SBML Model Report

Model name: "Xie2007_CircClock"

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 January 22nd 2008 at 7:26 a. m. and last time modified at July fifth 2012 at 2:37 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	25
events	0	constraints	0
reactions	41	function definitions	0
global parameters	47	unit definitions	2
rules	0	initial assignments	0

Model Notes

The model reproduces the oscillations for mRNA and protein species as depicted in Fig 3 of the plot. The model differs slightly from that given in the paper and this was made after a communication from the authors. The values of parameters tcvriclkp, tcdvpmt and dccpt are slightly different. Also, although it is not given in the paper, rate laws for reactions re20, re28, re35, re42, re43 and re45 are multiplied by a specie. Model was successfully tested on MathSBML

[1]California Institute of Technology, hdharuri@cds.caltech.edu

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 `substance`

Name nano mole

Definition nmol

2.2 Unit `time`

Name hour

Definition 3600 s

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 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

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

3.1 Compartment `wholeCell`

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

Name wholeCell

4 Species

This model contains 25 species. The boundary condition of one of these species is set to `true` so that this species' amount cannot be changed by any reaction. 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
CC	CC	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
CCPT	CCPT	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
clkp	clkp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
perp	perp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
clkm	clkm	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
perm	perm	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PT	PT	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
vrip	vrip	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
vrim	vrim	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
VRI	VRI	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
pdpp	pdpp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
pdpm	pdpm	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PDP	PDP	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
CLK	CLK	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PER	PER	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
timp	timp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
timm	timm	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
TIM	TIM	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
CYC	CYC	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☑	☑
prcper	CCbindingPer	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
prcv	CCbindingvri	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
prcpdp	CCbindingpdp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
prvc	VRIbindingclkp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
prpc	PDPbindingclkp	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
prct	CCbindingtim	wholeCell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 47 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dccpt			15.060		☑
bccperp			0.069		☑
ubccperp			0.262		☑
bccpt			51.000		☑
dperm			0.053		☑
tlper			36.000		☑
tcccperp			11.000		☑
tcdvpmt			0.028		☑
dvri			1.226		☑
tcclkp			1.420		☑
bcc			2.349		☑
dclk			0.200		☑
ubcc			0.890		☑
bpt			1.100		☑
ubpt			2.930		☑
dper			0.620		☑
tcccvrip			16.860		☑
tcccpdpp			9.831		☑
dvrim			0.070		☑
dpdpm			0.060		☑
ubccpt			7.890		☑
tlvri			14.680		☑
tlpdp			1.870		☑
bccvrip			0.100		☑
bccpdpp			0.062		☑
ubccvrip			0.276		☑
ubccpdpp			0.145		☑
tcpdpclkp			125.540		☑
dclkm			0.643		☑
bvriclkp			1.858		☑
bpdpclkp			1.155		☑
ubvriclkp			1.043		☑
ubpdpclkp			0.952		☑
tcvriclkp			0.053		☑
dpdp			0.156		☑
tlclk			35.000		☑
dcc			0.184		☑

Id	Name	SBO	Value	Unit	Constant
dpt			0.279		☑
dtim			0.620		☑
dtimm			0.053		☑
tltim			36.000		☑
bcctimp			0.069		☑
ubcctimp			0.262		☑
tccctimp			11.000		☑
npt			5.000		☑
nvri			4.000		☑
npdp			6.000		☑

