SBML Model Report

Model name: "Gould2013 - Temperature Sensitive Circadian Clock"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Mirela Domijan[2] at October 21st 2010 at 5:09 p. m. and last time modified at January eighth 2015 at 2:13 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	19
events	0		constraints	0
reactions	38		function definitions	38
global parameters	115		unit definitions	1
rules	9		initial assignments	0

Model Notes

Gould2011 - Temperature Sensitive CircadianClockThis model is a temperature sensitiveversion of Pokhilko *et al*. 2010 (PMID:20865009),which is BIOMD0000000273in BioModels.

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This model is described in the article:Gould PD, Ugarte N, Domijan M, Costa M, Foreman J, Macgregor D, Rose K, Griffiths J, Millar AJ, Finkenstdt B, Penfield S, Rand DA, Halliday KJ, Hall AJ.Mol. Syst. Biol. 2013; 9: 650

Abstract:

Circadian clocks exhibit 'temperature compensation', meaning that they show only small changes in period over a broad temperature range. Several clock genes have been implicated in the temperature-dependent control of period in Arabidopsis. We show that blue light is essential for this, suggesting that the effects of light and temperature interact or converge upon common targets in the circadian clock. Our data demonstrate that two cryptochrome photoreceptors differentially control circadian period and sustain rhythmicity across the physiological temperature range. In order to test the hypothesis that the targets of light regulation are sufficient to mediate temperature compensation, we constructed a temperature-compensated clock model by adding passive temperature effects into only the light-sensitive processes in the model. Remarkably, this model was not only capable of full temperature compensation and consistent with mRNA profiles across a temperature range, but also predicted the temperature-dependent change in the level of LATE ELONGATED HYPOCOTYL, a key clock protein. Our analysis provides a systems-level understanding of period control in the plant circadian oscillator.

2 Unit Definitions

This is an overview of five unit definitions of which four are predefined by SBML and not mentioned in the model.

2.1 Unit substance

Definition item

2.2 Unit volume

Notes Litre is the predefined SBML unit for volume.

Definition l

2.3 Unit area

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

Definition m^2

2.4 Unit `length`

Notes Metre is the predefined SBML unit for `length` since SBML Level 2 Version 1.

Definition m

2.5 Unit `time`

Notes Second is the predefined SBML unit for `time`.

Definition s

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

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

3.1 Compartment `def`

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

Name def

SBO:0000290 physical compartment

4 Species

This model contains 19 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
cG	cG	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cG_m	cG_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cL	cL	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cL_m	cL_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cLm	cLm	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cNI	cNI	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cNI_m	cNI_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cP	cP	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cP7	cP7	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cP7_m	cP7_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cP9	cP9	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cP9_m	cP9_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cT	cT	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cT_m	cT_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cTm	cTm	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cY	cY	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cY_m	cY_m	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cZG	cZG	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟
cZTL	cZTL	def	$\text{item} \cdot \text{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 115 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
n0	n0	0000009	0.400		⊟
n1	n1	0000009	1.800		☑
n2	n2	0000009	0.700		☑
n3	n3	0000009	0.060		☑
n4	n4	0000009	0.000		☑
n5	n5	0000009	3.400		☑
n6	n6	0000009	1.250		☑
n7	n7	0000009	0.200		☑
n8	n8	0000009	0.420		☑
n9	n9	0000009	0.260		☑
n10	n10	0000009	0.180		☑
n11	n11	0000009	0.710		☑
n12	n12	0000009	2.350		⊟
g1	g1	0000027	0.100		☑
g2	g2	0000027	0.280		☑
g3	g3	0000027	0.400		☑
g4	g4	0000027	0.910		☑
g5	g5	0000027	0.300		☑
g6	g6	0000027	0.300		☑
g7	g7	0000027	0.180		☑
g8	g8	0000027	0.140		☑
g9	g9	0000027	0.300		☑
g10	g10	0000027	0.700		☑
g11	g11	0000027	0.700		☑
g12	g12	0000027	0.500		☑
g13	g13	0000027	0.600		☑
g14	g14	0000027	0.170		☑
g15	g15	0000027	0.400		☑
g16	g16	0000027	0.200		☑
m1	m1	0000356	0.540		⊟
m2	m2	0000356	0.240		☑
m3	m3	0000356	0.200		☑
m4	m4	0000356	0.200		☑
m5	m5	0000356	0.300		☑
m6	m6	0000356	0.250		⊟
m7	m7	0000356	0.500		☑
m8	m8	0000356	0.100		☑

Id	Name	SBO	Value	Unit	Constant
m9	m9	0000356	1.000		☑
m10	m10	0000356	0.300		☑
m11	m11	0000356	1.000		☑
m12	m12	0000356	1.000		☑
m13	m13	0000356	0.320		☑
m14	m14	0000356	0.280		☑
m15	m15	0000356	0.310		☐
m16	m16	0000356	0.500		☑
m17	m17	0000356	0.300		☑
m18	m18	0000356	1.000		☑
m19	m19	0000356	0.200		☑
m20	m20	0000356	1.200		☑
m21	m21	0000356	0.200		☑
m22	m22	0000356	2.000		☑
m23	m23	0000356	1.000		☑
m24	m24	0000356	0.405		☑
m25	m25	0000356	0.280		☐
m26	m26	0000356	0.140		☑
a	a	0000191	2.000		☑
b	b	0000191	3.000		☑
c	c	0000191	3.000		☑
d	d	0000191	2.500		☑
e	e	0000191	2.000		☑
f	f	0000191	3.000		☑
h	h	0000191	2.000		☑
g	g	0000191	2.000		☑
i	i	0000191	3.000		☑
j	j	0000191	3.000		☑
k	k	0000191	3.000		☑
l	l	0000191	2.000		☑
m	m	0000191	2.000		☑
n	n	0000191	1.000		☑
o	o	0000191	2.000		☑
s	s	0000191	3.000		☑
p1	p1	0000009	0.400		☐
p2	p2	0000009	0.270		☑
p3	p3	0000009	0.100		☑
p4	p4	0000009	0.268		☑
p5	p5	0000009	1.000		☑
p6	p6	0000009	0.440		☑
p7	p7	0000009	0.300		☑
p8	p8	0000009	0.700		☑

Id	Name	SBO	Value	Unit	Constant
p9	p9	0000009	0.400		☑
p10	p10	0000009	0.360		☑
p11	p11	0000009	0.230		☑
p12	p12	0000009	30.000		☑
p13	p13	0000009	0.400		☑
p14	p14	0000009	0.450		☑
p15	p15	0000009	0.050		☑
q1	q1	0000009	0.800		☑
q2	q2	0000009	0.500		☑
q3	q3	0000009	2.900		☑
q4	q4	0000009	0.600		☑
dawn	dawn		0.000		☑
dusk	dusk		12.000		☑
dawn1	dawn1		0.000		☑
dusk1	dusk1		3.000		☑
dawn2	dawn2		9.000		☑
dusk2	dusk2		12.000		☑
L	L		0.500		⊟
D	D		0.500		⊟
parameter_1	quantity		0.500		☑
An0	An0		4638600.000		☑
En0	En0		40.594		☑
Temp	Temp		300.150		☑
Rgas	Rgas		0.008		☑
Am1	Am1		2.332		☑
Em1	Em1		3.651		☑
Ap1	Ap1		559910.000		☑
Ep1	Ep1		35.317		☑
Am6	Am6		1499400.000		☑
Em6	Em6		38.948		☑
Am25	Am25		0.559		☑
Em25	Em25		1.725		☑
Am15	Am15		1287.000		☑
Em15	Em15		20.791		☑
An12	An12		3.537		☑
En12	En12		1.020		☑

6 Function definitions

This is an overview of 38 function definitions.

