SBML Model Report

Model name: "Locke2006_CircClock_LL"

May 5, 2016

1 General Overview

This is a document in SBML Level 2 Version 3 format. This model was created by the following three authors: Nicolas Le Novre[1], Enuo He[2] and Anthony Hall[3] at February 20th 2007 at 1:57 p. m. and last time modified at February 25th 2015 at 1:40 p. m. Table 1 provides 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	16
events	0	constraints	0
reactions	36	function definitions	1
global parameters	78	unit definitions	2
rules	0	initial assignments	0

Model Notes

This a model from the article:
Experimental validation of a predicted feedback loop in the multi-oscillator clock of Arabidopsis thaliana.
Locke JC, Kozma-Bognr L, Gould PD, Fehr B, Kevei E, Nagy F, Turner MS, Hall A, Millar AJ Mol. Syst. Biol.2006;Volume:2;Page:59 17102804,

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Abstract:
Our computational model of the circadian clock comprised the feedback loop between LATE ELONGATED HYPOCOTYL (LHY), CIRCADIAN CLOCK ASSOCIATED 1 (CCA1) and TIMING OF CAB EXPRESSION 1 (TOC1), and a predicted, interlocking feedback loop involving TOC1 and a hypothetical component Y. Experiments based on model predictions suggested GIGANTEA (GI) as a candidate for Y. We now extend the model to include a recently demonstrated feedback loop between the TOC1 homologues PSEUDO-RESPONSE REGULATOR 7 (PRR7), PRR9 and LHY and CCA1. This three-loop network explains the rhythmic phenotype of toc1 mutant alleles. Model predictions fit closely to new data on the gi;lhy;cca1 mutant, which confirm that GI is a major contributor to Y function. Analysis of the three-loop network suggests that the plant clock consists of morning and evening oscillators, coupled intracellularly, which may be analogous to coupled, morning and evening clock cells in Drosophila and the mouse.

The model describes a three loops model of the Arabidopsis circadian clock. It provides initial conditions, parameter values and reactions for the production rates of the following species: LHY mRNA (cLm), cytoplasmic LHY (cLc), nuclear LHY (cLn), TOC1 mRNA (cTm), cytoplasmic TOC1 (cTc), nuclear TOC1 (cTn), X mRNA (cXm), cytoplasmic X (cXc), nuclear X (cXn), Y mRNA (cYm), cytoplasmic Y (cYc), nuclear Y (cYn), nuclear P (cPn), APRR7/9 mRNA, cytoplasmic APRR7/9, and nuclear APRR7/9.

The paper describes the behaviour of the model in constant light (LL) and day-night cycle (LD). However, the current model only contains the LL cycle. Some parameter values should be changed from the wild-type (WT) ones in order to simulate the effect of mutations. These changes are listed in the notes of relevant parameters.

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`

Definition 3600 s

2.2 Unit substance

Name nM

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 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
compartment	cell	0000290	3	1	litre	☑	

3.1 Compartment compartment

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

Name cell

SBO:0000290 physical compartment

4 Species

This model contains 16 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
cLm	LHY mRNA	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cLc	LHY protein in cytoplasm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cLn	LHY protein in nucleus	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cTm	TOC1 mRNA	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cTc	TOC1 protein in cytoplasm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cTn	TOC1 protein in nucleus	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cXm	X mRNA	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cXc	X protein in cytoplasm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cXn	X protein in nucleus	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cYm	Y mRNA	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cYc	Y protein in the cytoplasm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cYn	Y protein in nucleus	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cPn	light sensitive protein P	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cAm	PPR7/9 mRNA	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cAc	PPR7/9 protein in cytoplasm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
cAn	PPR7/9 protein in nucleus	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 78 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
q1	q1	0000337	4.195		☑
n0	n0	0000186	0.050		☑
g0	g0	0000186	1.000		☑
alpha	alpha	0000261	4.000		☑
n1	n1	0000186	7.814		☑
a	a	0000190	1.248		☑
g1	g1	0000363	3.138		☑
m1	m1	0000324	1.999		☑
k1	k1	0000027	2.392		☑
p1	p1	0000153	0.830		☑
r1	r1	0000153	16.836		☑
r2	r2	0000156	0.169		☑
m2	m2	0000324	20.440		☑
k2	k2	0000027	1.564		☑
m3	m3	0000324	3.689		☑
k3	k3	0000027	1.277		☑
n2	n2	0000186	3.009		☑
b	b	0000190	1.026		☑
g2	g2	0000363	0.037		☑
g3	g3	0000261	0.266		☑
c	c	0000190	1.026		☑
m4	m4	0000324	3.823		☑
k4	k4	0000027	2.573		☑
p2	p2	0000153	4.324		☑
r3	r3	0000153	0.317		☑
r4	r4	0000156	2.151		☑
m5	m5	0000324	0.001		☑
m6	m6	0000324	3.174		☑
k5	k5	0000027	2.745		☑
m7	m7	0000324	0.049		☑
m8	m8	0000324	4.042		☑
k6	k6	0000027	0.403		☑
n3	n3	0000186	0.243		☑
d	d	0000190	1.442		☑
g4	g4	0000363	0.539		☑
m9	m9	0000324	10.113		☑
k7	k7	0000027	6.559		☑