6 Reactions

This model contains 41 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	re1	CC PT association	$CC + PT \longrightarrow CCPT$	
2	re2	Degradation of CLK CYK dimer	$CC \longrightarrow \emptyset$	
3	re3	Degradation of CC PT dimer	$CCPT \longrightarrow \emptyset$	
4	re4	Degradation of PER TIM dimer	$PT \longrightarrow \emptyset$	
5	re9	Degradation of clk mRNA	$clkm \longrightarrow \emptyset$	
6	re10	clkm translation	$\emptyset \xrightarrow{clkm} CLK$	
7	re15	Degradation of per mRNA	$perm \longrightarrow \emptyset$	
8	re17	perm translation	$\emptyset \xrightarrow{perm} PER$	
9	re20	per transcription	$\emptyset \xrightarrow{prcper,\ perp} perm$	
10	re28	vri transcription	$\emptyset \xrightarrow{prcv,\ vrip} vrim$	
11	re30	Degradation of vri mRNA	$vrim \longrightarrow \emptyset$	
12	re31	vrim translation	$\emptyset \xrightarrow{vrim} VRI$	
13	re32	VRI protein degradation	$VRI \longrightarrow \emptyset$	
14	re35	pdp transcription	$\emptyset \xrightarrow{prcpdp,\ pdpp} pdpm$	
15	re37	Degradation of pdp mRNA	$pdpm \longrightarrow \emptyset$	
16	re38	pdpm translation	$\emptyset \xrightarrow{pdpm} PDP$	
17	re39	PDP protein degradation	$PDP \longrightarrow \emptyset$	
18	re42	clk transcription	$\emptyset \xrightarrow{prvc,\ clkp,\ prpc} clkm$	
19	re43	CLK CYC association	$CLK + CYC \longrightarrow CC$	

№	Id	Name	Reaction Equation	SBO
20	re44	CLK protein degradation	$\mathrm{CLK} \longrightarrow \emptyset$	
21	re45	CLK CYC dissociation	$\mathrm{CC} \longrightarrow \mathrm{CLK} + \mathrm{CYC}$	
22	re46	PER TIM association	$\mathrm{PER} + \mathrm{TIM} \longrightarrow \mathrm{PT}$	
23	re47	PER TIM dissociation	$\mathrm{PT} \longrightarrow \mathrm{PER} + \mathrm{TIM}$	
24	re48	PER protein degradation	$\mathrm{PER} \longrightarrow \emptyset$	
25	re51	tim transcription	$\emptyset \xrightarrow{\text{prct, timp}} \mathrm{timm}$	
26	re53	Degradation of tim mRNA	$\mathrm{timm} \longrightarrow \emptyset$	
27	re54	timm translation	$\emptyset \xrightarrow{\text{timm}} \mathrm{TIM}$	
28	re55	TIM protein degradation	$\mathrm{TIM} \longrightarrow \emptyset$	
29	re56	CC PT dimer dissociation	$\mathrm{CCPT} \longrightarrow \mathrm{CC} + \mathrm{PT}$	
30	re57	CC binding probability in per promoter	$\emptyset \xrightarrow{\text{CC}} \mathrm{prcper}$	
31	re58	CC Unbinding probability in per promoter	$\mathrm{prcper} \longrightarrow \emptyset$	
32	re59	CC Unbinding probability in vri promoter	$\mathrm{prcv} \longrightarrow \emptyset$	
33	re60	CC binding probability in vri promoter	$\emptyset \xrightarrow{\text{CC}} \mathrm{prcv}$	
34	re61	CC Unbinding probability in pdp1 promoter	$\mathrm{prcpdp} \longrightarrow \emptyset$	
35	re62	CC binding probability in pdp1 promoter	$\emptyset \xrightarrow{\text{CC}} \mathrm{prcpdp}$	
36	re63	VRI binding clk promoter	$\emptyset \xrightarrow{\text{prpc, VRI}} \mathrm{prvc}$	
37	re64	VRI unbinding clk promoter	$\mathrm{prvc} \longrightarrow \emptyset$	
38	re65	PDP binding clk promoter	$\emptyset \xrightarrow{\text{prvc, PDP}} \mathrm{prpc}$	
39	re66	PDP unbinding clk promoter	$\mathrm{prpc} \longrightarrow \emptyset$	
40	re68	CC binding probability in tim promoter	$\emptyset \xrightarrow{\text{CC}} \mathrm{prct}$	
41	re69	CC Unbinding probability in tim promoter	$\mathrm{prct} \longrightarrow \emptyset$	

6.1 Reaction re1

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

Name CC PT association

Reaction equation

$$\mathrm{CC} + \mathrm{PT} \longrightarrow \mathrm{CCPT} \tag{1}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
CC	CC	
PT	PT	

Product

Table 7: Properties of each product.