6.1 Function definition `function_4_cL_degr_1`

Name function_4_cL_degr_1

Arguments c, [cL], vol (def), g3, m3, p3

Mathematical Expression

$$\frac{\text{m3} \cdot [\text{cL}] + \frac{\text{p3} \cdot [\text{cL}]^{\text{c}}}{[\text{cL}]^{\text{c}} + \text{g3}^{\text{c}}}}{\text{vol (def)}} \tag{1}$$

6.2 Function definition `function_4_cL_m_trscr_1`

Name function_4_cL_m_trscr_1

Arguments L, a, b, [cNI], [cP], [cP7], [cP9], [cTm], vol (def), g1, g2, n0, n1, q1

Mathematical Expression

$$\frac{\frac{\left(\text{n0} \cdot \text{L} + \text{L} \cdot \text{q1} \cdot [\text{cP}] + \frac{\text{n1} \cdot [\text{cTm}]^{\text{b}}}{[\text{cTm}]^{\text{b}} + \text{g2}^{\text{b}}}\right) \cdot \text{g1}^{\text{a}}}{([\text{cP9}] + [\text{cP7}] + [\text{cNI}])^{\text{a}} + \text{g1}^{\text{a}}}}{\text{vol (def)}} \tag{2}$$

6.3 Function definition `function_4_cL_m_degr_1`

Name function_4_cL_m_degr_1

Arguments D, L, [cL_m], vol (def), m1, m2

Mathematical Expression

$$\frac{(\text{m1} \cdot \text{L} + \text{m2} \cdot \text{D}) \cdot [\text{cL\_m}]}{\text{vol (def)}} \tag{3}$$

6.4 Function definition `function_4_cL_trsl_1`

Name function_4_cL_trsl_1

Arguments D, L, [cL_m], vol (def), p1, p2

Mathematical Expression

$$\frac{[\text{cL\_m}] \cdot (\text{p1} \cdot \text{L} + \text{p2} \cdot \text{D})}{\text{vol (def)}} \tag{4}$$

6.5 Function definition `function_4_cL_modif_1`

Name function_4_cL_modif_1

Arguments c, [cL], vol (def), g3, p3

Mathematical Expression

$$
\frac{\frac{\text{p3} \cdot [\text{cL}]^{\text{c}}}{[\text{cL}]^{\text{c}} + \text{g3}^{\text{c}}}}{\text{vol (def)}} \tag{5}
$$

6.6 Function definition `function_4_cLm_degr_1`

Name function_4_cLm_degr_1

Arguments [cLm], vol (def), m4

Mathematical Expression

$$
\frac{\text{m4} \cdot [\text{cLm}]}{\text{vol (def)}} \tag{6}
$$

6.7 Function definition `function_4_cT_m_trscr_1`

Name function_4_cT_m_trscr_1

Arguments [cL], [cY], d, vol (def), e, g4, g5, n2, n3

Mathematical Expression

$$
\frac{\frac{\left(\frac{\text{n2} \cdot [\text{cY}]^{\text{d}}}{[\text{cY}]^{\text{d}} + \text{g4}^{\text{d}}} + \text{n3} \right) \cdot \text{g5}^{\text{e}}}{[\text{cL}]^{\text{e}} + \text{g5}^{\text{e}}}}{\text{vol (def)}} \tag{7}
$$

6.8 Function definition `function_4_cT_m_degr_1`

Name function_4_cT_m_degr_1

Arguments [cT_m], vol (def), m5

Mathematical Expression

$$
\frac{\text{m5} \cdot [\text{cT\_m}]}{\text{vol (def)}} \tag{8}
$$

6.9 Function definition `function_4_cT_trsl_1`

Name function_4_cT_trsl_1

Arguments [cT_m], vol (def), p4

Mathematical Expression

$$\frac{\text{p4} \cdot [\text{cT\_m}]}{\text{vol (def)}} \tag{9}$$

6.10 Function definition `function_4_cT_degr_1`

Name function_4_cT_degr_1

Arguments D, L, [cT], [cZG], [cZTL], vol (def), m6, m7, m8, p5

Mathematical Expression

$$\frac{(\text{m6} \cdot \text{L} + \text{m7} \cdot \text{D}) \cdot [\text{cT}] \cdot (\text{p5} \cdot [\text{cZTL}] + [\text{cZG}]) + \text{m8} \cdot [\text{cT}]}{\text{vol (def)}} \tag{10}$$

6.11 Function definition `function_4_cT_modif_1`

Name function_4_cT_modif_1

Arguments [cT], vol (def), f, g6, p15

Mathematical Expression

$$\frac{\frac{\text{p15} \cdot [\text{cT}]^{\text{f}}}{[\text{cT}]^{\text{f}} + \text{g6}^{\text{f}}}}{\text{vol (def)}} \tag{11}$$

6.12 Function definition `function_4_cY_m_trscr_1`

Name function_4_cY_m_trscr_1

Arguments D, L, [cL], [cP], [cT], vol (def), g, g16, g7, n5, n6, q2, s

Mathematical Expression

$$\frac{\text{L} \cdot \text{q2} \cdot [\text{cP}] + \frac{\frac{(\text{n5} \cdot \text{L} + \text{n6} \cdot \text{D}) \cdot \text{g7}^{\text{s}}}{[\text{cT}]^{\text{s}} + \text{g7}^{\text{s}}} \cdot \text{g16}^{\text{g}}}{[\text{cL}]^{\text{g}} + \text{g16}^{\text{g}}}}{\text{vol (def)}} \tag{12}$$

6.13 Function definition `function_4_cTm_degr_1`

Name function_4_cTm_degr_1

Arguments D, L, [cTm], vol (def), m25, m26

Mathematical Expression

$$\frac{(m25 \cdot L + m26 \cdot D) \cdot [cTm]}{\text{vol (def)}} \tag{13}$$

6.14 Function definition `function_4_cY_m_degr_1`

Name function_4_cY_m_degr_1

Arguments [cY_m], vol (def), m9

Mathematical Expression

$$\frac{m9 \cdot [cY\_m]}{\text{vol (def)}} \tag{14}$$

6.15 Function definition `function_4_cY_trsl_1`

Name function_4_cY_trsl_1

Arguments [cY_m], vol (def), p6

Mathematical Expression

$$\frac{p6 \cdot [cY\_m]}{\text{vol (def)}} \tag{15}$$

6.16 Function definition `function_4_cY_degr_1`

Name function_4_cY_degr_1

Arguments [cY], vol (def), m10

Mathematical Expression

$$\frac{m10 \cdot [cY]}{\text{vol (def)}} \tag{16}$$

6.17 Function definition `function_4_cP_trsl_1`

Name function_4_cP_trsl_1

Arguments D, [cP], vol (def), p7

Mathematical Expression

$$\frac{p7 \cdot D \cdot (1 - [cP])}{\text{vol (def)}} \tag{17}$$

6.18 Function definition `function_4_cP_degr_1`

Name function_4_cP_degr_1

Arguments L, [cP], vol (def), m11

Mathematical Expression

$$\frac{m11 \cdot [cP] \cdot L}{vol\,(def)} \tag{18}$$

6.19 Function definition `function_4_cP9_m_trscr_1`

Name function_4_cP9_m_trscr_1

Arguments L, [cL], [cP], [cT], vol (def), g8, g9, h, i, n4, n7, q3

Mathematical Expression

$$\frac{L \cdot q3 \cdot [cP] + \frac{\left(n4 \cdot L + \frac{n7 \cdot [cL]^i}{[cL]^i + g9^i}\right) \cdot g8^h}{[cT]^h + g8^h}}{vol\,(def)} \tag{19}$$

6.20 Function definition `function_4_cP9_m_degr_1`

Name function_4_cP9_m_degr_1

Arguments [cP9_m], vol (def), m12

Mathematical Expression

$$\frac{m12 \cdot [cP9\_m]}{vol\,(def)} \tag{20}$$

6.21 Function definition `function_4_cP9_trsl_1`

Name function_4_cP9_trsl_1

Arguments [cP9_m], vol (def), p8

Mathematical Expression

$$\frac{p8 \cdot [cP9\_m]}{vol\,(def)} \tag{21}$$

6.22 Function definition `function_4_cP9_degr_1`

Name function_4_cP9_degr_1

Arguments D, L, [cP9], vol (def), m13, m22

Mathematical Expression

$$\frac{(m13 \cdot L + m22 \cdot D) \cdot [cP9]}{vol\,(def)} \tag{22}$$

6.23 Function definition `function_4_cP7_m_trscr_1`

Name function_4_cP7_m_trscr_1

Arguments [cL], [cLm], [cP9], vol (def), g10, g11, j, k, n8, n9

Mathematical Expression

$$\frac{\frac{n8 \cdot ([cLm]+[cL])^j}{([cLm]+[cL])^j+g10^j} + \frac{n9 \cdot [cP9]^k}{[cP9]^k+g11^k}}{vol\,(def)} \tag{23}$$