Id	Name	SBO	Value	Unit	Constant
p3	p3	0000153	2.147		☑
r5	r5	0000153	1.035		☑
r6	r6	0000156	3.302		☑
m10	m10	0000324	0.218		☑
k8	k8	0000027	0.663		☑
m11	m11	0000324	3.344		☑
k9	k9	0000027	17.111		☑
q2	q2	0000337	2.402		☑
n4	n4	0000186	0.086		☑
n5	n5	0000186	0.165		☑
g5	g5	0000261	1.178		☑
g6	g6	0000261	0.065		☑
e	e	0000190	3.606		☑
f	f	0000190	1.024		☑
m12	m12	0000324	4.297		☑
k10	k10	0000027	1.730		☑
p4	p4	0000153	0.249		☑
r7	r7	0000153	2.212		☑
r8	r8	0000156	0.200		☑
m13	m13	0000324	0.135		☑
k11	k11	0000027	1.826		☑
m14	m14	0000324	0.611		☑
k12	k12	0000027	1.807		☑
p5	p5	0000153	0.500		☑
k13	k13	0000027	1.200		☑
m15	m15	0000324	1.200		☑
q3	q3	0000337	1.000		☑
q4	q4	0000337	2.451		☑
g	g	0000190	1.026		☑
n6	n6	0000186	8.071		☑
g7	g7	0000363	$4 \cdot 10^{-4}$		☑
m16	m16	0000324	12.240		☑
k14	k14	0000027	10.362		☑
p6	p6	0000153	0.291		☑
r9	r9	0000153	0.253		☑
r10	r10	0000156	0.221		☑
m17	m17	0000324	4.451		☑
k15	k15	0000027	0.070		☑
m18	m18	0000324	0.016		☑
k16	k16	0000027	0.610		☑
light	light	0000492	1.000		☑

6 Function definition

This is an overview of one function definition.

6.1 Function definition `function_1`

Name degradation (Michaelis_Menten_Equation)

SBO:0000029 Henri-Michaelis-Menten rate law

Arguments V, substrate, Km

Mathematical Expression

$$\frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{1}$$

7 Reactions

This model contains 36 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	reaction_1	cLm transcription	$\emptyset \xrightarrow{\text{cAn, cXn, cPn}} \text{cLm}$	0000183
2	reaction_0	cLm degradation	$\text{cLm} \longrightarrow \emptyset$	0000179
3	reaction_2	cLc translation	$\emptyset \xrightarrow{\text{cLm}} \text{cLc}$	0000184
4	reaction_3	LHY protein translocation	$\text{cLc} \rightleftharpoons \text{cLn}$	0000185
5	reaction_4	cLc degradation	$\text{cLc} \longrightarrow \emptyset$	0000179
6	reaction_5	cLn degradation	$\text{cLn} \longrightarrow \emptyset$	0000179
7	reaction_6	cTm transcription	$\emptyset \xrightarrow{\text{cYn, cLn}} \text{cTm}$	0000183
8	reaction_7	cTm degradation	$\text{cTm} \longrightarrow \emptyset$	0000179
9	reaction_9	Y protein translocation	$\text{cYc} \rightleftharpoons \text{cYn}$	0000185
10	reaction_10	cYn degradation	$\text{cYn} \longrightarrow \emptyset$	0000179
11	reaction_11	cYc translation	$\emptyset \xrightarrow{\text{cYm}} \text{cYc}$	0000184
12	reaction_12	cYc degradation	$\text{cYc} \longrightarrow \emptyset$	0000179
13	reaction_13	X protein translocation	$\text{cXc} \rightleftharpoons \text{cXn}$	0000185
14	reaction_14	cXc degradation	$\text{cXc} \longrightarrow \emptyset$	0000179
15	reaction_15	cXc translation	$\emptyset \xrightarrow{\text{cXm}} \text{cXc}$	0000184
16	reaction_16	cXn degradation	$\text{cXn} \longrightarrow \emptyset$	0000179
17	reaction_17	cAc translation	$\emptyset \xrightarrow{\text{cAm}} \text{cAc}$	0000184
18	reaction_18	PPR7/9 protein translocation	$\text{cAc} \rightleftharpoons \text{cAn}$	0000185
19	reaction_19	cAc degradation	$\text{cAc} \longrightarrow \emptyset$	0000179
20	reaction_20	cAn degradation	$\text{cAn} \longrightarrow \emptyset$	0000179