Id	Name	SBO
CCPT	CCPT	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{CC}] \cdot [\mathrm{PT}] \cdot \mathrm{bccpt} \tag{2}$$

6.2 Reaction re2

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

Name Degradation of CLK CYK dimer

Reaction equation

$$\mathrm{CC} \longrightarrow \emptyset \tag{3}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
CC	CC	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{CC}] \cdot \mathrm{dcc} \tag{4}$$

6.3 Reaction re3

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

Name Degradation of CC PT dimer

Reaction equation

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

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
CCPT	CCPT	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{CCPT}] \cdot \mathrm{dccpt} \tag{6}$$

6.4 Reaction re4

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

Name Degradation of PER TIM dimer

Reaction equation

$$\mathrm{PT} \longrightarrow \emptyset \tag{7}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
PT	PT	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{PT}] \cdot \mathrm{dpt} \tag{8}$$

6.5 Reaction re9

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

Name Degradation of clk mRNA

Reaction equation

$$\mathrm{clkm} \longrightarrow \emptyset \tag{9}$$

Reactant

Table 11: Properties of each reactant.

Id	Name	SBO
clkm	clkm	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{clkm}] \cdot \mathrm{dclkm} \tag{10}$$

6.6 Reaction re10

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

Name clkm translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{clkm}} \mathrm{CLK} \tag{11}$$

Modifier

Table 12: Properties of each modifier.

Id	Name	SBO
clkm	clkm	

Product

Table 13: Properties of each product.

Id	Name	SBO
CLK	CLK	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{clkm}] \cdot \mathrm{tlclk} \tag{12}$$

6.7 Reaction re15

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

Name Degradation of per mRNA

Reaction equation

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

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
perm	perm	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{perm}] \cdot \mathrm{dperm} \tag{14}$$

6.8 Reaction re17

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

Name perm translation

Reaction equation

$$\emptyset \xrightarrow{\text{perm}} \text{PER} \tag{15}$$

Modifier

Table 15: Properties of each modifier.

Id	Name	SBO
perm	perm	

Product

Table 16: Properties of each product.

Id	Name	SBO
PER	PER	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{vol}\left(\text{wholeCell}\right) \cdot [\text{perm}] \cdot \text{tlper} \tag{16}$$

6.9 Reaction re20

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

Name per transcription

Reaction equation

$$\emptyset \xrightarrow{\text{prcper, perp}} \text{perm} \tag{17}$$

Modifiers

Table 17: Properties of each modifier.

Id	Name	SBO
prcper	CCbindingPer	
perp	perp	

Product

Table 18: Properties of each product.

Id	Name	SBO
perm	perm	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot \left(\left(1 - (1 - [\mathrm{prcper}])^{\mathrm{npt}}\right) \cdot \mathrm{tcccperp} + (1 - [\mathrm{prcper}])^{\mathrm{npt}} \cdot \mathrm{tcdvpmt}\right) \cdot [\mathrm{perp}] \tag{18}$$

6.10 Reaction re28

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

Name vri transcription

Reaction equation

$$\emptyset \xrightarrow{\text{prcv, vrip}} \text{vrim} \tag{19}$$

Modifiers

Table 19: Properties of each modifier.

Id	Name	SBO
prcv	CCbindingvri	
vrip	vrip	

Product

Table 20: Properties of each product.

Id	Name	SBO
vrim	vrim	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot \left(\left(1 - (1 - [\mathrm{prcv}])^{\mathrm{nvri}} \right) \cdot \mathrm{tcccvrip} + (1 - [\mathrm{prcv}])^{\mathrm{nvri}} \cdot \mathrm{tcdvpmt} \right) \cdot [\mathrm{vrip}] \quad (20)$$

6.11 Reaction re30

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

Name Degradation of vri mRNA

Reaction equation

$$\mathrm{vrim} \longrightarrow \emptyset \quad (21)$$

Reactant

Table 21: Properties of each reactant.

Id	Name	SBO
vrim	vrim	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{vrim}] \cdot \mathrm{dvrim} \quad (22)$$

6.12 Reaction re31

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

Name vrim translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{vrim}} \mathrm{VRI} \quad (23)$$

Modifier

Table 22: Properties of each modifier.