6.24 Function definition `function_4_cP7_m_degr_1`

Name function_4_cP7_m_degr_1

Arguments [cP7_m], vol (def), m14

Mathematical Expression

$$\frac{m14 \cdot [cP7\_m]}{vol\,(def)} \tag{24}$$

6.25 Function definition `function_4_cP7_trsl_1`

Name function_4_cP7_trsl_1

Arguments [cP7_m], vol (def), p9

Mathematical Expression

$$\frac{p9 \cdot [cP7\_m]}{vol\,(def)} \tag{25}$$

6.26 Function definition `function_4_cNI_m_trscr_1`

Name function_4_cNI_m_trscr_1

Arguments [cLm], [cP7], vol (def), g12, g13, l, m, n10, n11

Mathematical Expression

$$\frac{\frac{\text{n10} \cdot [\text{cLm}]^{\text{l}}}{[\text{cLm}]^{\text{l}} + \text{g12}^{\text{l}}} + \frac{\text{n11} \cdot [\text{cP7}]^{\text{m}}}{[\text{cP7}]^{\text{m}} + \text{g13}^{\text{m}}}}{\text{vol} \, (\text{def})} \tag{26}$$

6.27 Function definition `function_4_cP7_degr_1`

Name function_4_cP7_degr_1

Arguments D, L, [cP7], vol (def), m15, m23

Mathematical Expression

$$\frac{(\text{m15} \cdot \text{L} + \text{m23} \cdot \text{D}) \cdot [\text{cP7}]}{\text{vol} \, (\text{def})} \tag{27}$$

6.28 Function definition `function_4_cNI_m_degr_1`

Name function_4_cNI_m_degr_1

Arguments [cNI_m], vol (def), m16

Mathematical Expression

$$\frac{\text{m16} \cdot [\text{cNI\_m}]}{\text{vol} \, (\text{def})} \tag{28}$$

6.29 Function definition `function_4_cNI_trsl_1`

Name function_4_cNI_trsl_1

Arguments [cNI_m], vol (def), p10

Mathematical Expression

$$\frac{\text{p10} \cdot [\text{cNI\_m}]}{\text{vol} \, (\text{def})} \tag{29}$$

6.30 Function definition `function_4_cG_m_trscr_1`

Name function_4_cG_m_trscr_1

Arguments L, [cL], [cP], [cT], vol (def), g14, g15, n, n12, o, q4

Mathematical Expression

$$\frac{L \cdot q4 \cdot [cP] + \frac{\frac{n12 \cdot L \cdot g15^o}{[cL]^o + g15^o} \cdot g14^n}{[cT]^n + g14^n}}{\text{vol (def)}} \tag{30}$$

6.31 Function definition `function_4_cNI_degr_1`

Name function_4_cNI_degr_1

Arguments D, L, [cNI], vol (def), m17, m24

Mathematical Expression

$$\frac{(m17 \cdot L + m24 \cdot D) \cdot [cNI]}{\text{vol (def)}} \tag{31}$$

6.32 Function definition `function_4_cG_m_degr_1`

Name function_4_cG_m_degr_1

Arguments [cG_m], vol (def), m18

Mathematical Expression

$$\frac{m18 \cdot [cG\_m]}{\text{vol (def)}} \tag{32}$$

6.33 Function definition `function_4_cG_trsl_1`

Name function_4_cG_trsl_1

Arguments [cG_m], vol (def), p11

Mathematical Expression

$$\frac{p11 \cdot [cG\_m]}{\text{vol (def)}} \tag{33}$$

6.34 Function definition `function_4_cG_degr_1`

Name function_4_cG_degr_1

Arguments [cG], vol (def), m19

Mathematical Expression

$$\frac{\text{m19} \cdot [\text{cG}]}{\text{vol (def)}} \tag{34}$$

6.35 Function definition `function_4_cG_cZTL_assoc_1`

Name function_4_cG_cZTL_assoc_1

Arguments D, L, [cG], [cZG], [cZTL], vol (def), p12, p13

Mathematical Expression

$$\frac{\text{p12} \cdot \text{L} \cdot [\text{cZTL}] \cdot [\text{cG}] - \text{p13} \cdot \text{D} \cdot [\text{cZG}]}{\text{vol (def)}} \tag{35}$$

6.36 Function definition `function_4_cZTL_trsl_1`

Name function_4_cZTL_trsl_1

Arguments vol (def), p14

Mathematical Expression

$$\frac{\text{p14}}{\text{vol (def)}} \tag{36}$$

6.37 Function definition `function_4_cZTL_degr_1`

Name function_4_cZTL_degr_1

Arguments [cZTL], vol (def), m20

Mathematical Expression

$$\frac{\text{m20} \cdot [\text{cZTL}]}{\text{vol (def)}} \tag{37}$$

6.38 Function definition `function_4_cZG_degr_1`

Name function_4_cZG_degr_1

Arguments [cZG], vol (def), m21

Mathematical Expression

$$\frac{\text{m21} \cdot [\text{cZG}]}{\text{vol (def)}} \tag{38}$$

7 Rules

This is an overview of nine rules.

7.1 Rule n12

Rule n12 is an assignment rule for parameter n12:

$$n12 = An12 \cdot \exp\left(\frac{En12}{Rgas \cdot Temp}\right) \tag{39}$$

7.2 Rule n0

Rule n0 is an assignment rule for parameter n0:

$$n0 = An0 \cdot \exp\left(\frac{En0}{Rgas \cdot Temp}\right) \tag{40}$$

7.3 Rule m1

Rule m1 is an assignment rule for parameter m1:

$$m1 = Am1 \cdot \exp\left(\frac{Em1}{Rgas \cdot Temp}\right) \tag{41}$$

7.4 Rule m6

Rule m6 is an assignment rule for parameter m6:

$$m6 = Am6 \cdot \exp\left(\frac{Em6}{Rgas \cdot Temp}\right) \tag{42}$$

7.5 Rule m15

Rule m15 is an assignment rule for parameter m15:

$$m15 = Am15 \cdot \exp\left(\frac{Em15}{Rgas \cdot Temp}\right) \tag{43}$$

7.6 Rule m25

Rule m25 is an assignment rule for parameter m25:

$$m25 = Am25 \cdot \exp\left(\frac{Em25}{Rgas \cdot Temp}\right) \tag{44}$$

7.7 Rule p1

Rule p1 is an assignment rule for parameter p1:

$$p1 = Ap1 \cdot \exp\left(\frac{Ep1}{Rgas \cdot Temp}\right) \tag{45}$$

7.8 Rule L

Rule L is an assignment rule for parameter L:

$$L = 0.5 \cdot \left(1 + \tanh\left(\frac{time - 24 \cdot \lfloor \frac{time}{24} \rfloor}{0.5}\right) - \left(1 + \tanh\left(\frac{time - 24 \cdot \lfloor \frac{time}{24} \rfloor - 12}{0.5}\right)\right) + 1 + \tanh\left(\frac{time - 24 \cdot \lfloor \frac{time}{24} \rfloor - 24}{0.5}\right)\right) \tag{46}$$

7.9 Rule D

Rule D is an assignment rule for parameter D:

$$D = 1 - L \tag{47}$$

8 Reactions

This model contains 38 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	cL_m_trscr	cL_m_trscr	$\emptyset \xrightarrow{\text{cNI, cP, cP7, cP9, cTm, cNI, cP, cP7, cP9, cTm}} \text{cL\_m}$	0000183
2	cL_m_degr	cL_m_degr	$\text{cL\_m} \xrightarrow{\text{cL\_m}} \emptyset$	0000179
3	cL_trsl	cL_trsl	$\emptyset \xrightarrow{\text{cL\_m, cL\_m}} \text{cL}$	0000184
4	cL_degr	cL_degr	$\text{cL} \xrightarrow{\text{cL}} \emptyset$	0000179
5	cL_modif	cL_modif	$\emptyset \xrightarrow{\text{cL, cL}} \text{cLm}$	0000176
6	cLm_degr	cLm_degr	$\text{cLm} \xrightarrow{\text{cLm}} \emptyset$	0000179
7	cT_m_trscr	cT_m_trscr	$\emptyset \xrightarrow{\text{cL, cY, cL, cY}} \text{cT\_m}$	0000183
8	cT_m_degr	cT_m_degr	$\text{cT\_m} \xrightarrow{\text{cT\_m}} \emptyset$	0000179
9	cT_trsl	cT_trsl	$\emptyset \xrightarrow{\text{cT\_m, cT\_m}} \text{cT}$	0000184
10	cT_degr	cT_degr	$\text{cT} \xrightarrow{\text{cZG, cZTL, cT, cZG, cZTL}} \emptyset$	0000179
11	cT_modif	cT_modif	$\emptyset \xrightarrow{\text{cT, cT}} \text{cTm}$	0000176
12	cTm_degr	cTm_degr	$\text{cTm} \xrightarrow{\text{cTm}} \emptyset$	0000179
13	cY_m_trscr	cY_m_trscr	$\emptyset \xrightarrow{\text{cL, cP, cT, cL, cP, cT}} \text{cY\_m}$	0000183
14	cY_m_degr	cY_m_degr	$\text{cY\_m} \xrightarrow{\text{cY\_m}} \emptyset$	0000179
15	cY_trsl	cY_trsl	$\emptyset \xrightarrow{\text{cY\_m, cY\_m}} \text{cY}$	0000184
16	cY_degr	cY_degr	$\text{cY} \xrightarrow{\text{cY}} \emptyset$	0000179

