SBML Model Report

Model name: "Smolen2004_CircClock"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by Nicolas Le Novre[1] at June 24th 2005 at 12:05 a. m. and last time modified at February 25th 2015 at 1:17 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	9
events	0	constraints	0
reactions	22	function definitions	0
global parameters	45	unit definitions	2
rules	6	initial assignments	0

Model Notes

No inititial conditions are specified in the paper. Because there is a basal rate of transcription for each gene, it doesn't matter much. With the agreement of Paul Smolen, I put all the initial concentration at 0.001 nanomoles. N Le Novre.

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In summary, you are entitled to use this encoded model in absolutely any manner you deem suitable, verbatim, or with modification, alone or embedded it in a larger context, redistribute it, commercially or not, in a restricted way or not.

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 of which three are predefined by SBML and not mentioned in the model.

2.1 Unit `time`

Name hour

Definition 3600 s

2.2 Unit `substance`

Name nanomole

Definition nmol

2.3 Unit `volume`

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

Definition l

2.4 Unit `area`

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

Definition m^2

2.5 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
compartment_0000002	cytoplasm		3	1	litre	☑	
compartment_0000001	nucleus		3	1	litre	☑	compartment_0000002

3.1 Compartment compartment_0000002

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

Name cytoplasm

3.2 Compartment compartment_0000001

This is a three dimensional compartment with a constant size of one litre, which is surrounded by compartment_0000002 (cytoplasm).

Name nucleus

4 Species

This model contains nine 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
species_0000001	P0nuc	compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000002	P1nuc	compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000003	P2nuc	compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000004	P0cyt	compartment_0000002	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000005	P1cyt	compartment_0000002	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000006	P2cyt	compartment_0000002	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000007	VRI	compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000008	CLK	compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_0000009	PDP	compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 45 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
parameter_0000001	ACvri		0.000		☐
parameter_0000002	ACper		0.000		☐
parameter_0000003	ACpdp		0.000		☐
parameter_0000005	Kpv		0.200		☑
parameter_0000006	Kpp		0.240		☑
parameter_0000007	Kppd		0.100		☑
parameter_0000008	Kvc		0.540		☑
parameter_0000010	Kpdc		0.540		☑
parameter_0000011	Kcv		0.083		☑
parameter_0000012	Kcp		0.134		☑
parameter_0000013	Kcpd		0.248		☑
parameter_0000014	Kvdeac		0.212		☑
parameter_0000015	Kpdeac		0.212		☑
parameter_0000016	Kpddeac		0.212		☑
parameter_0000017	Fv		1.062		☑
parameter_0000018	Fp		1.062		☑
parameter_0000019	Fpd		1.062		☑
parameter_0000020	OPvri		0.000		☐

Id	Name	SBO	Value	Unit	Constant
parameter_0000021	OPper		0.000		⊟
parameter_0000022	OPpdp		0.000		⊟
parameter_0000023	Tvriop		2.825		☑
parameter_0000024	Tperop		2.825		☑
parameter_0000025	Tpdpop		2.825		☑
parameter_0000026	N		5.000		☑
parameter_0000027	Vper		10.620		☑
parameter_0000028	Vvri		76.464		☑
parameter_0000029	Vpdp		344.090		☑
parameter_0000030	Vclk		1.062		☑
parameter_0000031	Rpbas		0.021		☑
parameter_0000032	Rvbas		0.191		☑
parameter_0000033	Rcbas		0.001		☑
parameter_0000034	Rpdbas		0.382		☑
parameter_0000036	Vdclk		0.212		☑
parameter_0000037	vdvri		0.743		☑
parameter_0000038	vdpdp		0.690		☑
parameter_0000039	Tdelay		2.825		☑
parameter_0000040	Vpcyt		1.699		☑
parameter_0000041	Kpcyt		0.250		☑
parameter_0000042	Vpnuc		0.319		☑

Id	Name	SBO	Value	Unit	Constant
parameter_0000043	Kpnuc		0.001		☑
parameter_0000044	Vtrans		1.699		☑
parameter_0000045	Ktrans		0.250		☑
parameter_0000046	Vdegp		5.310		☑
parameter_0000047	Kdegp		0.010		☑
parameter_0000048	kd		0.005		☑

6 Rules

This is an overview of six rules.