Id	Name	SBO
vrim	vrim	

Product

Table 23: Properties of each product.

Id	Name	SBO
VRI	VRI	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot \left[\mathrm{vrim}\right] \cdot \mathrm{tlvri} \tag{24}$$

6.13 Reaction re32

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

Name VRI protein degradation

Reaction equation

$$\mathrm{VRI} \longrightarrow \emptyset \tag{25}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
VRI	VRI	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot \left[\mathrm{VRI}\right] \cdot \mathrm{dvri} \tag{26}$$

6.14 Reaction re35

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

Name pdp transcription

Reaction equation

$$\emptyset \xrightarrow{\text{prcpdp, pdpp}} \text{pdpm} \tag{27}$$

Modifiers

Table 25: Properties of each modifier.

Id	Name	SBO
prcpdp	CCbindingpdp	
pdpp	pdpp	

Product

Table 26: Properties of each product.

Id	Name	SBO
pdpm	pdpm	

Kinetic Law

Derived unit contains undeclared units

$$\begin{aligned} v_{14} = {} & \text{vol}\left(\text{wholeCell}\right) \\ & \cdot \left(\left(1 - \left(1 - [\text{prcpdp}]\right)^{\text{npdp}}\right) \cdot \text{tcccpdpp} + \left(1 - [\text{prcpdp}]\right)^{\text{npdp}} \cdot \text{tcdvpmt}\right) \cdot [\text{pdpp}] \end{aligned} \tag{28}$$

6.15 Reaction re37

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

Name Degradation of pdp mRNA

Reaction equation

$$\text{pdpm} \longrightarrow \emptyset \tag{29}$$

Reactant

Table 27: Properties of each reactant.

Id	Name	SBO
pdpm	pdpm	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \mathrm{vol}(\mathrm{wholeCell}) \cdot [\mathrm{pdpm}] \cdot \mathrm{dpdpm} \tag{30}$$

6.16 Reaction re38

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

Name pdpm translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{pdpm}} \mathrm{PDP} \tag{31}$$

Modifier

Table 28: Properties of each modifier.

Id	Name	SBO
pdpm	pdpm	

Product

Table 29: Properties of each product.

Id	Name	SBO
PDP	PDP	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \mathrm{vol}(\mathrm{wholeCell}) \cdot [\mathrm{pdpm}] \cdot \mathrm{tlpdp} \tag{32}$$

6.17 Reaction re39

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

Name PDP protein degradation

Reaction equation

$$\text{PDP} \longrightarrow \emptyset \tag{33}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
PDP	PDP	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \text{vol}(\text{wholeCell}) \cdot [\text{PDP}] \cdot \text{dpdp} \tag{34}$$

6.18 Reaction re42

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

Name clk transcription

Reaction equation

$$\emptyset \xrightarrow{\text{prvc, clkp, prpc}} \text{clkm} \tag{35}$$

Modifiers

Table 31: Properties of each modifier.

Id	Name	SBO
prvc	VRIbindingclkp	
clkp	clkp	
prpc	PDPbindingclkp	

Product

Table 32: Properties of each product.

Id	Name	SBO
clkm	clkm	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot ([\mathrm{prvc}] \cdot \mathrm{tcvriclkp} + [\mathrm{prpc}] \cdot \mathrm{tcpdpclkp} + (1 - [\mathrm{prvc}] - [\mathrm{prpc}]) \cdot \mathrm{tcclkp}) \cdot [\mathrm{clkp}] \tag{36}$$

6.19 Reaction re43

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

Name CLK CYC association

Reaction equation

$$\mathrm{CLK} + \mathrm{CYC} \longrightarrow \mathrm{CC} \tag{37}$$

Reactants

Table 33: Properties of each reactant.

Id	Name	SBO
CLK	CLK	
CYC	CYC	

Product

Table 34: Properties of each product.