№	Id	Name	Reaction Equation	SBO
21	reaction_21	light dependent production of protein P	$\emptyset \longrightarrow \mathrm{cPn}$	0000393
22	reaction_22	light activation protein P degradation	$\mathrm{cPn} \longrightarrow \emptyset$	0000179
23	reaction_23	cPn degradation	$\mathrm{cPn} \longrightarrow \emptyset$	0000179
24	reaction_25	light activation of cAm transcription	$\emptyset \xrightarrow{\mathrm{cPn}} \mathrm{cAm}$	0000183
25	reaction_26	light independent cAm transcription	$\emptyset \xrightarrow{\mathrm{cLn}} \mathrm{cAm}$	0000183
26	reaction_27	cAm degradation	$\mathrm{cAm} \longrightarrow \emptyset$	0000179
27	reaction_28	cXm transcription	$\emptyset \xrightarrow{\mathrm{cTn}} \mathrm{cXm}$	0000183
28	reaction_29	cXm degradation	$\mathrm{cXm} \longrightarrow \emptyset$	0000179
29	reaction_30	cTc translation	$\emptyset \xrightarrow{\mathrm{cTm}} \mathrm{cTc}$	0000184
30	reaction_31	TOC1 protein translocation	$\mathrm{cTc} \rightleftharpoons \mathrm{cTn}$	0000185
31	reaction_32	light activation degradation of cTc	$\mathrm{cTc} \longrightarrow \emptyset$	0000179
32	reaction_33	light independent degradation of cTc	$\mathrm{cTc} \longrightarrow \emptyset$	0000179
33	reaction_34	light activation degradation of cTn	$\mathrm{cTn} \longrightarrow \emptyset$	0000179
34	reaction_38	light independent degradation cTn	$\mathrm{cTn} \longrightarrow \emptyset$	0000179
35	reaction_39	cYm transcription	$\emptyset \xrightarrow{\mathrm{cTn,\ cLn,\ cPn}} \mathrm{cYm}$	0000183
36	reaction_40	cYm degradation	$\mathrm{cYm} \longrightarrow \emptyset$	0000179

7.1 Reaction `reaction_1`

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

Name cLm transcription

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cAn, cXn, cPn}} \text{cLm} \tag{2}$$

Modifiers

Table 6: Properties of each modifier.

Id	Name	SBO
`cAn`	PPR7/9 protein in nucleus	
`cXn`	X protein in nucleus	
`cPn`	light sensitive protein P	

Product

Table 7: Properties of each product.

Id	Name	SBO
`cLm`	LHY mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \frac{\text{vol}\,(\text{compartment}) \cdot \text{g0}^{\text{alpha}}}{\text{g0}^{\text{alpha}} + [\text{cAn}]^{\text{alpha}}} \cdot \left(\text{light} \cdot (\text{q1} \cdot [\text{cPn}] + \text{n0}) + \frac{\text{n1} \cdot [\text{cXn}]^{\text{a}}}{\text{g1}^{\text{a}} + [\text{cXn}]^{\text{a}}} \right) \tag{3}$$

7.2 Reaction `reaction_0`

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

Name cLm degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cLm} \longrightarrow \emptyset \tag{4}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
cLm	LHY mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\left(\mathrm{compartment}\right) \cdot \mathrm{function\_1}\left(\mathrm{m1}, [\mathrm{cLm}], \mathrm{k1}\right) \tag{5}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{6}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{7}$$

7.3 Reaction reaction_2

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

Name cLc translation

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cLm}} \mathrm{cLc} \tag{8}$$

Modifier

Table 9: Properties of each modifier.

Id	Name	SBO
cLm	LHY mRNA	

Product

Table 10: Properties of each product.

Id	Name	SBO
cLc	LHY protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\left(\mathrm{compartment}\right) \cdot \mathrm{p1} \cdot [\mathrm{cLm}] \tag{9}$$

7.4 Reaction reaction_3

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

Name LHY protein translocation

SBO:0000185 transport reaction

Reaction equation

$$\mathrm{cLc} \rightleftharpoons \mathrm{cLn} \tag{10}$$

Reactant

Table 11: Properties of each reactant.

Id	Name	SBO
cLc	LHY protein in cytoplasm	

Product

Table 12: Properties of each product.