№	Id	Name	Reaction Equation	SBO
17	cP_trsl	cP_trsl	$\emptyset \xrightarrow{\text{cP}} \text{cP}$	0000184
18	cP_degr	cP_degr	$\text{cP} \xrightarrow{\text{cP}} \emptyset$	0000179
19	cP9_m_trscr	cP9_m_trscr	$\emptyset \xrightarrow{\text{cL, cP, cT, cL, cP, cT}} \text{cP9\_m}$	0000183
20	cP9_m_degr	cP9_m_degr	$\text{cP9\_m} \xrightarrow{\text{cP9\_m}} \emptyset$	0000179
21	cP9_trsl	cP9_trsl	$\emptyset \xrightarrow{\text{cP9\_m, cP9\_m}} \text{cP9}$	0000184
22	cP9_degr	cP9_degr	$\text{cP9} \xrightarrow{\text{cP9}} \emptyset$	0000179
23	cP7_m_trscr	cP7_m_trscr	$\emptyset \xrightarrow{\text{cL, cLm, cP9, cL, cLm, cP9}} \text{cP7\_m}$	0000183
24	cP7_m_degr	cP7_m_degr	$\text{cP7\_m} \xrightarrow{\text{cP7\_m}} \emptyset$	0000179
25	cP7_trsl	cP7_trsl	$\emptyset \xrightarrow{\text{cP7\_m, cP7\_m}} \text{cP7}$	0000184
26	cP7_degr	cP7_degr	$\text{cP7} \xrightarrow{\text{cP7}} \emptyset$	0000179
27	cNI_m_trscr	cNI_m_trscr	$\emptyset \xrightarrow{\text{cLm, cP7, cLm, cP7}} \text{cNI\_m}$	0000183
28	cNI_m_degr	cNI_m_degr	$\text{cNI\_m} \xrightarrow{\text{cNI\_m}} \emptyset$	0000179
29	cNI_trsl	cNI_trsl	$\emptyset \xrightarrow{\text{cNI\_m, cNI\_m}} \text{cNI}$	0000184
30	cNI_degr	cNI_degr	$\text{cNI} \xrightarrow{\text{cNI}} \emptyset$	0000179
31	cG_m_trscr	cG_m_trscr	$\emptyset \xrightarrow{\text{cL, cP, cT, cL, cP, cT}} \text{cG\_m}$	0000183
32	cG_m_degr	cG_m_degr	$\text{cG\_m} \xrightarrow{\text{cG\_m}} \emptyset$	0000179
33	cG_trsl	cG_trsl	$\emptyset \xrightarrow{\text{cG\_m, cG\_m}} \text{cG}$	0000184
34	cG_degr	cG_degr	$\text{cG} \xrightarrow{\text{cG}} \emptyset$	0000179
35	cG_cZTL_assoc	cG_cZTL_assoc	$\text{cG} + \text{cZTL} \xrightleftharpoons{\text{cG, cZG, cZTL}} \text{cZG}$	0000526
36	cZTL_trsl	cZTL_trsl	$\emptyset \longrightarrow \text{cZTL}$	0000183
37	cZTL_degr	cZTL_degr	$\text{cZTL} \xrightarrow{\text{cZTL}} \emptyset$	0000179

№	Id	Name	Reaction Equation	SBO
38	cZG_degr	cZG_degr	$cZG \xrightarrow{cZG} \emptyset$	0000179

8.1 Reaction `cL_m_trscr`

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

Name cL_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cNI, cP, cP7, cP9, cTm, cNI, cP, cP7, cP9, cTm}} \text{cL\_m} \tag{48}$$
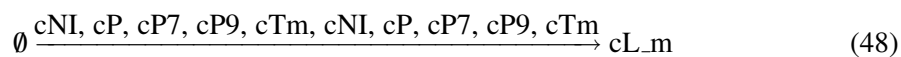
Modifiers

Table 6: Properties of each modifier.

Id	Name	SBO
cNI	cNI	
cP	cP	
cP7	cP7	
cP9	cP9	
cTm	cTm	
cNI	cNI	
cP	cP	
cP7	cP7	
cP9	cP9	
cTm	cTm	

Product

Table 7: Properties of each product.

Id	Name	SBO
cL_m	cL_m	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cL\_m\_trscr\_1}\,(\text{L}, \text{a}, \text{b}, [\text{cNI}], [\text{cP}], [\text{cP7}], [\text{cP9}], [\text{cTm}], \text{vol}\,(\text{def}), \\ \text{g1}, \text{g2}, \text{n0}, \text{n1}, \text{q1}) \tag{49}$$

$$\begin{aligned} & \text{function\_4\_cL\_m\_trscr\_1} \left(L, a, b, [cNI], [cP], [cP7], [cP9], [cTm], \right. \\ & \left. \text{vol} \left(\text{def} \right), g1, g2, n0, n1, q1 \right) = \frac{\frac{\left(n0 \cdot L + L \cdot q1 \cdot [cP] + \frac{n1 \cdot [cTm]^b}{[cTm]^b + g2^b} \right) \cdot g1^a}{\left([cP9] + [cP7] + [cNI] \right)^a + g1^a}}{\text{vol} \left(\text{def} \right)} \end{aligned}$$
(50)

$$\begin{aligned} & \text{function\_4\_cL\_m\_trscr\_1} \left(L, a, b, [cNI], [cP], [cP7], [cP9], [cTm], \right. \\ & \left. \text{vol} \left(\text{def} \right), g1, g2, n0, n1, q1 \right) = \frac{\frac{\left(n0 \cdot L + L \cdot q1 \cdot [cP] + \frac{n1 \cdot [cTm]^b}{[cTm]^b + g2^b} \right) \cdot g1^a}{\left([cP9] + [cP7] + [cNI] \right)^a + g1^a}}{\text{vol} \left(\text{def} \right)} \end{aligned}$$
(51)

8.2 Reaction `cL_m_degr`

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

Name cL_m_degr

SBO:0000179 degradation

Reaction equation

$$cL\_m \xrightarrow{cL\_m} \emptyset$$
(52)

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
cL_m	cL_m	

Modifier

Table 9: Properties of each modifier.

Id	Name	SBO
cL_m	cL_m	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{vol} \left(\text{def} \right) \cdot \text{function\_4\_cL\_m\_degr\_1} \left(D, L, [cL\_m], \text{vol} \left(\text{def} \right), m1, m2 \right)$$
(53)

$$\mathrm{function\_4\_cL\_m\_degr\_1}\left(\mathrm{D,L,[cL\_m],vol\,(def),m1,m2}\right) = \frac{(\mathrm{m1 \cdot L + m2 \cdot D}) \cdot [\mathrm{cL\_m}]}{\mathrm{vol\,(def)}} \quad (54)$$

$$\mathrm{function\_4\_cL\_m\_degr\_1}\left(\mathrm{D,L,[cL\_m],vol\,(def),m1,m2}\right) = \frac{(\mathrm{m1 \cdot L + m2 \cdot D}) \cdot [\mathrm{cL\_m}]}{\mathrm{vol\,(def)}} \quad (55)$$

8.3 Reaction `cL_trsl`

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

Name cL_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cL\_m, \ cL\_m}} \mathrm{cL} \quad (56)$$

Modifiers

Table 10: Properties of each modifier.

Id	Name	SBO
cL_m	cL_m	
cL_m	cL_m	

Product

Table 11: Properties of each product.