Id	Name	SBO
CC	CC	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{CLK}] \cdot \mathrm{bcc} \cdot [\mathrm{CYC}] \tag{38}$$

6.20 Reaction re44

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

Name CLK protein degradation

Reaction equation

$$\mathrm{CLK} \longrightarrow \emptyset \tag{39}$$

Reactant

Table 35: Properties of each reactant.

Id	Name	SBO
CLK	CLK	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{CLK}] \cdot \mathrm{dclk} \tag{40}$$

6.21 Reaction re45

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

Name CLK CYC dissociation

Reaction equation

$$\mathrm{CC} \longrightarrow \mathrm{CLK} + \mathrm{CYC} \tag{41}$$

Reactant

Table 36: Properties of each reactant.

Id	Name	SBO
CC	CC	

Products

Table 37: Properties of each product.

Id	Name	SBO
CLK	CLK	
CYC	CYC	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \mathrm{vol}(\mathrm{wholeCell}) \cdot [\mathrm{CC}] \cdot \mathrm{ubcc} \tag{42}$$

6.22 Reaction re46

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

Name PER TIM association

Reaction equation

$$\mathrm{PER} + \mathrm{TIM} \longrightarrow \mathrm{PT} \tag{43}$$

Reactants

Table 38: Properties of each reactant.

Id	Name	SBO
PER	PER	
TIM	TIM	

Product

Table 39: Properties of each product.

Id	Name	SBO
PT	PT	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \mathrm{vol}(\mathrm{wholeCell}) \cdot [\mathrm{PER}] \cdot [\mathrm{TIM}] \cdot \mathrm{bpt} \tag{44}$$

6.23 Reaction re47

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

Name PER TIM dissociation

Reaction equation

$$\mathrm{PT} \longrightarrow \mathrm{PER} + \mathrm{TIM} \tag{45}$$

Reactant

Table 40: Properties of each reactant.

Id	Name	SBO
PT	PT	

Products

Table 41: Properties of each product.

Id	Name	SBO
PER	PER	
TIM	TIM	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{PT}] \cdot \mathrm{ubpt} \tag{46}$$

6.24 Reaction re48

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

Name PER protein degradation

Reaction equation

$$\mathrm{PER} \longrightarrow \emptyset \tag{47}$$

Reactant

Table 42: Properties of each reactant.

Id	Name	SBO
PER	PER	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{PER}] \cdot \mathrm{dper} \tag{48}$$

6.25 Reaction re51

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

Name tim transcription

Reaction equation

$$\emptyset \xrightarrow{\mathrm{prct},\ \mathrm{timp}} \mathrm{timm} \tag{49}$$

Modifiers

Table 43: Properties of each modifier.

Id	Name	SBO
prct	CCbindingtim	
timp	timp	

Product

Table 44: Properties of each product.

Id	Name	SBO
timm	timm	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot \left(\left(1 - \left(1 - [\mathrm{prct}]\right)^{\mathrm{npt}}\right) \cdot \mathrm{tccctimp} + \left(1 - [\mathrm{prct}]\right)^{\mathrm{npt}} \cdot \mathrm{tcdvpmt}\right) \cdot [\mathrm{timp}] \tag{50}$$

6.26 Reaction re53

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

Name Degradation of tim mRNA

Reaction equation

$$\text{timm} \longrightarrow \emptyset \tag{51}$$

Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
timm	timm	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{vol}(\text{wholeCell}) \cdot [\text{timm}] \cdot \text{dtimm} \tag{52}$$

6.27 Reaction re54

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

Name timm translation

Reaction equation

$$\emptyset \xrightarrow{\text{timm}} \text{TIM} \tag{53}$$

Modifier

Table 46: Properties of each modifier.

Id	Name	SBO
timm	timm	

Product

Table 47: Properties of each product.

Id	Name	SBO
TIM	TIM	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{timm}] \cdot \mathrm{tltim} \tag{54}$$

6.28 Reaction re55

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

Name TIM protein degradation

Reaction equation

$$\mathrm{TIM} \longrightarrow \emptyset \tag{55}$$

Reactant

Table 48: Properties of each reactant.