Id	Name	SBO
cLn	LHY protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\,(\mathrm{compartment}) \cdot (\mathrm{r1} \cdot [\mathrm{cLc}] - \mathrm{r2} \cdot [\mathrm{cLn}]) \tag{11}$$

7.5 Reaction `reaction_4`

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

Name cLc degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cLc} \longrightarrow \emptyset \tag{12}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
`cLc`	LHY protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{function\_1}\,(\mathrm{m2}, [\mathrm{cLc}], \mathrm{k2}) \tag{13}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{14}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{15}$$

7.6 Reaction `reaction_5`

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

Name cLn degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cLn} \longrightarrow \emptyset \tag{16}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
cLn	LHY protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \text{vol}\left(\text{compartment}\right) \cdot \text{function\_1}\left(\text{m3}, [\text{cLn}], \text{k3}\right) \tag{17}$$

$$\text{function\_1}\left(\text{V}, \text{substrate}, \text{Km}\right) = \frac{\text{V} \cdot \text{substrate}}{\text{Km} + \text{substrate}} \tag{18}$$

$$\text{function\_1}\left(\text{V}, \text{substrate}, \text{Km}\right) = \frac{\text{V} \cdot \text{substrate}}{\text{Km} + \text{substrate}} \tag{19}$$

7.7 Reaction reaction_6

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

Name cTm transcription

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cYn, cLn}} \text{cTm} \tag{20}$$

Modifiers

Table 15: Properties of each modifier.

Id	Name	SBO
cYn	Y protein in nucleus	
cLn	LHY protein in nucleus	

Product

Table 16: Properties of each product.

Id	Name	SBO
cTm	TOC1 mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{n2} \cdot [\mathrm{cYn}]^{\mathrm{b}}}{\mathrm{g2}^{\mathrm{b}} + [\mathrm{cYn}]^{\mathrm{b}}} \cdot \frac{\mathrm{g3}^{\mathrm{c}}}{\mathrm{g3}^{\mathrm{c}} + [\mathrm{cLn}]^{\mathrm{c}}} \tag{21}$$

7.8 Reaction reaction_7

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

Name cTm degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cTm} \longrightarrow \emptyset \tag{22}$$

Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
cTm	TOC1 mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{function\_1}\,(\mathrm{m4}, [\mathrm{cTm}], \mathrm{k4}) \tag{23}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{24}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{25}$$

7.9 Reaction reaction_9

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

Name Y protein translocation

SBO:0000185 transport reaction

Reaction equation

$$\mathrm{cYc} \rightleftharpoons \mathrm{cYn} \tag{26}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
cYc	Y protein in the cytoplasm	

Product

Table 19: Properties of each product.

Id	Name	SBO
cYn	Y protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\,(\mathrm{compartment}) \cdot (\mathrm{r7} \cdot [\mathrm{cYc}] - \mathrm{r8} \cdot [\mathrm{cYn}]) \tag{27}$$

7.10 Reaction reaction_10

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

Name cYn degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cYn} \longrightarrow \emptyset \tag{28}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
cYn	Y protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{vol}\left(\text{compartment}\right) \cdot \text{function\_1}\left(\text{m14}, [\text{cYn}], \text{k12}\right) \tag{29}$$

$$\text{function\_1}\left(\text{V}, \text{substrate}, \text{Km}\right) = \frac{\text{V} \cdot \text{substrate}}{\text{Km} + \text{substrate}} \tag{30}$$

$$\text{function\_1}\left(\text{V}, \text{substrate}, \text{Km}\right) = \frac{\text{V} \cdot \text{substrate}}{\text{Km} + \text{substrate}} \tag{31}$$

7.11 Reaction reaction_11

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

Name cYc translation

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cYm}} \text{cYc} \tag{32}$$

Modifier

Table 21: Properties of each modifier.

Id	Name	SBO
cYm	Y mRNA	

Product

Table 22: Properties of each product.

Id	Name	SBO
cYc	Y protein in the cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{p4} \cdot [\mathrm{cYm}] \tag{33}$$

7.12 Reaction `reaction_12`

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

Name cYc degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cYc} \longrightarrow \emptyset \tag{34}$$

Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
`cYc`	Y protein in the cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{function\_1}\,(\mathrm{m13}, [\mathrm{cYc}], \mathrm{k11}) \tag{35}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{36}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{37}$$

7.13 Reaction `reaction_13`

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

Name X protein translocation

SBO:0000185 transport reaction

Reaction equation

$$\mathrm{cXc} \rightleftharpoons \mathrm{cXn} \tag{38}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
cXc	X protein in cytoplasm	

Product

Table 25: Properties of each product.