6.1 Rule parameter_0000001

Rule parameter_0000001 is a rate rule for parameter parameter_0000001:

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{parameter\_0000001} &= \mathrm{parameter\_0000017} \cdot \frac{[\mathrm{species\_0000008}]}{[\mathrm{species\_0000008}] + \mathrm{parameter\_0000011}} \\ &\quad \cdot \frac{\mathrm{parameter\_0000005}}{\mathrm{parameter\_0000005} + [\mathrm{species\_0000001}] + [\mathrm{species\_0000002}] + [\mathrm{species\_0000003}]} \\ &\quad \cdot (1 - \mathrm{parameter\_0000001}) - \mathrm{parameter\_0000014} \cdot \mathrm{parameter\_0000001}\end{aligned} \tag{1}$$

6.2 Rule parameter_0000002

Rule parameter_0000002 is a rate rule for parameter parameter_0000002:

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{parameter\_0000002} &= \mathrm{parameter\_0000018} \cdot \frac{[\mathrm{species\_0000008}]}{[\mathrm{species\_0000008}] + \mathrm{parameter\_0000012}} \\ &\quad \cdot \frac{\mathrm{parameter\_0000006}}{\mathrm{parameter\_0000006} + [\mathrm{species\_0000001}] + [\mathrm{species\_0000002}] + [\mathrm{species\_0000003}]} \\ &\quad \cdot (1 - \mathrm{parameter\_0000002}) - \mathrm{parameter\_0000015} \cdot \mathrm{parameter\_0000002}\end{aligned} \tag{2}$$

6.3 Rule parameter_0000003

Rule parameter_0000003 is a rate rule for parameter parameter_0000003:

$$\begin{aligned}&\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{parameter\_0000003}\\&\quad= \mathrm{parameter\_0000019}\cdot\frac{[\mathrm{species\_0000008}]}{[\mathrm{species\_0000008}]+\mathrm{parameter\_0000013}}\\&\qquad\cdot\frac{\mathrm{parameter\_0000007}}{\mathrm{parameter\_0000007}+[\mathrm{species\_0000001}]+[\mathrm{species\_0000002}]+[\mathrm{species\_0000003}]}\\&\qquad\cdot(1-\mathrm{parameter\_0000003})-\mathrm{parameter\_0000016}\cdot\mathrm{parameter\_0000003}\end{aligned}\tag{3}$$

6.4 Rule parameter_0000020

Rule parameter_0000020 is a rate rule for parameter parameter_0000020:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{parameter\_0000020}=\frac{\mathrm{parameter\_0000001}^{\mathrm{parameter\_0000026}}-\mathrm{parameter\_0000020}}{\mathrm{parameter\_0000023}}\tag{4}$$

6.5 Rule parameter_0000021

Rule parameter_0000021 is a rate rule for parameter parameter_0000021:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{parameter\_0000021}=\frac{\mathrm{parameter\_0000002}^{\mathrm{parameter\_0000026}}-\mathrm{parameter\_0000021}}{\mathrm{parameter\_0000024}}\tag{5}$$

6.6 Rule parameter_0000022

Rule parameter_0000022 is a rate rule for parameter parameter_0000022:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{parameter\_0000022}=\frac{\mathrm{parameter\_0000003}^{\mathrm{parameter\_0000026}}-\mathrm{parameter\_0000022}}{\mathrm{parameter\_0000025}}\tag{6}$$

7 Reactions

This model contains 22 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_0000001	Per production	$\emptyset \longrightarrow$ species_0000004	
2	reaction_0000002	Vri production	$\emptyset \longrightarrow$ species_0000007	
3	reaction_0000003	Pdp production	$\emptyset \longrightarrow$ species_0000009	
4	reaction_0000004	Clk production	$\emptyset \xrightarrow{\text{species\_0000009, species\_0000007}}$ species_0000008	
5	reaction_0000005	Clk specific degradation	species_0000008 $\longrightarrow \emptyset$	
6	reaction_0000006	Pdp specific degradation	species_0000009 $\longrightarrow \emptyset$	
7	reaction_0000007	Vri specific degradation	species_0000007 $\longrightarrow \emptyset$	
8	reaction_0000008	first cytoplasmic Per phosphorylation	species_0000004 $\longrightarrow$ species_0000005	
9	reaction_0000009	second cytoplasmic Per phosphorylation	species_0000005 $\longrightarrow$ species_0000006	
10	reaction_0000010	Per nuclear transport	species_0000006 $\longrightarrow$ species_0000001	
11	reaction_0000011	first nuclear Per phosphorylation	species_0000001 $\longrightarrow$ species_0000002	

