SBML Model Report

Model name: “Sivakumar2011 - Hedgehog Signaling Pathway”

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and KC Sivakumar[2] at November second 2011 at 2:45 p. m. and last time modified at April eighth 2016 at 5:16 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	4
species types	0	species	23
events	0	constraints	0
reactions	12	function definitions	0
global parameters	25	unit definitions	0
rules	0	initial assignments	0

Model Notes

Sivakumar2011 - Hedgehog Signaling Pathway

This is the current model for the Hedgehog signaling pathway. The best data for mechanism of signaling has been worked out in Drosophila, so this model is based largely on Drosophila data. Hedgehog target genes vary from tissue to tissue, so the identities of individual target genes have

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not been listed. The main difference between the Drosophila and mammalian Hedgehog signaling pathways is the fact that there are three mammalian homologs of Cubitus interruptus, Gli1 Gli2 and Gli3. Some or all of the mammalian homologs may be proteolytically processed, but the data are controversial. There are two mammalian Ptc genes and three mammalian Hedgehog genes as well. The pathway for Sonic Hedgehog appears to be most similar to the Drosophila hedgehog pathway.

References:

- Hedgehog signaling in animal development: paradigms and principles.
- Sonic hedgehog in the nervous system: functions, modifications and mechanisms.
- Hedgehog signal transduction: recent findings.
- Hedgehog signaling: Costal-2 bridges the transduction gap.

This model is described in the article:A systems biology approach to model neural stem cell regulation by notch, shh, wnt, and EGF signaling pathways.Sivakumar KC, Dhanesh SB, Shobana S, James J, Mundayoor S.Omics: a Journal of Integrative Biology. 2011; 15(10):729-737

Abstract:

The Notch, Sonic Hedgehog (Shh), Wnt, and EGF pathways have long been known to influence cell fate specification in the developing nervous system. Here we attempted to evaluate the contemporary knowledge about neural stem cell differentiation promoted by various drug-based regulations through a systems biology approach. Our model showed the phenomenon of DAPT-mediated antagonism of Enhancer of split [E(spl)] genes and enhancement of Shh target genes by a SAG agonist that were effectively demonstrated computationally and were consistent with experimental studies. However, in the case of model simulation of Wnt and EGF pathways, the model network did not supply any concurrent results with experimental data despite the fact that drugs were added at the appropriate positions. This paves insight into the potential of crosstalks between pathways considered in our study. Therefore, we manually developed a map of signaling crosstalk, which included the species connected by representatives from Notch, Shh, Wnt, and EGF pathways and highlighted the regulation of a single target gene, Hes-1, based on drug-induced simulations. These simulations provided results that matched with experimental studies. Therefore, these signaling crosstalk models complement as a tool toward the discovery of novel regulatory processes involved in neural stem cell maintenance, proliferation, and differentiation during mammalian central nervous system development. To our knowledge, this is the first report of a simple crosstalk map that highlights the differential regulation of neural stem cell differentiation and underscores the flow of positive and negative regulatory signals modulated by drugs.

This model is hosted on BioModels Database and identified by: BIOMD0000000395.

To cite BioModels Database, please use: BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models.

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 Compartments

This model contains four compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`default`			3	1	litre	☑	
`c1`	Receiving cell		3	1	litre	☑	`default`
`c4`	lipid raft		3	1	litre	☑	`c1`
`c5`	nucleus		3	1	litre	☑	`c1`

3.1 Compartment `default`

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

3.2 Compartment `c1`

This is a three dimensional compartment with a constant size of one litre, which is surrounded by `default`.

Name Receiving cell

3.3 Compartment `c4`

This is a three dimensional compartment with a constant size of one litre, which is surrounded by `c1` (Receiving cell).

Name lipid raft

3.4 Compartment `c5`

This is a three dimensional compartment with a constant size of one litre, which is surrounded by `c1` (Receiving cell).