Id	Name	SBO
cXn	X protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \mathrm{vol}\,(\mathrm{compartment}) \cdot (\mathrm{r5} \cdot [\mathrm{cXc}] - \mathrm{r6} \cdot [\mathrm{cXn}]) \tag{39}$$

7.14 Reaction reaction_14

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

Name cXc degradation

SBO:0000179 degradation

Reaction equation

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

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
cXc	X protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \mathrm{vol}\left(\mathrm{compartment}\right) \cdot \mathrm{function\_1}\left(\mathrm{m10}, [\mathrm{cXc}], \mathrm{k8}\right) \tag{41}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{42}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{43}$$

7.15 Reaction `reaction_15`

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

Name cXc translation

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cXm}} \mathrm{cXc} \tag{44}$$

Modifier

Table 27: Properties of each modifier.

Id	Name	SBO
`cXm`	X mRNA	

Product

Table 28: Properties of each product.

Id	Name	SBO
`cXc`	X protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \mathrm{vol}\left(\mathrm{compartment}\right) \cdot \mathrm{p3} \cdot [\mathrm{cXm}] \tag{45}$$

7.16 Reaction reaction_16

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

Name cXn degradation

SBO:0000179 degradation

Reaction equation

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

Reactant

Table 29: Properties of each reactant.

Id	Name	SBO
cXn	X protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \mathrm{vol}\left(\mathrm{compartment}\right) \cdot \mathrm{function\_1}\left(\mathrm{m11}, [\mathrm{cXn}], \mathrm{k9}\right) \tag{47}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{48}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{49}$$

7.17 Reaction reaction_17

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

Name cAc translation

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cAm}} \mathrm{cAc} \tag{50}$$

Modifier

Table 30: Properties of each modifier.

Id	Name	SBO
cAm	PPR7/9 mRNA	

Product

Table 31: Properties of each product.

Id	Name	SBO
cAc	PPR7/9 protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{p6} \cdot [\mathrm{cAm}] \tag{51}$$

7.18 Reaction reaction_18

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

Name PPR7/9 protein translocation

SBO:0000185 transport reaction

Reaction equation

$$\mathrm{cAc} \rightleftharpoons \mathrm{cAn} \tag{52}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
cAc	PPR7/9 protein in cytoplasm	

Product

Table 33: Properties of each product.

Id	Name	SBO
cAn	PPR7/9 protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \mathrm{vol}\,(\mathrm{compartment}) \cdot (\mathrm{r9} \cdot [\mathrm{cAc}] - \mathrm{r10} \cdot [\mathrm{cAn}]) \tag{53}$$

7.19 Reaction reaction_19

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

Name cAc degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cAc} \longrightarrow \emptyset \tag{54}$$

Reactant

Table 34: Properties of each reactant.

Id	Name	SBO
cAc	PPR7/9 protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{function\_1}\,(\mathrm{m17}, [\mathrm{cAc}], \mathrm{k15}) \tag{55}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{56}$$

$$\mathrm{function\_1}\,(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{57}$$

7.20 Reaction reaction_20

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

Name cAn degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cAn} \longrightarrow \emptyset \tag{58}$$

Reactant

Table 35: Properties of each reactant.

Id	Name	SBO
cAn	PPR7/9 protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \mathrm{vol}\left(\mathrm{compartment}\right) \cdot \mathrm{function\_1}\left(\mathrm{m18}, [\mathrm{cAn}], \mathrm{k16}\right) \tag{59}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{60}$$

$$\mathrm{function\_1}\left(\mathrm{V}, \mathrm{substrate}, \mathrm{Km}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate}} \tag{61}$$

7.21 Reaction reaction_21

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

Name light dependent production of protein P

SBO:0000393 production

Reaction equation

$$\emptyset \longrightarrow \mathrm{cPn} \tag{62}$$

Product

Table 36: Properties of each product.

Id	Name	SBO
cPn	light sensitive protein P	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = (1 - \text{light}) \cdot \text{p5} \cdot \text{vol}\,(\text{compartment}) \tag{63}$$

7.22 Reaction reaction_22

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

Name light activation protein P degradation

SBO:0000179 degradation

Reaction equation

$$\text{cPn} \longrightarrow \emptyset \tag{64}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
cPn	light sensitive protein P	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{q3} \cdot \text{light} \cdot [\text{cPn}] \cdot \text{vol}\,(\text{compartment}) \tag{65}$$

7.23 Reaction reaction_23

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

Name cPn degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cPn} \longrightarrow \emptyset \tag{66}$$

Reactant

Table 38: Properties of each reactant.

Id	Name	SBO
cPn	light sensitive protein P	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{m15} \cdot [\mathrm{cPn}]}{\mathrm{k13} + [\mathrm{cPn}]} \tag{67}$$

7.24 Reaction reaction_25

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

Name light activation of cAm transcription

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cPn}} \mathrm{cAm} \tag{68}$$

Modifier

Table 39: Properties of each modifier.