№	Id	Name	Reaction Equation	SBO
12	reaction_0000012	second nuclear Rer phosphorylation	species_0000002 ⟶ species_0000003	
13	reaction_0000013	Per specific degradation	species_0000003 ⟶ ∅	
14	reaction_0000014	Clk aspecific degradation	species_0000008 ⟶ ∅	
15	reaction_0000015	Pdp aspecific degradation	species_0000009 ⟶ ∅	
16	reaction_0000016	Vri aspecific degradation	species_0000007 ⟶ ∅	
17	reaction_0000017	Per_cyt aspecific degradation	species_0000004 ⟶ ∅	
18	reaction_0000018	Per-P_cyt aspecific degradation	species_0000005 ⟶ ∅	
19	reaction_0000019	Per-PP_cyt aspecific degradation	species_0000006 ⟶ ∅	
20	reaction_0000020	Per_nuc aspecific degradation	species_0000001 ⟶ ∅	
21	reaction_0000021	Per-P_nuc aspecific degradation	species_0000002 ⟶ ∅	
22	reaction_0000022	Per-PP_nuc aspecific degradation	species_0000003 ⟶ ∅	

7.1 Reaction reaction_0000001

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

Name Per production

Reaction equation

$$\emptyset \longrightarrow \text{species\_0000004} \tag{7}$$

Product

Table 6: Properties of each product.

Id	Name	SBO
species_0000004	P0cyt	

Kinetic Law

Derived unit contains undeclared units

$$\begin{aligned} v_1 = {} & \text{vol}(\text{compartment\_0000002}) \\ & \cdot (\text{parameter\_0000027} \cdot \text{parameter\_0000021} + \text{parameter\_0000031}) \end{aligned} \tag{8}$$

7.2 Reaction reaction_0000002

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

Name Vri production

Reaction equation

$$\emptyset \longrightarrow \text{species\_0000007} \tag{9}$$

Product

Table 7: Properties of each product.

Id	Name	SBO
species_0000007	VRI	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{parameter\_0000028} \cdot \mathrm{parameter\_0000020} + \mathrm{parameter\_0000032}\right) \tag{10}$$

7.3 Reaction `reaction_0000003`

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

Name Pdp production

Reaction equation

$$\emptyset \longrightarrow \mathrm{species\_0000009} \tag{11}$$

Product

Table 8: Properties of each product.

Id	Name	SBO
`species_0000009`	PDP	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{delay} \tag{12}$$

7.4 Reaction `reaction_0000004`

This is an irreversible reaction of no reactant forming one product influenced by two modifiers.

Name Clk production

Reaction equation

$$\emptyset \xrightarrow{\mathrm{species\_0000009},\ \mathrm{species\_0000007}} \mathrm{species\_0000008} \tag{13}$$

Modifiers

Table 9: Properties of each modifier.

Id	Name	SBO
species_0000009	PDP	
species_0000007	VRI	

Product

Table 10: Properties of each product.

Id	Name	SBO
species_0000008	CLK	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{parameter\_0000030} \cdot \frac{[\mathrm{species\_0000009}]^2}{[\mathrm{species\_0000009}]^2 + \mathrm{parameter\_0000010}^2} \cdot \frac{\mathrm{parameter\_0000008}^2}{[\mathrm{species\_0000007}]^2 + \mathrm{parameter\_0000008}^2} + \mathrm{parameter\_0000033}\right) \tag{14}$$

7.5 Reaction reaction_0000005

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

Name Clk specific degradation

Reaction equation

$$\mathrm{species\_0000008} \longrightarrow \emptyset \tag{15}$$

Reactant

Table 11: Properties of each reactant.