Id	Name	SBO
TIM	TIM	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{TIM}] \cdot \mathrm{dtim} \tag{56}$$

6.29 Reaction re56

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

Name CC PT dimer dissociation

Reaction equation

$$\mathrm{CCPT} \longrightarrow \mathrm{CC} + \mathrm{PT} \tag{57}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
CCPT	CCPT	

Products

Table 50: Properties of each product.

Id	Name	SBO
CC	CC	
PT	PT	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{CCPT}] \cdot \mathrm{ubccpt} \tag{58}$$

6.30 Reaction re57

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

Name CC binding probability in per promoter

Reaction equation

$$\emptyset \xrightarrow{\mathrm{CC}} \mathrm{prcper} \tag{59}$$

Modifier

Table 51: Properties of each modifier.

Id	Name	SBO
CC	CC	

Product

Table 52: Properties of each product.

Id	Name	SBO
prcper	CCbindingPer	

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \text{vol}(\text{wholeCell}) \cdot (1 - [\text{prcper}]) \cdot \text{bccperp} \cdot [\text{CC}] \tag{60}$$

6.31 Reaction re58

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

Name CC Unbinding probability in per promoter

Reaction equation

$$\text{prcper} \longrightarrow \emptyset \tag{61}$$

Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
prcper	CCbindingPer	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{vol}(\text{wholeCell}) \cdot [\text{prcper}] \cdot \text{ubccperp} \tag{62}$$

6.32 Reaction re59

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

Name CC Unbinding probability in vri promoter

Reaction equation

$$\text{prcv} \longrightarrow \emptyset \tag{63}$$

Reactant

Table 54: Properties of each reactant.

Id	Name	SBO
prcv	CCbindingvri	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot \mathrm{ubccvrip} \cdot [\mathrm{prcv}] \tag{64}$$

6.33 Reaction re60

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

Name CC binding probability in vri promoter

Reaction equation

$$\emptyset \xrightarrow{\mathrm{CC}} \mathrm{prcv} \tag{65}$$

Modifier

Table 55: Properties of each modifier.

Id	Name	SBO
CC	CC	

Product

Table 56: Properties of each product.

Id	Name	SBO
prcv	CCbindingvri	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot \left(1 - [\mathrm{prcv}]\right) \cdot \mathrm{bccvrip} \cdot [\mathrm{CC}] \tag{66}$$

6.34 Reaction re61

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

Name CC Unbinding probability in pdp1 promoter

Reaction equation

$$\text{prcpdp} \longrightarrow \emptyset \tag{67}$$

Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
prcpdp	CCbindingpdp	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \text{vol}\left(\text{wholeCell}\right) \cdot \text{ubccpdpp} \cdot [\text{prcpdp}] \tag{68}$$

6.35 Reaction re62

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

Name CC binding probability in pdp1 promoter

Reaction equation

$$\emptyset \xrightarrow{\text{CC}} \text{prcpdp} \tag{69}$$

Modifier

Table 58: Properties of each modifier.

Id	Name	SBO
CC	CC	

Product

Table 59: Properties of each product.

Id	Name	SBO
prcpdp	CCbindingpdp	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \text{vol}(\text{wholeCell}) \cdot (1 - [\text{prcpdp}]) \cdot \text{bccpdpp} \cdot [\text{CC}] \tag{70}$$

6.36 Reaction re63

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

Name VRI binding clk promoter

Reaction equation

$$\emptyset \xrightarrow{\text{prpc, VRI}} \text{prvc} \tag{71}$$

Modifiers

Table 60: Properties of each modifier.

Id	Name	SBO
prpc	PDPbindingclkp	
VRI	VRI	

Product

Table 61: Properties of each product.

Id	Name	SBO
prvc	VRIbindingclkp	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \text{vol}(\text{wholeCell}) \cdot (1 - [\text{prvc}] - [\text{prpc}]) \cdot \text{bvriclkp} \cdot [\text{VRI}] \tag{72}$$

6.37 Reaction re64

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

Name VRI unbinding clk promoter

Reaction equation

$$\text{prvc} \longrightarrow \emptyset \tag{73}$$

Reactant

Table 62: Properties of each reactant.