Id	Name	SBO
cL	cL	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol\,(def)} \cdot \mathrm{function\_4\_cL\_trsl\_1}\left(\mathrm{D,L,[cL\_m],vol\,(def),p1,p2}\right) \quad (57)$$

$$\mathrm{function\_4\_cL\_trsl\_1}\left(\mathrm{D,L,[cL\_m],vol\,(def),p1,p2}\right) = \frac{[\mathrm{cL\_m}] \cdot (\mathrm{p1 \cdot L + p2 \cdot D})}{\mathrm{vol\,(def)}} \quad (58)$$

$$\mathrm{function\_4\_cL\_trsl\_1}\left(\mathrm{D,L,[cL\_m],vol\,(def),p1,p2}\right) = \frac{[\mathrm{cL\_m}] \cdot (\mathrm{p1 \cdot L + p2 \cdot D})}{\mathrm{vol\,(def)}} \quad (59)$$

8.4 Reaction cL_degr

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

Name cL_degr

SBO:0000179 degradation

Reaction equation

$$cL \xrightarrow{cL} \emptyset \tag{60}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
cL	cL	

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
cL	cL	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{vol} \left(\text{def} \right) \cdot \text{function\_4\_cL\_degr\_1} \left(c, [cL], \text{vol} \left(\text{def} \right), g3, m3, p3 \right) \tag{61}$$

$$\text{function\_4\_cL\_degr\_1} \left(c, [cL], \text{vol} \left(\text{def} \right), g3, m3, p3 \right) = \frac{m3 \cdot [cL] + \frac{p3 \cdot [cL]^c}{[cL]^c + g3^c}}{\text{vol} \left(\text{def} \right)} \tag{62}$$

$$\text{function\_4\_cL\_degr\_1} \left(c, [cL], \text{vol} \left(\text{def} \right), g3, m3, p3 \right) = \frac{m3 \cdot [cL] + \frac{p3 \cdot [cL]^c}{[cL]^c + g3^c}}{\text{vol} \left(\text{def} \right)} \tag{63}$$

8.5 Reaction cL_modif

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

Name cL_modif

SBO:0000176 biochemical reaction

Reaction equation

$$\emptyset \xrightarrow{\text{cL, cL}} \text{cLm} \tag{64}$$
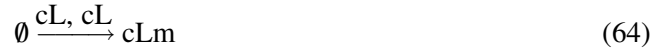
Modifiers

Table 14: Properties of each modifier.

Id	Name	SBO
cL	cL	
cL	cL	

Product

Table 15: Properties of each product.

Id	Name	SBO
cLm	cLm	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cL\_modif\_1}\,(\text{c}, [\text{cL}], \text{vol}\,(\text{def}), \text{g3}, \text{p3}) \tag{65}$$

$$\text{function\_4\_cL\_modif\_1}\,(\text{c}, [\text{cL}], \text{vol}\,(\text{def}), \text{g3}, \text{p3}) = \frac{\frac{\text{p3} \cdot [\text{cL}]^c}{[\text{cL}]^c + \text{g3}^c}}{\text{vol}\,(\text{def})} \tag{66}$$

$$\text{function\_4\_cL\_modif\_1}\,(\text{c}, [\text{cL}], \text{vol}\,(\text{def}), \text{g3}, \text{p3}) = \frac{\frac{\text{p3} \cdot [\text{cL}]^c}{[\text{cL}]^c + \text{g3}^c}}{\text{vol}\,(\text{def})} \tag{67}$$

8.6 Reaction `cLm_degr`

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

Name cLm_degr

SBO:0000179 degradation

Reaction equation

$$\text{cLm} \xrightarrow{\text{cLm}} \emptyset \tag{68}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
cLm	cLm	

Modifier

Table 17: Properties of each modifier.

Id	Name	SBO
cLm	cLm	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cLm\_degr\_1}\,([\text{cLm}], \text{vol}\,(\text{def}), \text{m4}) \tag{69}$$

$$\text{function\_4\_cLm\_degr\_1}\,([\text{cLm}], \text{vol}\,(\text{def}), \text{m4}) = \frac{\text{m4} \cdot [\text{cLm}]}{\text{vol}\,(\text{def})} \tag{70}$$

$$\text{function\_4\_cLm\_degr\_1}\,([\text{cLm}], \text{vol}\,(\text{def}), \text{m4}) = \frac{\text{m4} \cdot [\text{cLm}]}{\text{vol}\,(\text{def})} \tag{71}$$

8.7 Reaction `cT_m_trscr`

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

Name cT_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cL, cY, cL, cY}} \text{cT\_m} \tag{72}$$

Modifiers

Table 18: Properties of each modifier.

Id	Name	SBO
cL	cL	
cY	cY	
cL	cL	
cY	cY	

Product

Table 19: Properties of each product.

Id	Name	SBO
cT_m	cT_m	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol\,(def)} \cdot \mathrm{function\_4\_cT\_m\_trscr\_1}\,([cL],[cY],d,\mathrm{vol\,(def)},e,g4,g5,n2,n3) \qquad (73)$$

$$\mathrm{function\_4\_cT\_m\_trscr\_1}\,([cL],[cY],d,\mathrm{vol\,(def)},e,g4,g5,n2,n3) = \frac{\frac{\left(\frac{n2\cdot[cY]^d}{[cY]^d+g4^d}+n3\right)\cdot g5^e}{[cL]^e+g5^e}}{\mathrm{vol\,(def)}} \qquad (74)$$

$$\mathrm{function\_4\_cT\_m\_trscr\_1}\,([cL],[cY],d,\mathrm{vol\,(def)},e,g4,g5,n2,n3) = \frac{\frac{\left(\frac{n2\cdot[cY]^d}{[cY]^d+g4^d}+n3\right)\cdot g5^e}{[cL]^e+g5^e}}{\mathrm{vol\,(def)}} \qquad (75)$$

8.8 Reaction `cT_m_degr`

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

Name cT_m_degr

SBO:0000179 degradation

Reaction equation

$$\mathrm{cT\_m} \xrightarrow{\mathrm{cT\_m}} \emptyset \qquad (76)$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
cT_m	cT_m	

Modifier

Table 21: Properties of each modifier.

Id	Name	SBO
cT_m	cT_m	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\,(\mathrm{def}) \cdot \mathrm{function\_4\_cT\_m\_degr\_1}\,([\mathrm{cT\_m}], \mathrm{vol}\,(\mathrm{def}), \mathrm{m5}) \tag{77}$$

$$\mathrm{function\_4\_cT\_m\_degr\_1}\,([\mathrm{cT\_m}], \mathrm{vol}\,(\mathrm{def}), \mathrm{m5}) = \frac{\mathrm{m5} \cdot [\mathrm{cT\_m}]}{\mathrm{vol}\,(\mathrm{def})} \tag{78}$$

$$\mathrm{function\_4\_cT\_m\_degr\_1}\,([\mathrm{cT\_m}], \mathrm{vol}\,(\mathrm{def}), \mathrm{m5}) = \frac{\mathrm{m5} \cdot [\mathrm{cT\_m}]}{\mathrm{vol}\,(\mathrm{def})} \tag{79}$$

8.9 Reaction `cT_trsl`

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

Name cT_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\mathrm{cT\_m,\ cT\_m}} \mathrm{cT} \tag{80}$$

Modifiers

Table 22: Properties of each modifier.

Id	Name	SBO
cT_m	cT_m	
cT_m	cT_m	

Product

Produced by SBML2LATEX

Table 23: Properties of each product.

Id	Name	SBO
cT	cT	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\,(\mathrm{def}) \cdot \mathrm{function\_4\_cT\_trsl\_1}\,([\mathrm{cT\_m}], \mathrm{vol}\,(\mathrm{def}), \mathrm{p4}) \tag{81}$$

$$\mathrm{function\_4\_cT\_trsl\_1}\,([\mathrm{cT\_m}], \mathrm{vol}\,(\mathrm{def}), \mathrm{p4}) = \frac{\mathrm{p4} \cdot [\mathrm{cT\_m}]}{\mathrm{vol}\,(\mathrm{def})} \tag{82}$$

$$\mathrm{function\_4\_cT\_trsl\_1}\,([\mathrm{cT\_m}], \mathrm{vol}\,(\mathrm{def}), \mathrm{p4}) = \frac{\mathrm{p4} \cdot [\mathrm{cT\_m}]}{\mathrm{vol}\,(\mathrm{def})} \tag{83}$$

8.10 Reaction `cT_degr`

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

Name cT_degr

SBO:0000179 degradation

Reaction equation

$$\mathrm{cT} \xrightarrow{\mathrm{cZG,\ cZTL,\ cT,\ cZG,\ cZTL}} \emptyset \tag{84}$$
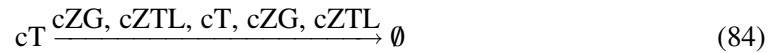
Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
cT	cT	

Modifiers

Table 25: Properties of each modifier.