Id	Name	SBO
species_0000008	CLK	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot \mathrm{parameter\_0000036} \cdot [\mathrm{species\_0000008}] \tag{16}$$

7.6 Reaction `reaction_0000006`

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

Name Pdp specific degradation

Reaction equation

$$\mathrm{species\_0000009} \longrightarrow \emptyset \tag{17}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
`species_0000009`	PDP	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot \mathrm{parameter\_0000038} \cdot [\mathrm{species\_0000009}] \tag{18}$$

7.7 Reaction `reaction_0000007`

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

Name Vri specific degradation

Reaction equation

$$\mathrm{species\_0000007} \longrightarrow \emptyset \tag{19}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
species_0000007	VRI	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot \mathrm{parameter\_0000037} \cdot [\mathrm{species\_0000007}] \tag{20}$$

7.8 Reaction reaction_0000008

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

Name first cytoplasmic Per phosphorylation

Reaction equation

$$\mathrm{species\_0000004} \longrightarrow \mathrm{species\_0000005} \tag{21}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
species_0000004	P0cyt	

Product

Table 15: Properties of each product.

Id	Name	SBO
species_0000005	P1cyt	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\,(\mathrm{compartment\_0000002}) \cdot \frac{\mathrm{parameter\_0000040} \cdot [\mathrm{species\_0000004}]}{\mathrm{parameter\_0000041} + [\mathrm{species\_0000004}]} \tag{22}$$

7.9 Reaction reaction_0000009

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

Name second cytoplasmic Per phosphorylation

Reaction equation

$$\text{species\_0000005} \longrightarrow \text{species\_0000006} \tag{23}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
species_0000005	P1cyt	

Product

Table 17: Properties of each product.

Id	Name	SBO
species_0000006	P2cyt	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{vol}\left(\text{compartment\_0000002}\right) \cdot \frac{\text{parameter\_0000040} \cdot [\text{species\_0000005}]}{\text{parameter\_0000041} + [\text{species\_0000005}]} \tag{24}$$

7.10 Reaction reaction_0000010

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

Name Per nuclear transport

Reaction equation

$$\text{species\_0000006} \longrightarrow \text{species\_0000001} \tag{25}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
species_0000006	P2cyt	

Product

Table 19: Properties of each product.

Id	Name	SBO
species_0000001	P0nuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \mathrm{vol}\,(\mathrm{compartment\_0000002}) \cdot \frac{\mathrm{parameter\_0000044} \cdot [\mathrm{species\_0000006}]}{\mathrm{parameter\_0000045} + [\mathrm{species\_0000006}]} \tag{26}$$

7.11 Reaction reaction_0000011

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

Name first nuclear Per phosphorylation

Reaction equation

$$\mathrm{species\_0000001} \longrightarrow \mathrm{species\_0000002} \tag{27}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
species_0000001	P0nuc	

Product

Table 21: Properties of each product.

Id	Name	SBO
species_0000002	P1nuc	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot \frac{\mathrm{parameter\_0000042} \cdot [\mathrm{species\_0000001}]}{\mathrm{parameter\_0000043} + [\mathrm{species\_0000001}]} \tag{28}$$

7.12 Reaction `reaction_0000012`

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

Name second nuclear Rer phosphorylation

Reaction equation

$$\mathrm{species\_0000002} \longrightarrow \mathrm{species\_0000003} \tag{29}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
`species_0000002`	P1nuc	

Product

Table 23: Properties of each product.

Id	Name	SBO
`species_0000003`	P2nuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot \frac{\mathrm{parameter\_0000042} \cdot [\mathrm{species\_0000002}]}{\mathrm{parameter\_0000043} + [\mathrm{species\_0000002}]} \tag{30}$$

7.13 Reaction `reaction_0000013`

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

Name Per specific degradation

Reaction equation

$$\text{species\_0000003} \longrightarrow \emptyset \tag{31}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
species_0000003	P2nuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \frac{\text{parameter\_0000046} \cdot [\text{species\_0000003}]}{\text{parameter\_0000047} + [\text{species\_0000003}]} \tag{32}$$

7.14 Reaction reaction_0000014

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

Name Clk aspecific degradation

Reaction equation

$$\text{species\_0000008} \longrightarrow \emptyset \tag{33}$$

Reactant

Table 25: Properties of each reactant.

Id	Name	SBO
species_0000008	CLK	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000008}] \tag{34}$$

7.15 Reaction reaction_0000015

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

Name Pdp aspecific degradation

Reaction equation

$$\text{species\_0000009} \longrightarrow \emptyset \tag{35}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
species_0000009	PDP	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000009}] \tag{36}$$

7.16 Reaction reaction_0000016

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

Name Vri aspecific degradation

Reaction equation

$$\text{species\_0000007} \longrightarrow \emptyset \tag{37}$$

Reactant

Table 27: Properties of each reactant.

