SBML Model Report

Model name: "Novak2001_FissionYeast_CellCycle"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by Harish Dharuri[1] at April thirteenth 2007 at 5:35 a. m. and last time modified at July fifth 2012 at 4:47 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	1
species types	0	species	10
events	2	constraints	0
reactions	19	function definitions	0
global parameters	53	unit definitions	3
rules	6	initial assignments	0

Model Notes

The model reproduces the time evolution of several species as depicted in Fig 4 of the paper. Events have been used to reset cell mass when the value of M-phase promoting factor (MPF) decreases through 0.1. The model was successfully tested on Cell Designer.

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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 six 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 `min_inv`

Name min_inv

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

2.3 Unit `substance`

Name norm. substance

Definition dimensionless

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 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`cell`	cell		3	1	litre	☑	

3.1 Compartment `cell`

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

Name cell

4 Species

This model contains ten species. Section 9 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
cdc13T	Total cdc13	cell	dimensionless	⊟	⊟
preMPF	preMPF	cell	dimensionless	⊟	⊟
ste9	ste9	cell	dimensionless	⊟	⊟
slp1T	slp1T	cell	dimensionless	⊟	⊟
slp1	slp1	cell	dimensionless	⊟	⊟
IEP	IEP	cell	dimensionless	⊟	⊟
rum1T	rum1T	cell	dimensionless	⊟	⊟
SK	SK	cell	dimensionless	⊟	⊟
M	Cell Mass	cell	dimensionless	⊟	⊟
MPF	M-phase promoting factor	cell	dimensionless	⊟	⊟

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5 Parameters

This model contains 53 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
flag_MPF			0.000	dimensionless	☐
sigma			0.000	dimensionless	☐
Kdiss			0.001	dimensionless	☑
Trimer			0.000	dimensionless	☐
TF			0.000	dimensionless	☐
k15			1.500	$(60\ \mathrm{s})^{-1}$	☑
J16			0.010	dimensionless	☑
k16_prime			1.000	$(60\ \mathrm{s})^{-1}$	☑
k16_double_prime			2.000	$(60\ \mathrm{s})^{-1}$	☑
J15			0.010	dimensionless	☑
kwee			0.000	$(60\ \mathrm{s})^{-1}$	☐
kwee_prime			0.150	$(60\ \mathrm{s})^{-1}$	☑
kwee_double_prime			1.300	$(60\ \mathrm{s})^{-1}$	☑
Vawee			0.250	$(60\ \mathrm{s})^{-1}$	☑
Jiwee			0.010	dimensionless	☑
Viwee			1.000	$(60\ \mathrm{s})^{-1}$	☑
Jawee			0.010	dimensionless	☑
k25			0.000	$(60\ \mathrm{s})^{-1}$	☐
k25_prime			0.050	$(60\ \mathrm{s})^{-1}$	☑
k25_double_prime			5.000	$(60\ \mathrm{s})^{-1}$	☑
Va25			1.000	$(60\ \mathrm{s})^{-1}$	☑
Ji25			0.010	dimensionless	☑
Vi25			0.250	$(60\ \mathrm{s})^{-1}$	☑
Ja25			0.010	dimensionless	☑
k1			0.030	$(60\ \mathrm{s})^{-1}$	☑
k2_prime			0.030	$(60\ \mathrm{s})^{-1}$	☑
k2_double_prime			1.000	$(60\ \mathrm{s})^{-1}$	☑
k2_triple_prime			0.100	$(60\ \mathrm{s})^{-1}$	☑
k3_prime			1.000	$(60\ \mathrm{s})^{-1}$	☑

Id	Name	SBO	Value	Unit	Constant
k3_double-_prime			10.000	$(60\ \mathrm{s})^{-1}$	☑
J3			0.010	dimensionless	☑
k4_prime			2.000	$(60\ \mathrm{s})^{-1}$	☑
k4			35.000	$(60\ \mathrm{s})^{-1}$	☑
J4			0.010	dimensionless	☑
k5_prime			0.005	$(60\ \mathrm{s})^{-1}$	☑
k5_double-_prime			0.300	$(60\ \mathrm{s})^{-1}$	☑
J5			0.300	dimensionless	☑
k6			0.100	$(60\ \mathrm{s})^{-1}$	☑
k7			1.000	$(60\ \mathrm{s})^{-1}$	☑
J7			0.001	dimensionless	☑
k8			0.250	$(60\ \mathrm{s})^{-1}$	☑
J8			0.001	dimensionless	☑
k9			0.100	$(60\ \mathrm{s})^{-1}$	☑
J9			0.010	dimensionless	☑
k10			0.040	$(60\ \mathrm{s})^{-1}$	☑
J10			0.010	dimensionless	☑
k11			0.100	$(60\ \mathrm{s})^{-1}$	☑
k12			0.010	$(60\ \mathrm{s})^{-1}$	☑
k12_prime			1.000	$(60\ \mathrm{s})^{-1}$	☑
k12_double-_prime			3.000	$(60\ \mathrm{s})^{-1}$	☑
k13			0.100	$(60\ \mathrm{s})^{-1}$	☑
k14			0.100	$(60\ \mathrm{s})^{-1}$	☑
mu			0.005	$(60\ \mathrm{s})^{-1}$	☑