Id	Name	SBO
prvc	VRIbindingclkp	

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \text{vol}\left(\text{wholeCell}\right) \cdot [\text{prvc}] \cdot \text{ubvriclkp} \tag{74}$$

6.38 Reaction re65

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

Name PDP binding clk promoter

Reaction equation

$$\emptyset \xrightarrow{\text{prvc, PDP}} \text{prpc} \tag{75}$$

Modifiers

Table 63: Properties of each modifier.

Id	Name	SBO
prvc	VRIbindingclkp	
PDP	PDP	

Product

Table 64: Properties of each product.

Id	Name	SBO
prpc	PDPbindingclkp	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot (1 - [\mathrm{prvc}] - [\mathrm{prpc}]) \cdot \mathrm{bpdpclkp} \cdot [\mathrm{PDP}] \tag{76}$$

6.39 Reaction re66

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

Name PDP unbinding clk promoter

Reaction equation

$$\mathrm{prpc} \longrightarrow \emptyset \tag{77}$$

Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
prpc	PDPbindingclkp	

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \mathrm{vol}\,(\mathrm{wholeCell}) \cdot [\mathrm{prpc}] \cdot \mathrm{ubpdpclkp} \tag{78}$$

6.40 Reaction re68

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

Name CC binding probability in tim promoter

Reaction equation

$$\emptyset \xrightarrow{\mathrm{CC}} \mathrm{prct} \tag{79}$$

Modifier

Table 66: Properties of each modifier.

Id	Name	SBO
CC	CC	

Product

Table 67: Properties of each product.

Id	Name	SBO
prct	CCbindingtim	

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot \left(1 - [\mathrm{prct}]\right) \cdot \mathrm{bcctimp} \cdot [\mathrm{CC}] \tag{80}$$

6.41 Reaction re69

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

Name CC Unbinding probability in tim promoter

Reaction equation

$$\mathrm{prct} \longrightarrow \emptyset \tag{81}$$

Reactant

Table 68: Properties of each reactant.

Id	Name	SBO
prct	CCbindingtim	

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \mathrm{vol}\left(\mathrm{wholeCell}\right) \cdot [\mathrm{prct}] \cdot \mathrm{ubcctimp} \tag{82}$$

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 `CC`

Name CC

Initial concentration $0.5566\ \mathrm{nmol \cdot l^{-1}}$

This species takes part in nine reactions (as a reactant in `re1`, `re2`, `re45` and as a product in `re43`, `re56` and as a modifier in `re57`, `re60`, `re62`, `re68`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{CC} = v_{19} + v_{29} - v_1 - v_2 - v_{21} \tag{83}$$

7.2 Species `CCPT`

Name CCPT

Initial concentration $0.4982\ \mathrm{nmol \cdot l^{-1}}$

This species takes part in three reactions (as a reactant in `re3`, `re56` and as a product in `re1`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{CCPT} = v_1 - v_3 - v_{29} \tag{84}$$

7.3 Species `clkp`

Name clkp

Initial concentration $0.003185\ \mathrm{nmol \cdot l^{-1}}$

This species takes part in one reaction (as a modifier in `re42`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{clkp} = 0 \tag{85}$$

7.4 Species perp

Name perp

Initial concentration $0.003185\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a modifier in re20).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{perp} = 0 \tag{86}$$

7.5 Species clkm

Name clkm

Initial concentration $0.2583\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in re9 and as a product in re42 and as a modifier in re10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{clkm} = v_{18} - v_5 \tag{87}$$

7.6 Species perm

Name perm

Initial concentration $0.2395\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in re15 and as a product in re20 and as a modifier in re17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{perm} = v_9 - v_7 \tag{88}$$

7.7 Species PT

Name PT

Initial concentration $0.4014\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in re1, re4, re47 and as a product in re46, re56).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PT} = v_{22} + v_{29} - v_1 - v_4 - v_{23} \tag{89}$$

7.8 Species vrip

Name vrip

Initial concentration $0.003185\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a modifier in re28).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{vrip} = 0 \tag{90}$$

7.9 Species vrim

Name vrim

Initial concentration $0.2571\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in re30 and as a product in re28 and as a modifier in re31).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{vrim} = v_{10} - v_{11} \tag{91}$$