Name nucleus

4 Species

This model contains 23 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
s9	ATP	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s10	ADP	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s1	Patched	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s75	Hedgehog target gene	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s135	Sap18	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s7	Hedgehog	default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s21	Complex_br_(Patched/Hedgehog)	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s46	Complex_br_(Costal2/Fused/_br-_Smoothened)	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s48	Complex_br_(Costal2/Smoothened/_br-_Fused)	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s69	Complex_br_(Costal2/Fused/_br-_Smoothened)	c4	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s71	CBP	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s68	Microtubule	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s70	Cubitus_space_interruptus	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s128	Complex_br_(Cubitus_space_interruptus-_space_repressor/Su(fu))	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s140	Complex_br_(Sap18/Su(fu)/_br_Cubitus-_space_interruptus_space_repressor)	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s148	smoothened	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s150	complex	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
s152	MIcrotubule	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s157	sag	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s158	Complex_br_(CBP/Cubitus)	c5	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s159	Complex_br-_(Costal2/Fused/../microtubule)	c4	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s160	Complex_br_(Su(fu)/Fused/../_br-_Smoothened)	c4	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
s161	Complex_br_(Su(fu)/Cubitus)	c1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 25 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kass_r7			1.130		☑
kdiss_r7			1.122		☑
kcatp_r14			1.146		☑
kM_r14_s69			1.030		☑
kcatn_r14			1.750		☑
kM_r14_s46			0.215		☑
kass_r25			1.270		☑
kdiss_r25			0.730		☑
kass_r26			1.330		☑
kdiss_r26			0.610		☑
kass_r51			1.230		☑
kdiss_r51			0.460		☑
kass_r52			0.600		☑
kdiss_r52			1.670		☑
kcatp_r53			1.290		☑
kM_r53_s70			0.790		☑
kcatn_r53			1.620		☑
kass_r54			1.280		☑
kdiss_r54			0.710		☑
kass_r55			1.560		☑
kass_r15_s21			1.530		☑
kdiss_r15_s21			0.890		☑
kass_re24_s157			1.000		☑
kass_r23_s21			1.000		☑
kdiss_r23_s21			1.000		☑

6 Reactions

This model contains twelve 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	r52		$s140 \longrightarrow s75$	
2	r55		$s158 \longrightarrow s75$	
3	r7		$s7 + s1 \rightleftharpoons s21$	
4	r14		$s69 \overset{s21}{\rightleftharpoons} s46$	
5	r51		$s135 + s128 \rightleftharpoons s140$	
6	r53		$s70 \overset{s48}{\rightleftharpoons} s70$	
7	re24		$s148 + s150 \overset{s157}{\longrightarrow} s159$	
8	r15		$s46 + s9 \overset{s21}{\rightleftharpoons} s48 + s10$	
9	r23		$s159 \overset{s21}{\rightleftharpoons} s68 + s160$	
10	r54		$s70 + s71 \rightleftharpoons s158$	
11	r26		$s161 \rightleftharpoons s70$	
12	r25		$s160 \rightleftharpoons s161 + s69$	

6.1 Reaction r52

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

Reaction equation

$$\text{s140} \longrightarrow \text{s75} \tag{1}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
s140	Complex_br_(Sap18/Su(fu)/_br_Cubitus_space_interruptus_space_repressor)	

Product

Table 7: Properties of each product.

Id	Name	SBO
s75	Hedgehog target gene	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{kass\_r52} \cdot [\text{s140}] - \text{kdiss\_r52} \cdot [\text{s75}] \tag{2}$$

6.2 Reaction r55

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

Reaction equation

$$\text{s158} \longrightarrow \text{s75} \tag{3}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
s158	Complex_br_(CBP/Cubitus)	

Product

Table 9: Properties of each product.

Id	Name	SBO
s75	Hedgehog target gene	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{kass\_r55} \cdot [\text{s158}] \tag{4}$$

6.3 Reaction r7

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

Notes mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Reaction equation

$$\text{s7} + \text{s1} \rightleftharpoons \text{s21} \tag{5}$$

Reactants

Table 10: Properties of each reactant.

Id	Name	SBO
s7	Hedgehog	
s1	Patched	

Product

Table 11: Properties of each product.

Id	Name	SBO
s21	Complex_br_(Patched/Hedgehog)	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{kass\_r7} \cdot [\text{s7}] \cdot [\text{s1}] - \text{kdiss\_r7} \cdot [\text{s21}] \tag{6}$$

6.4 Reaction r14

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Notes kinetics of non-modulated unireactant enzymes

Reaction equation

$$\text{s69} \overset{\text{s21}}{\rightleftharpoons} \text{s46} \tag{7}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
s69	Complex_br_(Costal2/Fused/_br_Smoothened)	

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
s21	Complex_br_(Patched/Hedgehog)	

Product

Table 14: Properties of each product.

Id	Name	SBO
s46	Complex_br_(Costal2/Fused/_br_Smoothened)	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = [\text{s21}] \cdot \frac{\frac{\text{kcatp\_r14}}{\text{kM\_r14\_s69}} \cdot [\text{s69}] - \frac{\text{kcatn\_r14}}{\text{kM\_r14\_s46}} \cdot [\text{s46}]}{1 + \frac{[\text{s69}]}{\text{kM\_r14\_s69}} + \frac{[\text{s46}]}{\text{kM\_r14\_s46}}} \tag{8}$$

6.5 Reaction r51

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

Notes mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Reaction equation

$$\mathrm{s135} + \mathrm{s128} \rightleftharpoons \mathrm{s140} \tag{9}$$

Reactants

Table 15: Properties of each reactant.