Id	Name	SBO
cZG	cZG	

Id	Name	SBO
cZTL	cZTL	
cT	cT	
cZG	cZG	
cZTL	cZTL	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{vol}(\text{def}) \cdot \text{function\_4\_cT\_degr\_1}(D, L, [cT], [cZG], [cZTL], \text{vol}(\text{def}), m6, m7, m8, p5) \tag{85}$$

$$\begin{aligned} &\text{function\_4\_cT\_degr\_1}(D, L, [cT], [cZG], [cZTL], \text{vol}(\text{def}), m6, m7, m8, p5) \\ &= \frac{(m6 \cdot L + m7 \cdot D) \cdot [cT] \cdot (p5 \cdot [cZTL] + [cZG]) + m8 \cdot [cT]}{\text{vol}(\text{def})} \end{aligned} \tag{86}$$

$$\begin{aligned} &\text{function\_4\_cT\_degr\_1}(D, L, [cT], [cZG], [cZTL], \text{vol}(\text{def}), m6, m7, m8, p5) \\ &= \frac{(m6 \cdot L + m7 \cdot D) \cdot [cT] \cdot (p5 \cdot [cZTL] + [cZG]) + m8 \cdot [cT]}{\text{vol}(\text{def})} \end{aligned} \tag{87}$$

8.11 Reaction `cT_modif`

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

Name cT_modif

SBO:0000176 biochemical reaction

Reaction equation

$$\emptyset \xrightarrow{\text{cT, cT}} \text{cTm} \tag{88}$$

Modifiers

Table 26: Properties of each modifier.

Id	Name	SBO
cT	cT	
cT	cT	

Product

Table 27: Properties of each product.

Id	Name	SBO
cTm	cTm	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cT\_modif\_1}\,([\text{cT}], \text{vol}\,(\text{def}), \text{f}, \text{g6}, \text{p15}) \tag{89}$$

$$\text{function\_4\_cT\_modif\_1}\,([\text{cT}], \text{vol}\,(\text{def}), \text{f}, \text{g6}, \text{p15}) = \frac{\frac{\text{p15} \cdot [\text{cT}]^{\text{f}}}{[\text{cT}]^{\text{f}} + \text{g6}^{\text{f}}}}{\text{vol}\,(\text{def})} \tag{90}$$

$$\text{function\_4\_cT\_modif\_1}\,([\text{cT}], \text{vol}\,(\text{def}), \text{f}, \text{g6}, \text{p15}) = \frac{\frac{\text{p15} \cdot [\text{cT}]^{\text{f}}}{[\text{cT}]^{\text{f}} + \text{g6}^{\text{f}}}}{\text{vol}\,(\text{def})} \tag{91}$$

8.12 Reaction `cTm_degr`

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

Name cTm_degr

SBO:0000179 degradation

Reaction equation

$$\text{cTm} \xrightarrow{\text{cTm}} \emptyset \tag{92}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
cTm	cTm	

Modifier

Table 29: Properties of each modifier.

Id	Name	SBO
cTm	cTm	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cTm\_degr\_1}\,(\text{D}, \text{L}, [\text{cTm}], \text{vol}\,(\text{def}), \text{m25}, \text{m26}) \tag{93}$$

$$\text{function\_4\_cTm\_degr\_1}\,(\text{D}, \text{L}, [\text{cTm}], \text{vol}\,(\text{def}), \text{m25}, \text{m26}) = \frac{(\text{m25} \cdot \text{L} + \text{m26} \cdot \text{D}) \cdot [\text{cTm}]}{\text{vol}\,(\text{def})} \tag{94}$$

$$\text{function\_4\_cTm\_degr\_1}\,(\text{D}, \text{L}, [\text{cTm}], \text{vol}\,(\text{def}), \text{m25}, \text{m26}) = \frac{(\text{m25} \cdot \text{L} + \text{m26} \cdot \text{D}) \cdot [\text{cTm}]}{\text{vol}\,(\text{def})} \tag{95}$$

8.13 Reaction `cY_m_trscr`

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

Name cY_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cL, cP, cT, cL, cP, cT}} \text{cY\_m} \tag{96}$$
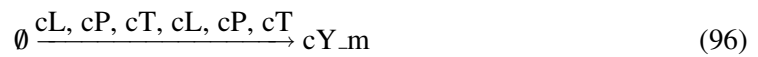
Modifiers

Table 30: Properties of each modifier.

Id	Name	SBO
cL	cL	
cP	cP	
cT	cT	
cL	cL	
cP	cP	
cT	cT	

Product

Table 31: Properties of each product.

Id	Name	SBO
cY_m	cY_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{vol} \, (\text{def}) \cdot \text{function\_4\_cY\_m\_trscr\_1} \, (D, L, [cL], [cP], [cT], \text{vol} \, (\text{def}), g, g16, g7, n5, n6, q2, s) \tag{97}$$

$$\text{function\_4\_cY\_m\_trscr\_1} \, (D, L, [cL], [cP], [cT], \text{vol} \, (\text{def}), g, g16, g7, n5, n6, q2, s) \\ = \frac{L \cdot q2 \cdot [cP] + \frac{\frac{(n5 \cdot L + n6 \cdot D) \cdot g7^s}{[cT]^s + g7^s} \cdot g16^g}{[cL]^g + g16^g}}{\text{vol} \, (\text{def})} \tag{98}$$

$$\text{function\_4\_cY\_m\_trscr\_1} \, (D, L, [cL], [cP], [cT], \text{vol} \, (\text{def}), g, g16, g7, n5, n6, q2, s) \\ = \frac{L \cdot q2 \cdot [cP] + \frac{\frac{(n5 \cdot L + n6 \cdot D) \cdot g7^s}{[cT]^s + g7^s} \cdot g16^g}{[cL]^g + g16^g}}{\text{vol} \, (\text{def})} \tag{99}$$

8.14 Reaction `cY_m_degr`

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

Name cY_m_degr

SBO:0000179 degradation

Reaction equation

$$\text{cY\_m} \xrightarrow{\text{cY\_m}} \emptyset \tag{100}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
cY_m	cY_m	

Modifier

Id	Name	SBO
cY_m	cY_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cY\_m\_degr\_1}\,([\text{cY\_m}], \text{vol}\,(\text{def}), \text{m9}) \tag{101}$$

$$\text{function\_4\_cY\_m\_degr\_1}\,([\text{cY\_m}], \text{vol}\,(\text{def}), \text{m9}) = \frac{\text{m9} \cdot [\text{cY\_m}]}{\text{vol}\,(\text{def})} \tag{102}$$

$$\text{function\_4\_cY\_m\_degr\_1}\,([\text{cY\_m}], \text{vol}\,(\text{def}), \text{m9}) = \frac{\text{m9} \cdot [\text{cY\_m}]}{\text{vol}\,(\text{def})} \tag{103}$$

8.15 Reaction `cY_trsl`

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

Name cY_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cY\_m, cY\_m}} \text{cY} \tag{104}$$

Modifiers

Table 34: Properties of each modifier.

Id	Name	SBO
cY_m	cY_m	
cY_m	cY_m	

Product

Produced by SBML2LATEX

Table 35: Properties of each product.

Id	Name	SBO
cY	cY	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cY\_trsl\_1}\,([\text{cY\_m}], \text{vol}\,(\text{def}), \text{p6}) \tag{105}$$

$$\text{function\_4\_cY\_trsl\_1}\,([\text{cY\_m}], \text{vol}\,(\text{def}), \text{p6}) = \frac{\text{p6} \cdot [\text{cY\_m}]}{\text{vol}\,(\text{def})} \tag{106}$$

$$\text{function\_4\_cY\_trsl\_1}\,([\text{cY\_m}], \text{vol}\,(\text{def}), \text{p6}) = \frac{\text{p6} \cdot [\text{cY\_m}]}{\text{vol}\,(\text{def})} \tag{107}$$

8.16 Reaction `cY_degr`

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

Name cY_degr

SBO:0000179 degradation

Reaction equation

$$\text{cY} \xrightarrow{\text{cY}} \emptyset \tag{108}$$

Reactant

Table 36: Properties of each reactant.

Id	Name	SBO
cY	cY	

Modifier

Table 37: Properties of each modifier.

Id	Name	SBO
cY	cY	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cY\_degr\_1}\,([\text{cY}], \text{vol}\,(\text{def}), \text{m10}) \tag{109}$$

$$\text{function\_4\_cY\_degr\_1}\,([\text{cY}], \text{vol}\,(\text{def}), \text{m10}) = \frac{\text{m10} \cdot [\text{cY}]}{\text{vol}\,(\text{def})} \tag{110}$$

$$\text{function\_4\_cY\_degr\_1}\,([\text{cY}], \text{vol}\,(\text{def}), \text{m10}) = \frac{\text{m10} \cdot [\text{cY}]}{\text{vol}\,(\text{def})} \tag{111}$$

8.17 Reaction `cP_trsl`

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

Name cP_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cP}} \text{cP} \tag{112}$$

Modifier

Table 38: Properties of each modifier.