7.10 Species VRI

Name VRI

Initial concentration $3.175\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in re32 and as a product in re31 and as a modifier in re63).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{VRI} = v_{12} - v_{13} \tag{92}$$

7.11 Species pdpp

Name pdpp

Initial concentration $0.003185\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a modifier in re35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{pdpp} = 0 \tag{93}$$

7.12 Species pdpm

Name pdpm

Initial concentration $0.3175\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in re37 and as a product in re35 and as a modifier in re38).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{pdpm} = v_{14} - v_{15} \tag{94}$$

7.13 Species PDP

Name PDP

Initial concentration $4.1953\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in re39 and as a product in re38 and as a modifier in re65).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PDP} = v_{16} - v_{17} \tag{95}$$

7.14 Species CLK

Name CLK

Initial concentration $3.6628\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in re43, re44 and as a product in re10, re45).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{CLK} = v_{6} + v_{21} - v_{19} - v_{20} \tag{96}$$

7.15 Species PER

Name PER

Initial concentration $2.7527\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in re46, re48 and as a product in re17, re47).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PER} = v_{8} + v_{23} - v_{22} - v_{24} \tag{97}$$

7.16 Species timp

Name timp

Initial concentration $0.003185\ \text{nmol} \cdot \text{l}^{-1}$

This species takes part in one reaction (as a modifier in re51).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{timp} = 0 \tag{98}$$

7.17 Species timm

Name timm

Initial concentration $0.2395\ \text{nmol} \cdot \text{l}^{-1}$

This species takes part in three reactions (as a reactant in re53 and as a product in re51 and as a modifier in re54).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{timm} = v_{25} - v_{26} \tag{99}$$

7.18 Species TIM

Name TIM

Initial concentration $2.7527\ \text{nmol} \cdot \text{l}^{-1}$

This species takes part in four reactions (as a reactant in re46, re55 and as a product in re47, re54).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{TIM} = v_{23} + v_{27} - v_{22} - v_{28} \tag{100}$$

7.19 Species CYC

Name CYC

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

This species takes part in two reactions (as a reactant in re43 and as a product in re45), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{CYC} = 0 \tag{101}$$

7.20 Species prcper

Name CCbindingPer

Initial amount 0.0431 nmol

This species takes part in three reactions (as a reactant in re58 and as a product in re57 and as a modifier in re20).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{prcper} = v_{30} - v_{31} \tag{102}$$

7.21 Species prcv

Name CCbindingvri

Initial amount 0.0585 nmol

This species takes part in three reactions (as a reactant in re59 and as a product in re60 and as a modifier in re28).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{prcv} = v_{33} - v_{32} \tag{103}$$

7.22 Species prcpdp

Name CCbindingpdp

Initial amount 0.08 nmol

This species takes part in three reactions (as a reactant in re61 and as a product in re62 and as a modifier in re35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{prcpdp} = v_{35} - v_{34} \tag{104}$$

7.23 Species prvc

Name VRIbindingclkp

Initial amount 0.489 nmol

This species takes part in four reactions (as a reactant in re64 and as a product in re63 and as a modifier in re42, re65).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{prvc} = v_{36} - v_{37} \tag{105}$$

7.24 Species prpc

Name PDPbindingclkp

Initial amount 0.426 nmol

This species takes part in four reactions (as a reactant in re66 and as a product in re65 and as a modifier in re42, re63).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{prpc} = v_{38} - v_{39} \tag{106}$$

7.25 Species prct

Name CCbindingtim

Initial amount 0.043 nmol

This species takes part in three reactions (as a reactant in re69 and as a product in re68 and as a modifier in re51).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{prct} = v_{40} - v_{41} \tag{107}$$

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.

[a]Center for Bioinformatics Tübingen (ZBIT), Germany
[b]California Institute of Technology, Beckman Institute BNMC, Pasadena, United States
[c]European Bioinformatics Institute, Wellcome Trust Genome Campus, Hinxton, United Kingdom
[d]EML Research gGmbH, Heidelberg, Germany