Id	Name	SBO
s135	Sap18	
s128	Complex_br_(Cubitus_space_interruptus_space_repressor/Su(fu))	

Product

Table 16: Properties of each product.

Id	Name	SBO
s140	Complex_br_(Sap18/Su(fu)/_br_Cubitus_space_interruptus_space_repressor)	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{kass\_r51} \cdot [\mathrm{s135}] \cdot [\mathrm{s128}] - \mathrm{kdiss\_r51} \cdot [\mathrm{s140}] \tag{10}$$

6.6 Reaction r53

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Notes kinetics of non-modulated unireactant enzymes

Reaction equation

$$\mathrm{s70} \overset{\mathrm{s48}}{\rightleftharpoons} \mathrm{s70} \tag{11}$$

Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
s70	Cubitus_space_interruptus	

Modifier

Table 18: Properties of each modifier.

Id	Name	SBO
s48	Complex_br_(Costal2/Smoothened/_br_Fused)	

Product

Table 19: Properties of each product.

Id	Name	SBO
s70	Cubitus_space_interruptus	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = [\mathrm{s48}] \cdot \frac{\frac{\mathrm{kcatp\_r53}}{\mathrm{kM\_r53\_s70}} \cdot [\mathrm{s70}] - \frac{\mathrm{kcatn\_r53}}{\mathrm{kM\_r53\_s70}} \cdot [\mathrm{s70}]}{1 + \frac{[\mathrm{s70}]}{\mathrm{kM\_r53\_s70}} + \frac{[\mathrm{s70}]}{\mathrm{kM\_r53\_s70}}} \tag{12}$$

6.7 Reaction re24

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

Notes mass action rate law for second order irreversible reactions, two reactants, continuous scheme

Reaction equation

$$\mathrm{s148} + \mathrm{s150} \xrightarrow{\mathrm{s157}} \mathrm{s159} \tag{13}$$

Reactants

Table 20: Properties of each reactant.

Id	Name	SBO
s148	smoothened	
s150	complex	

Modifier

Table 21: Properties of each modifier.

Id	Name	SBO
s157	sag	

Product

Table 22: Properties of each product.

Id	Name	SBO
s159	Complex_br_(Costal2/Fused/../microtubule)	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = [\text{s157}] \cdot \text{kass\_re24\_s157} \cdot [\text{s148}] \cdot [\text{s150}] \tag{14}$$

6.8 Reaction r15

This is a reversible reaction of two reactants forming two products influenced by one modifier.

Notes reversible rapid-equilibrium random order ternary-complex mechanism with two products

Reaction equation

$$\text{s46} + \text{s9} \overset{\text{s21}}{\rightleftharpoons} \text{s48} + \text{s10} \tag{15}$$

Reactants

Table 23: Properties of each reactant.

Id	Name	SBO
s46	Complex_br_(Costal2/Fused/_br_Smoothened)	
s9	ATP	

Modifier

Table 24: Properties of each modifier.

Id	Name	SBO
s21	Complex_br_(Patched/Hedgehog)	

Products

Table 25: Properties of each product.

Id	Name	SBO
s48	Complex_br_(Costal2/Smoothened/_br_Fused)	
s10	ADP	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = [\text{s21}] \cdot (\text{kass\_r15\_s21} \cdot [\text{s46}] \cdot [\text{s9}] - \text{kdiss\_r15\_s21} \cdot [\text{s48}] \cdot [\text{s10}]) \tag{16}$$

6.9 Reaction r23

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

Notes reversible simple convenience kinetics

Reaction equation

$$\text{s159} \overset{\text{s21}}{\rightleftharpoons} \text{s68} + \text{s160} \tag{17}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
s159	Complex_br_(Costal2/Fused/../microtubule)	

Modifier

Table 27: Properties of each modifier.

Id	Name	SBO
s21	Complex_br_(Patched/Hedgehog)	

Products

Table 28: Properties of each product.