Id	Name	SBO
species_0000007	VRI	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000007}] \tag{38}$$

7.17 Reaction reaction_0000017

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

Name Per_cyt aspecific degradation

Reaction equation

$$\text{species\_0000004} \longrightarrow \emptyset \tag{39}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
species_0000004	P0cyt	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \text{vol}\left(\text{compartment\_0000002}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000004}] \tag{40}$$

7.18 Reaction reaction_0000018

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

Name Per-P_cyt aspecific degradation

Reaction equation

$$\text{species\_0000005} \longrightarrow \emptyset \tag{41}$$

Reactant

Table 29: Properties of each reactant.

Id	Name	SBO
species_0000005	P1cyt	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{vol}\left(\text{compartment\_0000002}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000005}] \tag{42}$$

7.19 Reaction reaction_0000019

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

Name Per-PP_cyt aspecific degradation

Reaction equation

$$\text{species\_0000006} \longrightarrow \emptyset \tag{43}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
species_0000006	P2cyt	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{vol}\left(\text{compartment\_0000002}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000006}] \tag{44}$$

7.20 Reaction reaction_0000020

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

Name Per_nuc aspecific degradation

Reaction equation

$$\text{species\_0000001} \longrightarrow \emptyset \tag{45}$$

Reactant

Table 31: Properties of each reactant.

Id	Name	SBO
species_0000001	P0nuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000001}] \tag{46}$$

7.21 Reaction reaction_0000021

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

Name Per-P_nuc aspecific degradation

Reaction equation

$$\text{species\_0000002} \longrightarrow \emptyset \tag{47}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
species_0000002	P1nuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000002}] \tag{48}$$

7.22 Reaction reaction_0000022

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

Name Per-PP_nuc aspecific degradation

Reaction equation

$$\text{species\_0000003} \longrightarrow \emptyset \tag{49}$$

Reactant

Table 33: Properties of each reactant.

Id	Name	SBO
species_0000003	P2nuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{parameter\_0000048} \cdot [\text{species\_0000003}] \tag{50}$$

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 `species_0000001`

Name P0nuc

Initial concentration $0.0010\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_0000011`, `reaction_0000020` and as a product in `reaction_0000010`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000001} = v_{10} - v_{11} - v_{20} \tag{51}$$

8.2 Species `species_0000002`

Name P1nuc

Initial concentration $0.0010\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_0000012`, `reaction_0000021` and as a product in `reaction_0000011`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000002} = v_{11} - v_{12} - v_{21} \tag{52}$$

8.3 Species `species_0000003`

Name P2nuc

Initial concentration $0.0010\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_0000013`, `reaction_0000022` and as a product in `reaction_0000012`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000003} = v_{12} - v_{13} - v_{22} \tag{53}$$

8.4 Species species_0000004

Name P0cyt

Initial concentration $0.0010\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_0000008, reaction_0000017 and as a product in reaction_0000001).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000004} = v_1 - v_8 - v_{17} \tag{54}$$

8.5 Species species_0000005

Name P1cyt

Initial concentration $0.0010\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_0000009, reaction_0000018 and as a product in reaction_0000008).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000005} = v_8 - v_9 - v_{18} \tag{55}$$

8.6 Species species_0000006

Name P2cyt

Initial concentration $0.0010\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_0000010, reaction_0000019 and as a product in reaction_0000009).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000006} = v_9 - v_{10} - v_{19} \tag{56}$$

8.7 Species species_0000007

Name VRI

Initial concentration $0.0010\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in reaction_0000007, reaction_0000016 and as a product in reaction_0000002 and as a modifier in reaction_0000004).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000007} = v_2 - v_7 - v_{16} \tag{57}$$

8.8 Species species_0000008

Name CLK

Initial concentration $0.0010\,\mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_0000005, reaction_0000014 and as a product in reaction_0000004).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000008} = v_4 - v_5 - v_{14} \tag{58}$$

8.9 Species species_0000009

Name PDP

Initial concentration $0.0010\,\mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in reaction_0000006, reaction_0000015 and as a product in reaction_0000003 and as a modifier in reaction_0000004).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_0000009} = v_3 - v_6 - v_{15} \tag{59}$$

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