Id	Name	SBO
cP	cP	

Product

Table 39: Properties of each product.

Id	Name	SBO
cP	cP	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cP\_trsl\_1}\,(\text{D}, [\text{cP}], \text{vol}\,(\text{def})\,, \text{p7}) \tag{113}$$

$$\text{function\_4\_cP\_trsl\_1}\,(\text{D}, [\text{cP}], \text{vol}\,(\text{def})\,, \text{p7}) = \frac{\text{p7} \cdot \text{D} \cdot (1 - [\text{cP}])}{\text{vol}\,(\text{def})} \tag{114}$$

$$\text{function\_4\_cP\_trsl\_1}\,(\text{D}, [\text{cP}], \text{vol}\,(\text{def})\,, \text{p7}) = \frac{\text{p7} \cdot \text{D} \cdot (1 - [\text{cP}])}{\text{vol}\,(\text{def})} \tag{115}$$

8.18 Reaction `cP_degr`

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

Name cP_degr

SBO:0000179 degradation

Reaction equation

$$\text{cP} \xrightarrow{\text{cP}} \emptyset \tag{116}$$

Reactant

Table 40: Properties of each reactant.

Id	Name	SBO
cP	cP	

Modifier

Table 41: Properties of each modifier.

Id	Name	SBO
cP	cP	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cP\_degr\_1}\,(\text{L}, [\text{cP}], \text{vol}\,(\text{def})\,, \text{m11}) \tag{117}$$

$$\text{function\_4\_cP\_degr\_1}\left(\text{L}, [\text{cP}], \text{vol}\left(\text{def}\right), \text{m11}\right) = \frac{\text{m11} \cdot [\text{cP}] \cdot \text{L}}{\text{vol}\left(\text{def}\right)} \tag{118}$$

$$\text{function\_4\_cP\_degr\_1}\left(\text{L}, [\text{cP}], \text{vol}\left(\text{def}\right), \text{m11}\right) = \frac{\text{m11} \cdot [\text{cP}] \cdot \text{L}}{\text{vol}\left(\text{def}\right)} \tag{119}$$
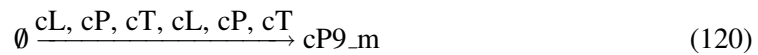
8.19 Reaction `cP9_m_trscr`

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

Name cP9_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cL, cP, cT, cL, cP, cT}} \text{cP9\_m} \tag{120}$$

Modifiers

Table 42: Properties of each modifier.

Id	Name	SBO
cL	cL	
cP	cP	
cT	cT	
cL	cL	
cP	cP	
cT	cT	

Product

Table 43: Properties of each product.

Id	Name	SBO
cP9_m	cP9_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{vol}\left(\text{def}\right) \cdot \text{function\_4\_cP9\_m\_trscr\_1}\left(\text{L}, [\text{cL}], [\text{cP}], [\text{cT}], \text{vol}\left(\text{def}\right), \text{g8}, \text{g9}, \text{h}, \text{i}, \text{n4}, \text{n7}, \text{q3}\right) \tag{121}$$

$$\text{function\_4\_cP9\_m\_trscr\_1}\left(L, [cL], [cP], [cT], \text{vol}\left(\text{def}\right), g8, g9, h, i, n4, n7, q3\right)$$

$$= \frac{L \cdot q3 \cdot [cP] + \frac{\left(n4 \cdot L + \frac{n7 \cdot [cL]^i}{[cL]^i + g9^i}\right) \cdot g8^h}{[cT]^h + g8^h}}{\text{vol}\left(\text{def}\right)} \tag{122}$$

$$\text{function\_4\_cP9\_m\_trscr\_1}\left(L, [cL], [cP], [cT], \text{vol}\left(\text{def}\right), g8, g9, h, i, n4, n7, q3\right)$$

$$= \frac{L \cdot q3 \cdot [cP] + \frac{\left(n4 \cdot L + \frac{n7 \cdot [cL]^i}{[cL]^i + g9^i}\right) \cdot g8^h}{[cT]^h + g8^h}}{\text{vol}\left(\text{def}\right)} \tag{123}$$

8.20 Reaction `cP9_m_degr`

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

Name cP9_m_degr

SBO:0000179 degradation

Reaction equation

$$\text{cP9\_m} \xrightarrow{\text{cP9\_m}} \emptyset \tag{124}$$

Reactant

Table 44: Properties of each reactant.

Id	Name	SBO
cP9_m	cP9_m	

Modifier

Table 45: Properties of each modifier.

Id	Name	SBO
cP9_m	cP9_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{vol}\left(\text{def}\right) \cdot \text{function\_4\_cP9\_m\_degr\_1}\left([cP9\_m], \text{vol}\left(\text{def}\right), m12\right) \tag{125}$$

$$\text{function\_4\_cP9\_m\_degr\_1}\left([\text{cP9\_m}], \text{vol}\left(\text{def}\right), \text{m12}\right) = \frac{\text{m12} \cdot [\text{cP9\_m}]}{\text{vol}\left(\text{def}\right)} \tag{126}$$

$$\text{function\_4\_cP9\_m\_degr\_1}\left([\text{cP9\_m}], \text{vol}\left(\text{def}\right), \text{m12}\right) = \frac{\text{m12} \cdot [\text{cP9\_m}]}{\text{vol}\left(\text{def}\right)} \tag{127}$$

8.21 Reaction `cP9_trsl`

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

Name cP9_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cP9\_m, cP9\_m}} \text{cP9} \tag{128}$$

Modifiers

Table 46: Properties of each modifier.

Id	Name	SBO
cP9_m	cP9_m	
cP9_m	cP9_m	

Product

Table 47: Properties of each product.

Id	Name	SBO
cP9	cP9	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{vol}\left(\text{def}\right) \cdot \text{function\_4\_cP9\_trsl\_1}\left([\text{cP9\_m}], \text{vol}\left(\text{def}\right), \text{p8}\right) \tag{129}$$

$$\text{function\_4\_cP9\_trsl\_1}\left([\text{cP9\_m}], \text{vol}\left(\text{def}\right), \text{p8}\right) = \frac{\text{p8} \cdot [\text{cP9\_m}]}{\text{vol}\left(\text{def}\right)} \tag{130}$$

$$\text{function\_4\_cP9\_trsl\_1}\left([\text{cP9\_m}], \text{vol}\left(\text{def}\right), \text{p8}\right) = \frac{\text{p8} \cdot [\text{cP9\_m}]}{\text{vol}\left(\text{def}\right)} \tag{131}$$

8.22 Reaction `cP9_degr`

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

Name cP9_degr

SBO:0000179 degradation

Reaction equation

$$cP9 \xrightarrow{cP9} \emptyset \tag{132}$$

Reactant

Table 48: Properties of each reactant.

Id	Name	SBO
cP9	cP9	

Modifier

Table 49: Properties of each modifier.

Id	Name	SBO
cP9	cP9	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cP9\_degr\_1}\,(D, L, [cP9], \text{vol}\,(\text{def}), m13, m22) \tag{133}$$

$$\text{function\_4\_cP9\_degr\_1}\,(D, L, [cP9], \text{vol}\,(\text{def}), m13, m22) = \frac{(m13 \cdot L + m22 \cdot D) \cdot [cP9]}{\text{vol}\,(\text{def})} \tag{134}$$

$$\text{function\_4\_cP9\_degr\_1}\,(D, L, [cP9], \text{vol}\,(\text{def}), m13, m22) = \frac{(m13 \cdot L + m22 \cdot D) \cdot [cP9]}{\text{vol}\,(\text{def})} \tag{135}$$
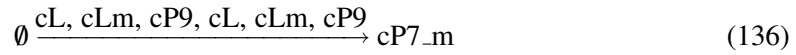
8.23 Reaction `cP7_m_trscr`

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

Name cP7_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cL, cLm, cP9, cL, cLm, cP9}} \text{cP7\_m} \tag{136}$$

Modifiers

Table 50: Properties of each modifier.

Id	Name	SBO
cL	cL	
cLm	cLm	
cP9	cP9	
cL	cL	
cLm	cLm	
cP9	cP9	

Product

Table 51: Properties of each product.