Id	Name	SBO
cPn	light sensitive protein P	

Product

Table 40: Properties of each product.

Id	Name	SBO
cAm	PPR7/9 mRNA	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{light} \cdot \text{q4} \cdot [\text{cPn}] \cdot \text{vol}\,(\text{compartment}) \tag{69}$$

7.25 Reaction `reaction_26`

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

Name light independent cAm transcription

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cLn}} \text{cAm} \tag{70}$$

Modifier

Table 41: Properties of each modifier.

Id	Name	SBO
`cLn`	LHY protein in nucleus	

Product

Table 42: Properties of each product.

Id	Name	SBO
`cAm`	PPR7/9 mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \frac{\text{vol}\,(\text{compartment}) \cdot \text{n6} \cdot [\text{cLn}]^{\text{g}}}{\text{g7}^{\text{g}} + [\text{cLn}]^{\text{g}}} \tag{71}$$

7.26 Reaction reaction_27

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

Name cAm degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cAm} \longrightarrow \emptyset \tag{72}$$

Reactant

Table 43: Properties of each reactant.

Id	Name	SBO
cAm	PPR7/9 mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{m16} \cdot [\mathrm{cAm}]}{\mathrm{k14} + [\mathrm{cAm}]} \tag{73}$$

7.27 Reaction reaction_28

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

Name cXm transcription

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cTn}} \mathrm{cXm} \tag{74}$$

Modifier

Table 44: Properties of each modifier.

Id	Name	SBO
cTn	TOC1 protein in nucleus	

Product

Table 45: Properties of each product.

Id	Name	SBO
cXm	X mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{n3} \cdot [\mathrm{cTn}]^{\mathrm{d}}}{\mathrm{g4}^{\mathrm{d}} + [\mathrm{cTn}]^{\mathrm{d}}} \tag{75}$$

7.28 Reaction reaction_29

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

Name cXm degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cXm} \longrightarrow \emptyset \tag{76}$$

Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
cXm	X mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{m9} \cdot [\mathrm{cXm}]}{\mathrm{k7} + [\mathrm{cXm}]} \tag{77}$$

7.29 Reaction reaction_30

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

Name cTc translation

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cTm}} \text{cTc} \tag{78}$$

Modifier

Table 47: Properties of each modifier.

Id	Name	SBO
cTm	TOC1 mRNA	

Product

Table 48: Properties of each product.

Id	Name	SBO
cTc	TOC1 protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{p2} \cdot \text{vol}\left(\text{compartment}\right) \cdot [\text{cTm}] \tag{79}$$

7.30 Reaction reaction_31

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

Name TOC1 protein translocation

SBO:0000185 transport reaction

Reaction equation

$$\text{cTc} \rightleftharpoons \text{cTn} \tag{80}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
cTc	TOC1 protein in cytoplasm	

Product

Table 50: Properties of each product.

Id	Name	SBO
cTn	TOC1 protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \mathrm{vol}\,(\mathrm{compartment}) \cdot (\mathrm{r4} \cdot [\mathrm{cTn}] + \mathrm{r3} \cdot [\mathrm{cTc}]) \tag{81}$$

7.31 Reaction reaction_32

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

Name light activation degradation of cTc

SBO:0000179 degradation

Reaction equation

$$\mathrm{cTc} \longrightarrow \emptyset \tag{82}$$

Reactant

Table 51: Properties of each reactant.

Id	Name	SBO
cTc	TOC1 protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot (1 - \mathrm{light}) \cdot \mathrm{m5} \cdot [\mathrm{cTc}]}{\mathrm{k5} + [\mathrm{cTc}]} \tag{83}$$

7.32 Reaction reaction_33

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

Name light independent degradation of cTc

SBO:0000179 degradation

Reaction equation

$$\mathrm{cTc} \longrightarrow \emptyset \tag{84}$$

Reactant

Table 52: Properties of each reactant.

Id	Name	SBO
cTc	TOC1 protein in cytoplasm	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \frac{\mathrm{m6} \cdot \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{cTc}]}{\mathrm{k5} + [\mathrm{cTc}]} \tag{85}$$

7.33 Reaction reaction_34

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

Name light activation degradation of cTn

SBO:0000179 degradation

Reaction equation

$$\mathrm{cTn} \longrightarrow \emptyset \tag{86}$$

Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
cTn	TOC1 protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot (1 - \mathrm{light}) \cdot \mathrm{m7} \cdot [\mathrm{cTn}]}{\mathrm{k6} + [\mathrm{cTn}]} \tag{87}$$

7.34 Reaction `reaction_38`

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

Name light independent degradation cTn

SBO:0000179 degradation

Reaction equation

$$\mathrm{cTn} \longrightarrow \emptyset \tag{88}$$

Reactant

Table 54: Properties of each reactant.