Id	Name	SBO
s68	Microtubule	
s160	Complex_br_(Su(fu)/Fused/../_br_Smoothened)	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = [\text{s21}] \cdot (\text{kass\_r23\_s21} \cdot [\text{s159}] - \text{kdiss\_r23\_s21} \cdot [\text{s68}] \cdot [\text{s160}]) \tag{18}$$

6.10 Reaction r54

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

Notes mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Reaction equation

$$\text{s70} + \text{s71} \rightleftharpoons \text{s158} \tag{19}$$

Reactants

Table 29: Properties of each reactant.

Id	Name	SBO
s70	Cubitus_space_interruptus	
s71	CBP	

Product

Table 30: Properties of each product.

Id	Name	SBO
s158	Complex_br_(CBP/Cubitus)	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{kass\_r54} \cdot [\text{s70}] \cdot [\text{s71}] - \text{kdiss\_r54} \cdot [\text{s158}] \tag{20}$$

6.11 Reaction r26

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

Notes mass action rate law for first order forward, first order reverse, reversible reactions, continuous scheme

Reaction equation

$$\text{s161} \rightleftharpoons \text{s70} \tag{21}$$

Reactant

Table 31: Properties of each reactant.

Id	Name	SBO
s161	Complex_br_(Su(fu)/Cubitus)	

Product

Table 32: Properties of each product.

Id	Name	SBO
s70	Cubitus_space_interruptus	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{kass\_r26} \cdot [\text{s161}] - \text{kdiss\_r26} \cdot [\text{s70}] \tag{22}$$

6.12 Reaction r25

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

Notes mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Reaction equation

$$\text{s160} \rightleftharpoons \text{s161} + \text{s69} \tag{23}$$

Reactant

Table 33: Properties of each reactant.

Id	Name	SBO
s160	Complex_br_(Su(fu)/Fused/../_br_Smoothened)	

Products

Table 34: Properties of each product.

Id	Name	SBO
s161	Complex_br_(Su(fu)/Cubitus)	
s69	Complex_br_(Costal2/Fused/_br_Smoothened)	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{kass\_r25} \cdot [\text{s160}] - \text{kdiss\_r25} \cdot [\text{s161}] \cdot [\text{s69}] \tag{24}$$

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.

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.

7.1 Species `s9`

Name ATP

Notes Long Name: ATPSynonym: Synonym not specifiedAccession: S01691

Initial amount 2 mol

Charge 0

This species takes part in one reaction (as a reactant in `r15`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s9} = -v_8 \tag{25}$$

7.2 Species `s10`

Name ADP

Notes Long Name: ADPSynonym: Synonym not specifiedAccession: S01693

Initial amount 0 mol

Charge 0

This species takes part in one reaction (as a product in `r15`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s10} = v_8 \tag{26}$$

7.3 Species s1

Name Patched

Notes Long Name: PatchedSynonym: Ptc,Ptc1Accession: P00689

Initial amount 5 mol

Charge 0

This species takes part in one reaction (as a reactant in r7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s1} = -v_3 \tag{27}$$

7.4 Species s75

Name Hedgehog target gene

Notes Long Name: e.g., ptcSynonym: Synonym not specifiedAccession: G01526

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a product in r52, r55).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s75} = v_1 + v_2 \tag{28}$$

7.5 Species s135

Name Sap18

Notes Long Name: Sap18Synonym: Sin3-associated polypeptide 18Accession: P00697

Initial amount 2.5 mol

Charge 0

This species takes part in one reaction (as a reactant in r51).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s135} = -v_5 \tag{29}$$

7.6 Species s7

Name Hedgehog

Notes Long Name: HedgehogSynonym: Hh,Shh,Sonic hedgehogAccession: P00688

Initial amount 5 mol

Charge 0

This species takes part in one reaction (as a reactant in r7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s7} = -v_3 \tag{30}$$

7.7 Species s21

Name Complex_br_(Patched/Hedgehog)

Notes Long Name: Long Name: Long name not specifiedSynonym: Synonym not specifiedAccession: U05221Heterodimer Member Info: Hedgehog#PROTEIN#Hedgehog#P00688#Hh—Shh—Son hedgehog#;Patched#PROTEIN#Patched#P00689#Ptc—Ptc1#

Initial amount 0 mol

Charge 0

This species takes part in four reactions (as a product in r7 and as a modifier in r14, r15, r23).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s21} = v_3 \tag{31}$$

7.8 Species s46

Name Complex_br_(Costal2/Fused/_br_Smoothened)

Notes Long Name: Long Name: SmoothenedSynonym: Synonym not specifiedAccession: U05226Heterodimer Member Info: Smoothened#PROTEIN#Smoothened#P00685#Smo#;Fused#PROTEIN#F 2—Cos2—Costal-2#

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r15 and as a product in r14).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s46} = v_4 - v_8 \tag{32}$$