6 Rules

This is an overview of six rules.

6.1 Rule sigma

Rule sigma is an assignment rule for parameter sigma:

$$\mathrm{sigma} = \mathrm{cdc13T} + \mathrm{rum1T} + \mathrm{Kdiss} \tag{1}$$

Derived unit dimensionless

6.2 Rule `Trimer`

Rule `Trimer` is an assignment rule for parameter `Trimer`:

$$\text{Trimer} = \frac{2 \cdot \text{cdc13T} \cdot \text{rum1T}}{\text{sigma} + \left(\text{sigma}^2 - 4 \cdot \text{cdc13T} \cdot \text{rum1T}\right)^{0.5}} \tag{2}$$

6.3 Rule `MPF`

Rule `MPF` is an assignment rule for species `MPF`:

$$[\text{MPF}] = \frac{(\text{cdc13T} - \text{preMPF}) \cdot (\text{cdc13T} - \text{Trimer})}{\text{cdc13T}} \tag{3}$$

Derived unit dimensionless

6.4 Rule `TF`

Rule `TF` is an assignment rule for parameter `TF`:

$$\text{TF} = \frac{2 \cdot \text{k15} \cdot \text{M} \cdot \text{J16}}{\text{k16\_prime} + \text{k16\_double\_prime} \cdot \text{MPF} - \text{k15} \cdot \text{M} + (\text{k16\_prime} + \text{k16\_double\_prime} \cdot \text{MPF}) \cdot \text{J15} + \text{k15} \cdot \text{M} \cdot \text{J1}} \tag{4}$$

6.5 Rule `kwee`

Rule `kwee` is an assignment rule for parameter `kwee`:

$$\text{kwee} = \text{kwee\_prime} + (\text{kwee\_double\_prime} - \text{kwee\_prime}) \cdot \frac{2 \cdot \text{Vawee} \cdot \text{Jiwee}}{\text{Viwee} \cdot \text{MPF} - \text{Vawee} + \text{Viwee} \cdot \text{MPF} \cdot \text{Jawee} + \text{Vawee} \cdot \text{Jiwee} + \sqrt{2}} \tag{5}$$

6.6 Rule `k25`

Rule `k25` is an assignment rule for parameter `k25`:

$$\text{k25} = \text{k25\_prime} + (\text{k25\_double\_prime} - \text{k25\_prime}) \cdot \frac{2 \cdot \text{Va25} \cdot \text{MPF} \cdot \text{Ji25}}{\text{Vi25} - \text{Va25} \cdot \text{MPF} + \text{Vi25} \cdot \text{Ja25} + \text{Va25} \cdot \text{MPF} \cdot \text{Ji25} + \sqrt{2}} \tag{6}$$

7 Events

This is an overview of two events. 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.

7.1 Event event_0000001

Notes The two events are used to reset the cell mass (divide by two) when MPF decreases through 0.1