Id	Name	SBO
cTn	TOC1 protein in nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \frac{\mathrm{m8} \cdot \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{cTn}]}{\mathrm{k6} + [\mathrm{cTn}]} \tag{89}$$

7.35 Reaction `reaction_39`

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

Name cYm transcription

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cTn},\ \mathrm{cLn},\ \mathrm{cPn}} \mathrm{cYm} \tag{90}$$

Modifiers

Table 55: Properties of each modifier.

Id	Name	SBO
cTn	TOC1 protein in nucleus	
cLn	LHY protein in nucleus	
cPn	light sensitive protein P	

Product

Table 56: Properties of each product.

Id	Name	SBO
cYm	Y mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \left(\mathrm{light} \cdot \mathrm{q2} \cdot [\mathrm{cPn}] + \frac{(\mathrm{light} \cdot \mathrm{n4} + \mathrm{n5}) \cdot \mathrm{g5}^{\mathrm{e}}}{\mathrm{g5}^{\mathrm{e}} + [\mathrm{cTn}]^{\mathrm{e}}}\right) \cdot \frac{\mathrm{g6}^{\mathrm{f}}}{\mathrm{g6}^{\mathrm{f}} + [\mathrm{cLn}]^{\mathrm{f}}} \quad (91)$$

7.36 Reaction reaction_40

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

Name cYm degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{cYm} \longrightarrow \emptyset \quad (92)$$

Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
cYm	Y mRNA	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \frac{\mathrm{vol}\,(\mathrm{compartment}) \cdot \mathrm{m12} \cdot [\mathrm{cYm}]}{\mathrm{k10} + [\mathrm{cYm}]} \tag{93}$$

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 `cLm`

Name LHY mRNA

SBO:0000278 messenger RNA

Initial concentration $0.4625\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_0` and as a product in `reaction_1` and as a modifier in `reaction_2`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cLm} = v_1 - v_2 \tag{94}$$

8.2 Species `cLc`

Name LHY protein in cytoplasm

SBO:0000245 macromolecule

Initial concentration $0.0132\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_3`, `reaction_4` and as a product in `reaction_2`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cLc} = v_3 - v_4 - v_5 \tag{95}$$

8.3 Species cLn

Name LHY protein in nucleus

SBO:0000245 macromolecule

Initial concentration $0.0699\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in reaction_5 and as a product in reaction_3 and as a modifier in reaction_6, reaction_26, reaction_39).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cLn} = v_4 - v_6 \tag{96}$$

8.4 Species cTm

Name TOC1 mRNA

SBO:0000278 messenger RNA

Initial concentration $0.4303\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_7 and as a product in reaction_6 and as a modifier in reaction_30).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cTm} = v_7 - v_8 \tag{97}$$

8.5 Species cTc

Name TOC1 protein in cytoplasm

SBO:0000245 macromolecule

Initial concentration $10.2965\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in reaction_31, reaction_32, reaction_33 and as a product in reaction_30).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cTc} = v_{29} - v_{30} - v_{31} - v_{32} \tag{98}$$

8.6 Species cTn

Name TOC1 protein in nucleus

SBO:0000245 macromolecule

Initial concentration $0.5402\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in reaction_34, reaction_38 and as a product in reaction_31 and as a modifier in reaction_28, reaction_39).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cTn} = v_{30} - v_{33} - v_{34} \tag{99}$$

8.7 Species cXm

Name X mRNA

SBO:0000278 messenger RNA

Initial concentration $0.0957\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_29 and as a product in reaction_28 and as a modifier in reaction_15).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cXm} = v_{27} - v_{28} \tag{100}$$

8.8 Species cXc

Name X protein in cytoplasm

SBO:0000245 macromolecule

Initial concentration $1.5413\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_13, reaction_14 and as a product in reaction_15).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cXc} = v_{15} - v_{13} - v_{14} \tag{101}$$

8.9 Species cXn

Name X protein in nucleus

SBO:0000245 macromolecule

Initial concentration $0.4585\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_16 and as a product in reaction_13 and as a modifier in reaction_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cXn} = v_{13} - v_{16} \tag{102}$$

8.10 Species cYm

Name Y mRNA

SBO:0000278 messenger RNA

Initial concentration $0.0303\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_40 and as a product in reaction_39 and as a modifier in reaction_11).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cYm} = v_{35} - v_{36} \tag{103}$$

8.11 Species cYc

Name Y protein in the cytoplasm

SBO:0000245 macromolecule

Initial concentration $0.0041\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_9, reaction_12 and as a product in reaction_11).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cYc} = v_{11} - v_9 - v_{12} \tag{104}$$

