v_6 - v_7 \tag{28}$$

8.9 Species smad4_nuc

Name Smad4_nuc

Initial amount 30000 item

This species takes part in two reactions (as a reactant in reaction_4 and as a product in reaction_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{smad4\_nuc} = v_6 - v_3 \tag{29}$$

8.10 Species Pi

Name Pi

Initial amount 0 item

This species takes part in one reaction (as a product in reaction_7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Pi} = v_7 \tag{30}$$

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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