Trigger condition

$$(\mathrm{MPF} \leq 0.1) \wedge (\mathrm{flag\_MPF} = 1) \tag{7}$$

Assignments

$$[\mathrm{M}] = \frac{\mathrm{M}}{2} \tag{8}$$

$$\mathrm{flag\_MPF} = 0 \tag{9}$$

7.2 Event event_0000002

Trigger condition

$$\mathrm{MPF} > 0.1 \tag{10}$$

Assignment

$$\mathrm{flag\_MPF} = 1 \tag{11}$$

8 Reactions

This model contains 19 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	cdc13T synthesis	$\emptyset \xrightarrow{\text{M}} \text{cdc13T}$	
2	R2	Targeting cdc13T to APC core	$\text{cdc13T} \xrightarrow{\text{ste9, slp1}} \emptyset$	
3	R3	wee1 dependent MPF inactivation	$\emptyset \xrightarrow{\text{cdc13T}} \text{preMPF}$	
4	R4	cdc25 dependent preMPF phosphorylation	$\text{preMPF} \longrightarrow \emptyset$	
5	R5	preMPF inactivation	$\text{preMPF} \xrightarrow{\text{ste9, slp1}} \emptyset$	
6	R6	slp1 dependent ste9 activation	$\emptyset \xrightarrow{\text{slp1}} \text{ste9}$	
7	R7	ste9 phosphorylation (inactivation) by starter kinase	$\text{ste9} \xrightarrow{\text{SK, MPF}} \emptyset$	
8	R8	slp1T activation by MPF	$\emptyset \xrightarrow{\text{MPF}} \text{slp1T}$	
9	R9	slp1T inactivation	$\text{slp1T} \longrightarrow \emptyset$	
10	R10	slp1 activation by intermediary enzyme	$\emptyset \xrightarrow{\text{IEP, slp1T}} \text{slp1}$	
11	R11	slp1 inactivation	$\text{slp1} \longrightarrow \emptyset$	
12	R12	slp1 inactivation	$\text{slp1} \longrightarrow \emptyset$	
13	R13	Intermediary enzyme activation	$\emptyset \xrightarrow{\text{MPF}} \text{IEP}$	
14	R14	IEP inactivation	$\text{IEP} \longrightarrow \emptyset$	
15	R15	rum1T activation	$\emptyset \longrightarrow \text{rum1T}$	
16	R16	SK dependent rum1T inactivation	$\text{rum1T} \xrightarrow{\text{SK, MPF}} \emptyset$	
17	R17	SK synthesis	$\emptyset \longrightarrow \text{SK}$	
18	R18	SK degradation	$\text{SK} \longrightarrow \emptyset$	

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№	Id	Name	Reaction Equation	SBO
19	`R19`	Cell growth	$\emptyset \longrightarrow \mathrm{M}$	

Produced by SBML2LaTeX

8.1 Reaction R1

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

Name cdc13T synthesis

Reaction equation

$$\emptyset \xrightarrow{\mathrm{M}} \mathrm{cdc13T} \tag{12}$$

Modifier

Table 6: Properties of each modifier.

Id	Name	SBO
M	Cell Mass	

Product

Table 7: Properties of each product.

Id	Name	SBO
cdc13T	Total cdc13	

Kinetic Law

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

$$v_1 = \mathrm{k1} \cdot \mathrm{M} \tag{13}$$

8.2 Reaction R2

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

Name Targeting cdc13T to APC core

Reaction equation

$$\mathrm{cdc13T} \xrightarrow{\mathrm{ste9,\ slp1}} \emptyset \tag{14}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
cdc13T	Total cdc13	

Modifiers

Table 9: Properties of each modifier.

Id	Name	SBO
ste9	ste9	
slp1	slp1	

Kinetic Law

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

$$v_2 = (\mathrm{k2\_prime} + \mathrm{k2\_double\_prime} \cdot \mathrm{ste9} + \mathrm{k2\_triple\_prime} \cdot \mathrm{slp1}) \cdot \mathrm{cdc13T} \tag{15}$$

8.3 Reaction R3

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

Name wee1 dependent MPF inactivation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cdc13T}} \mathrm{preMPF} \tag{16}$$

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
cdc13T	Total cdc13	

Product

Table 11: Properties of each product.

Id	Name	SBO
preMPF	preMPF	

Kinetic Law

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

$$v_3 = \mathrm{kwee} \cdot (\mathrm{cdc13T} - \mathrm{preMPF}) \tag{17}$$

8.4 Reaction R4

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

Name cdc25 dependent preMPF phosphorylation

Reaction equation

$$\mathrm{preMPF} \longrightarrow \emptyset \tag{18}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
preMPF	preMPF	

Kinetic Law

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

$$v_4 = \mathrm{k25} \cdot \mathrm{preMPF} \tag{19}$$

8.5 Reaction R5

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

Name preMPF inactivation

Reaction equation

$$\mathrm{preMPF} \xrightarrow{\mathrm{ste9,\ slp1}} \emptyset \tag{20}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
preMPF	preMPF	

Modifiers

Table 14: Properties of each modifier.

Id	Name	SBO
ste9	ste9	
slp1	slp1	

Kinetic Law

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

$$v_5 = (\mathrm{k2\_prime} + \mathrm{k2\_double\_prime} \cdot \mathrm{ste9} + \mathrm{k2\_triple\_prime} \cdot \mathrm{slp1}) \cdot \mathrm{preMPF} \tag{21}$$

8.6 Reaction R6

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

Name slp1 dependent ste9 activation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{slp1}} \mathrm{ste9} \tag{22}$$

Modifier

Table 15: Properties of each modifier.