8.12 Species cYn

Name Y protein in nucleus

SBO:0000245 macromolecule

Initial concentration $0.0122\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_10 and as a product in reaction_9 and as a modifier in reaction_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cYn} = v_9 - v_{10} \tag{105}$$

8.13 Species cPn

Name light sensitive protein P

SBO:0000245 macromolecule

Initial concentration $0.8476\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in reaction_22, reaction_23 and as a product in reaction_21 and as a modifier in reaction_1, reaction_25, reaction_39).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cPn} = v_{21} - v_{22} - v_{23} \tag{106}$$

8.14 Species cAm

Name PPR7/9 mRNA

SBO:0000278 messenger RNA

Initial concentration $14.6921\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in reaction_27 and as a product in reaction_25, reaction_26 and as a modifier in reaction_17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cAm} = v_{24} + v_{25} - v_{26} \tag{107}$$

8.15 Species cAc

Name PPR7/9 protein in cytoplasm

SBO:0000245 macromolecule

Initial concentration $0.7027\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_18, reaction_19 and as a product in reaction_17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cAc} = v_{17} - v_{18} - v_{19} \tag{108}$$

8.16 Species cAn

Name PPR7/9 protein in nucleus

SBO:0000245 macromolecule

Initial concentration $0.8648\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_20 and as a product in reaction_18 and as a modifier in reaction_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cAn} = v_{18} - v_{20} \tag{109}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000027 Michaelis constant: Substrate concentration at which the velocity of reaction is half its maximum. Michaelis constant is an experimental parameter. According to the underlying molecular mechanism it can be interpreted differently in terms of microscopic constants

SBO:0000029 Henri-Michaelis-Menten rate law: First general rate equation for reactions involving enzymes, it was presented in"Victor Henri. Lois Gnrales de l'Action des Diastases. Paris, Hermann, 1903". The reaction is assumed to be made of a reversible of the binding of the substrate to the enzyme, followed by the breakdown of the complex generating the product. Ten years after Henri, Michaelis and Menten presented a variant of his equation, based on the hypothesis that the dissociation rate of the substrate was much larger than the rate of the product generation. Leonor Michaelis, Maud Menten (1913). Die Kinetik der Invertinwirkung, Biochem. Z. 49:333-369.

SBO:0000153 forward rate constant: Numerical parameter that quantifies the forward velocity of a chemical reaction. This parameter encompasses all the contributions to the velocity except the quantity of the reactants

SBO:0000156 reverse rate constant: Numerical parameter that quantifies the forward velocity of a chemical reaction. This parameter encompasses all the contributions to the velocity except the quantity of the reactants.

SBO:0000179 degradation: Complete disappearance of a physical entity

SBO:0000183 transcription: Process through which a DNA sequence is copied to produce a complementary RNA

SBO:0000184 translation: Process in which a polypeptide chain is produced from a messenger RNA

SBO:0000185 transport reaction: Movement of a physical entity without modification of the structure of the entity

SBO:0000186 maximal velocity: Limiting maximal velocity of an enzymatic reaction, reached when the substrate is in large excess and all the enzyme is complexed.

SBO:0000190 Hill coefficient: Empirical parameter created by Archibald Vivian Hill to describe the cooperative binding of oxygen on hemoglobine (Hill (1910). The possible effects of the aggregation of the molecules of haemoglobin on its dissociation curves. J Physiol 40: iv-vii)

SBO:0000245 macromolecule: Molecular entity mainly built-up by the repetition of pseudo-identical units. CHEBI:3383

SBO:0000261 inhibitory constant: Dissociation constant of a compound from a target of which it inhibits the function.

SBO:0000278 messenger RNA: A messenger RNA is a ribonucleic acid synthesized during the transcription of a gene, and that carries the information to encode one or several proteins

SBO:0000290 physical compartment: Specific location of space, that can be bounded or not. A physical compartment can have 1, 2 or 3 dimensions

SBO:0000324 forward maximal velocity: Limiting maximal velocity of the forward reaction of a reversible enzyme, reached when the substrate is in large excess and all the enzyme is complexed.

SBO:0000337 association constant: Equilibrium constant that measures the propensity of two objects to assemble (associate) reversibly into a larger component. The association constant is usually denoted Ka and is the inverse of the dissociation constant.

SBO:0000363 activation constant: Dissociation constant of a potentiator (activator) from a target (e.g. an enzyme) of which it activates the function

SBO:0000393 production: Generation of a material or conceptual entity.

SBO:0000492 amplitude: Amplitude is the magnitude of change in the oscillating variable, with each oscillation, within an oscillating system.

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