7.9 Species s48

Name Complex_br_(Costal2/Smoothened/_br_Fused)

Notes Long Name: Long Name: Long name not specifiedSynonym: Synonym not specifiedAccession: U05228Heterodimer Member Info: Smoothened#PROTEIN#Smoothened#P00685#Smo#;Fuse 2—Cos2—Costal-2#

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a product in r15 and as a modifier in r53).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s48} = v_8 \tag{33}$$

7.10 Species s69

Name Complex_br_(Costal2/Fused/_br_Smoothened)

Notes Long Name: Long Name: Long name not specifiedSynonym: Synonym not specifiedAccession: U05229Heterodimer Member Info: Smoothened#PROTEIN#Smoothened#P00685#Smo#;Fuse 2—Cos2—Costal-2#

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r14 and as a product in r25).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s69} = v_{12} - v_4 \tag{34}$$

7.11 Species s71

Name CBP

Notes Long Name: CBPSynonym: CREB binding protein,p300Accession: P00691

Initial amount 2 mol

Charge 0

This species takes part in one reaction (as a reactant in r54).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s71} = -v_{10} \tag{35}$$

7.12 Species s68

Name Microtubule

Notes Long Name: MicrotubuleSynonym: Synonym not specifiedAccession: P00696

Initial amount 0 mol

Charge 0

This species takes part in one reaction (as a product in r23).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s68} = v_9 \tag{36}$$

7.13 Species s70

Name Cubitus_space_interruptus

Notes Long Name: Cubitus interruptusSynonym: Ci,CiFL,Gli1,Gli2,Gli3Accession: P00690

Initial amount 0 mol

Charge 0

This species takes part in four reactions (as a reactant in r53, r54 and as a product in r53, r26).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s70} = v_6 + v_{11} - v_6 - v_{10} \tag{37}$$

7.14 Species s128

Name Complex_br_(Cubitus_space_interruptus_space_repressor/Su(fu))

Notes Long Name: Long Name: Long name not specifiedSynonym: Synonym not specifiedAccession: U05220Heterodimer Member Info: Cubitus interruptus repressor#PROTEIN#Cubitus interruptus repressor#P00687#CiR#;Su(fu)#PROTEIN#Su(fu)#P00699#Suppressor of Fused#

Initial amount 2.5 mol

Charge 0

This species takes part in one reaction (as a reactant in r51).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s128} = -v_5 \tag{38}$$

7.15 Species s140

Name Complex_br_(Sap18/Su(fu)/_br_Cubitus_space_interruptus_space_repressor)

Notes Long Name: Long Name: Long name not specifiedSynonym: Synonym not specifiedAccession: U05217Heterodimer Member Info: Cubitus interruptus repressor#PROTEIN#Cubitus interruptus repressor#P00687#CiR#;Sap18#PROTEIN#Sap18#P00697#Sin3-associated polypeptide 18#;Su(fu)#PROTEIN#Su(fu)#P00699#Suppressor of Fused#

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r52 and as a product in r51).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s140} = v_5 - v_1 \tag{39}$$

7.16 Species s148

Name smoothened

Initial amount 3 mol

Charge 0

This species takes part in one reaction (as a reactant in re24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s148} = -v_7 \tag{40}$$

7.17 Species s150

Name complex

Initial amount 3 mol

Charge 0

This species takes part in one reaction (as a reactant in re24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s150} = -v_7 \tag{41}$$

7.18 Species s152

Name MIcrotubule

Initial amount 0 mol

This species does not take part in any reactions. Its quantity does hence not change over time:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s152} = 0 \tag{42}$$

7.19 Species s157

Name sag

Initial amount 0.5 mol

Charge 0

This species takes part in one reaction (as a modifier in re24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s157} = 0 \tag{43}$$

7.20 Species s158

Name Complex_br_(CBP/Cubitus)

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r55 and as a product in r54).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s158} = v_{10} - v_2 \tag{44}$$

7.21 Species s159

Name Complex_br_(Costal2/Fused/../microtubule)

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r23 and as a product in re24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s159} = v_7 - v_9 \tag{45}$$

7.22 Species s160

Name Complex_br_(Su(fu)/Fused/../_br_Smoothened)

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r25 and as a product in r23).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s160} = v_9 - v_{12} \tag{46}$$

7.23 Species s161

Name Complex_br_(Su(fu)/Cubitus)

Initial amount 0 mol

Charge 0

This species takes part in two reactions (as a reactant in r26 and as a product in r25).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{s161} = v_{12} - v_{11} \tag{47}$$

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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