Id	Name	SBO
slp1	slp1	

Product

Table 16: Properties of each product.

Id	Name	SBO
ste9	ste9	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \frac{(\text{k3\_prime} + \text{k3\_double\_prime} \cdot \text{slp1}) \cdot (1 - \text{ste9})}{\text{J3} + 1 - \text{ste9}} \tag{23}$$

8.7 Reaction R7

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

Name ste9 phosphorylation (inactivation) by starter kinase

Reaction equation

$$\text{ste9} \xrightarrow{\text{SK, MPF}} \emptyset \tag{24}$$

Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
ste9	ste9	

Modifiers

Table 18: Properties of each modifier.

Id	Name	SBO
SK	SK	
MPF	M-phase promoting factor	

Kinetic Law

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

$$v_7 = \frac{(\text{k4\_prime} \cdot \text{SK} + \text{k4} \cdot \text{MPF}) \cdot \text{ste9}}{\text{J4} + \text{ste9}} \tag{25}$$

8.8 Reaction R8

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

Name slp1T activation by MPF

Reaction equation

$$\emptyset \xrightarrow{\text{MPF}} \text{slp1T} \tag{26}$$

Modifier

Table 19: Properties of each modifier.

Id	Name	SBO
MPF	M-phase promoting factor	

Product

Table 20: Properties of each product.

Id	Name	SBO
slp1T	slp1T	

Kinetic Law

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

$$v_8 = \text{k5\_prime} + \frac{\text{k5\_double\_prime} \cdot \text{MPF}^4}{\text{J5}^4 + \text{MPF}^4} \tag{27}$$

8.9 Reaction R9

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

Name slp1T inactivation

Reaction equation

$$\text{slp1T} \longrightarrow \emptyset \tag{28}$$

Reactant

Table 21: Properties of each reactant.

Id	Name	SBO
slp1T	slp1T	

Kinetic Law

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

$$v_9 = \mathrm{k6} \cdot \mathrm{slp1T} \tag{29}$$

8.10 Reaction R10

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

Name slp1 activation by intermediary enzyme

Reaction equation

$$\emptyset \xrightarrow{\mathrm{IEP},\ \mathrm{slp1T}} \mathrm{slp1} \tag{30}$$

Modifiers

Table 22: Properties of each modifier.

Id	Name	SBO
IEP	IEP	
slp1T	slp1T	

Product

Table 23: Properties of each product.

Id	Name	SBO
slp1	slp1	

Kinetic Law

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

$$v_{10} = \frac{\mathrm{k7} \cdot \mathrm{IEP} \cdot (\mathrm{slp1T} - \mathrm{slp1})}{\mathrm{J7} + \mathrm{slp1T} - \mathrm{slp1}} \tag{31}$$

8.11 Reaction R11

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

Name slp1 inactivation

Reaction equation

$$\text{slp1} \longrightarrow \emptyset \tag{32}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
slp1	slp1	

Kinetic Law

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

$$v_{11} = \frac{\text{k8} \cdot \text{slp1}}{\text{J8} + \text{slp1}} \tag{33}$$

8.12 Reaction R12

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

Name slp1 inactivation

Reaction equation

$$\text{slp1} \longrightarrow \emptyset \tag{34}$$

Reactant

Table 25: Properties of each reactant.

Id	Name	SBO
slp1	slp1	

Kinetic Law

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

$$v_{12} = \mathrm{k6} \cdot \mathrm{slp1} \tag{35}$$

8.13 Reaction R13

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

Name Intermediary enzyme activation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{MPF}} \mathrm{IEP} \tag{36}$$

Modifier

Table 26: Properties of each modifier.

Id	Name	SBO
MPF	M-phase promoting factor	

Product

Table 27: Properties of each product.

Id	Name	SBO
IEP	IEP	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \frac{\mathrm{k9} \cdot \mathrm{MPF} \cdot (1 - \mathrm{IEP})}{\mathrm{J9} + 1 - \mathrm{IEP}} \tag{37}$$

8.14 Reaction R14

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

Name IEP inactivation

Reaction equation

$$\mathrm{IEP} \longrightarrow \emptyset \tag{38}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
IEP	IEP	

Kinetic Law

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

$$v_{14} = \frac{\mathrm{k10} \cdot \mathrm{IEP}}{\mathrm{J10} + \mathrm{IEP}} \tag{39}$$

8.15 Reaction R15

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

Name rum1T activation

Reaction equation

$$\emptyset \longrightarrow \mathrm{rum1T} \tag{40}$$

Product

Table 29: Properties of each product.

Id	Name	SBO
rum1T	rum1T	

Kinetic Law

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

$$v_{15} = \mathrm{k11} \tag{41}$$

8.16 Reaction R16

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

Name SK dependent rum1T inactivation

Reaction equation

$$\mathrm{rum1T} \xrightarrow{\mathrm{SK,\ MPF}} \emptyset \tag{42}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
rum1T	rum1T	

Modifiers

Table 31: Properties of each modifier.

Id	Name	SBO
SK	SK	
MPF	M-phase promoting factor	

Kinetic Law

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

$$v_{16} = (\mathrm{k12} + \mathrm{k12\_prime} \cdot \mathrm{SK} + \mathrm{k12\_double\_prime} \cdot \mathrm{MPF}) \cdot \mathrm{rum1T} \tag{43}$$

8.17 Reaction R17

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

Name SK synthesis

Reaction equation

$$\emptyset \longrightarrow \mathrm{SK} \tag{44}$$

Product

Table 32: Properties of each product.

Id	Name	SBO
SK	SK	

Kinetic Law

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

$$v_{17} = \mathrm{k13} \cdot \mathrm{TF} \tag{45}$$

8.18 Reaction R18

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

Name SK degradation

Reaction equation

$$\mathrm{SK} \longrightarrow \emptyset \tag{46}$$

Reactant

Table 33: Properties of each reactant.

Id	Name	SBO
SK	SK	

Kinetic Law

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

$$v_{18} = \mathrm{k14} \cdot \mathrm{SK} \tag{47}$$

8.19 Reaction R19

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

Name Cell growth

Reaction equation

$$\emptyset \longrightarrow \mathrm{M} \tag{48}$$

Product

Table 34: Properties of each product.

Id	Name	SBO
M	Cell Mass	

Kinetic Law

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

$$v_{19} = \mathrm{mu} \cdot \mathrm{M} \tag{49}$$

9 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.

9.1 Species `cdc13T`

Name Total cdc13

Initial amount 0.2 dimensionless

This species takes part in three reactions (as a reactant in R2 and as a product in R1 and as a modifier in R3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cdc13T} = v_1 - v_2 \tag{50}$$

9.2 Species `preMPF`

Name preMPF

Initial amount 0 dimensionless

This species takes part in three reactions (as a reactant in R4, R5 and as a product in R3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{preMPF} = v_3 - v_4 - v_5 \tag{51}$$

9.3 Species ste9

Name ste9

Initial amount 1 dimensionless

This species takes part in four reactions (as a reactant in R7 and as a product in R6 and as a modifier in R2, R5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ste9} = v_6 - v_7 \tag{52}$$

9.4 Species slp1T

Name slp1T

Initial amount 0 dimensionless

This species takes part in three reactions (as a reactant in R9 and as a product in R8 and as a modifier in R10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{slp1T} = v_8 - v_9 \tag{53}$$

9.5 Species slp1

Name slp1

Initial amount 2.2 dimensionless

This species takes part in six reactions (as a reactant in R11, R12 and as a product in R10 and as a modifier in R2, R5, R6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{slp1} = v_{10} - v_{11} - v_{12} \tag{54}$$

9.6 Species IEP

Name IEP

Initial amount 0 dimensionless

This species takes part in three reactions (as a reactant in R14 and as a product in R13 and as a modifier in R10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IEP} = v_{13} - v_{14} \tag{55}$$

9.7 Species rum1T

Name rum1T

Initial amount 0 dimensionless

This species takes part in two reactions (as a reactant in R16 and as a product in R15).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{rum1T} = v_{15} - v_{16} \tag{56}$$

9.8 Species SK

Name SK

Initial amount 0 dimensionless

This species takes part in four reactions (as a reactant in R18 and as a product in R17 and as a modifier in R7, R16).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{SK} = v_{17} - v_{18} \tag{57}$$

9.9 Species M

Name Cell Mass

Initial amount 1 dimensionless

Involved in event event_0000001

This species takes part in two reactions (as a product in R19 and as a modifier in R1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{M} = v_{19} \tag{58}$$

Furthermore, one event influences this species' rate of change.

9.10 Species MPF

Name M-phase promoting factor

Initial amount 0 dimensionless

Involved in rule MPF

This species takes part in four reactions (as a modifier in R7, R8, R13, R16) and is also involved in one rule which determines this species' quantity.

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