Id	Name	SBO
cP7_m	cP7_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cP7\_m\_trscr\_1}\,([\text{cL}],[\text{cLm}],[\text{cP9}],\text{vol}\,(\text{def})\,,\text{g10},\text{g11},\text{j},\text{k},\text{n8},\text{n9}) \tag{137}$$

$$\text{function\_4\_cP7\_m\_trscr\_1}\,([\text{cL}],[\text{cLm}],[\text{cP9}],\text{vol}\,(\text{def})\,,\text{g10},\text{g11},\text{j},\text{k},\text{n8},\text{n9})$$
$$= \frac{\frac{\text{n8}\cdot([\text{cLm}]+[\text{cL}])^{\text{j}}}{([\text{cLm}]+[\text{cL}])^{\text{j}}+\text{g10}^{\text{j}}} + \frac{\text{n9}\cdot[\text{cP9}]^{\text{k}}}{[\text{cP9}]^{\text{k}}+\text{g11}^{\text{k}}}}{\text{vol}\,(\text{def})} \tag{138}$$

$$\text{function\_4\_cP7\_m\_trscr\_1}\,([\text{cL}],[\text{cLm}],[\text{cP9}],\text{vol}\,(\text{def})\,,\text{g10},\text{g11},\text{j},\text{k},\text{n8},\text{n9})$$
$$= \frac{\frac{\text{n8}\cdot([\text{cLm}]+[\text{cL}])^{\text{j}}}{([\text{cLm}]+[\text{cL}])^{\text{j}}+\text{g10}^{\text{j}}} + \frac{\text{n9}\cdot[\text{cP9}]^{\text{k}}}{[\text{cP9}]^{\text{k}}+\text{g11}^{\text{k}}}}{\text{vol}\,(\text{def})} \tag{139}$$

8.24 Reaction `cP7_m_degr`

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

Name cP7_m_degr

SBO:0000179 degradation

Reaction equation

$$cP7\_m \xrightarrow{cP7\_m} \emptyset \tag{140}$$

Reactant

Table 52: Properties of each reactant.

Id	Name	SBO
cP7_m	cP7_m	

Modifier

Table 53: Properties of each modifier.

Id	Name	SBO
cP7_m	cP7_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cP7\_m\_degr\_1}\,([\text{cP7\_m}], \text{vol}\,(\text{def}), \text{m14}) \tag{141}$$

$$\text{function\_4\_cP7\_m\_degr\_1}\,([\text{cP7\_m}], \text{vol}\,(\text{def}), \text{m14}) = \frac{\text{m14} \cdot [\text{cP7\_m}]}{\text{vol}\,(\text{def})} \tag{142}$$

$$\text{function\_4\_cP7\_m\_degr\_1}\,([\text{cP7\_m}], \text{vol}\,(\text{def}), \text{m14}) = \frac{\text{m14} \cdot [\text{cP7\_m}]}{\text{vol}\,(\text{def})} \tag{143}$$

8.25 Reaction `cP7_trsl`

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

Name cP7_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cP7\_m, cP7\_m}} \text{cP7} \tag{144}$$

Modifiers

Table 54: Properties of each modifier.

Id	Name	SBO
cP7_m	cP7_m	
cP7_m	cP7_m	

Product

Table 55: Properties of each product.

Id	Name	SBO
cP7	cP7	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cP7\_trsl\_1}\,([\text{cP7\_m}], \text{vol}\,(\text{def})\,, \text{p9}) \tag{145}$$

$$\text{function\_4\_cP7\_trsl\_1}\,([\text{cP7\_m}], \text{vol}\,(\text{def})\,, \text{p9}) = \frac{\text{p9} \cdot [\text{cP7\_m}]}{\text{vol}\,(\text{def})} \tag{146}$$

$$\text{function\_4\_cP7\_trsl\_1}\,([\text{cP7\_m}], \text{vol}\,(\text{def})\,, \text{p9}) = \frac{\text{p9} \cdot [\text{cP7\_m}]}{\text{vol}\,(\text{def})} \tag{147}$$
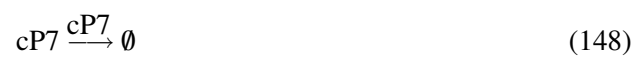
8.26 Reaction `cP7_degr`

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

Name cP7_degr

SBO:0000179 degradation

Reaction equation

$$\text{cP7} \xrightarrow{\text{cP7}} \emptyset \tag{148}$$

Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
cP7	cP7	

Modifier

Table 57: Properties of each modifier.

Id	Name	SBO
cP7	cP7	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{vol}(\text{def}) \cdot \text{function\_4\_cP7\_degr\_1}(D, L, [cP7], \text{vol}(\text{def}), m15, m23) \tag{149}$$

$$\text{function\_4\_cP7\_degr\_1}(D, L, [cP7], \text{vol}(\text{def}), m15, m23) = \frac{(m15 \cdot L + m23 \cdot D) \cdot [cP7]}{\text{vol}(\text{def})} \tag{150}$$

$$\text{function\_4\_cP7\_degr\_1}(D, L, [cP7], \text{vol}(\text{def}), m15, m23) = \frac{(m15 \cdot L + m23 \cdot D) \cdot [cP7]}{\text{vol}(\text{def})} \tag{151}$$

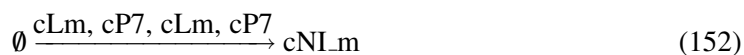## 8.27 Reaction `cNI_m_trscr`

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

Name cNI_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cLm, cP7, cLm, cP7}} \text{cNI\_m} \tag{152}$$

Modifiers

Table 58: Properties of each modifier.

Id	Name	SBO
cLm	cLm	
cP7	cP7	
cLm	cLm	
cP7	cP7	

Product

Table 59: Properties of each product.

Id	Name	SBO
cNI_m	cNI_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cNI\_m\_trscr\_1}\,([\text{cLm}], [\text{cP7}], \text{vol}\,(\text{def}), g12, g13, l, m, n10, n11) \tag{153}$$

$$\text{function\_4\_cNI\_m\_trscr\_1}\,([\text{cLm}], [\text{cP7}], \text{vol}\,(\text{def}), g12, g13, l, m, n10, n11)$$
$$= \frac{\frac{n10 \cdot [\text{cLm}]^l}{[\text{cLm}]^l + g12^l} + \frac{n11 \cdot [\text{cP7}]^m}{[\text{cP7}]^m + g13^m}}{\text{vol}\,(\text{def})} \tag{154}$$

$$\text{function\_4\_cNI\_m\_trscr\_1}\,([\text{cLm}], [\text{cP7}], \text{vol}\,(\text{def}), g12, g13, l, m, n10, n11)$$
$$= \frac{\frac{n10 \cdot [\text{cLm}]^l}{[\text{cLm}]^l + g12^l} + \frac{n11 \cdot [\text{cP7}]^m}{[\text{cP7}]^m + g13^m}}{\text{vol}\,(\text{def})} \tag{155}$$

8.28 Reaction `cNI_m_degr`

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

Name cNI_m_degr

SBO:0000179 degradation

Reaction equation

$$\text{cNI\_m} \xrightarrow{\text{cNI\_m}} \emptyset \tag{156}$$

Reactant

Table 60: Properties of each reactant.

Id	Name	SBO
cNI_m	cNI_m	

Produced by SBML2LATEX

Modifier

Table 61: Properties of each modifier.

Id	Name	SBO
cNI_m	cNI_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cNI\_m\_degr\_1}\,([\text{cNI\_m}], \text{vol}\,(\text{def}), \text{m16}) \tag{157}$$

$$\text{function\_4\_cNI\_m\_degr\_1}\,([\text{cNI\_m}], \text{vol}\,(\text{def}), \text{m16}) = \frac{\text{m16} \cdot [\text{cNI\_m}]}{\text{vol}\,(\text{def})} \tag{158}$$

$$\text{function\_4\_cNI\_m\_degr\_1}\,([\text{cNI\_m}], \text{vol}\,(\text{def}), \text{m16}) = \frac{\text{m16} \cdot [\text{cNI\_m}]}{\text{vol}\,(\text{def})} \tag{159}$$

8.29 Reaction `cNI_trsl`

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

Name cNI_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cNI\_m, cNI\_m}} \text{cNI} \tag{160}$$

Modifiers

Table 62: Properties of each modifier.

Id	Name	SBO
cNI_m	cNI_m	
cNI_m	cNI_m	

Product

Table 63: Properties of each product.

Id	Name	SBO
cNI	cNI	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cNI\_trsl\_1}\,([\text{cNI\_m}], \text{vol}\,(\text{def}), \text{p10}) \tag{161}$$

$$\text{function\_4\_cNI\_trsl\_1}\,([\text{cNI\_m}], \text{vol}\,(\text{def}), \text{p10}) = \frac{\text{p10} \cdot [\text{cNI\_m}]}{\text{vol}\,(\text{def})} \tag{162}$$

$$\text{function\_4\_cNI\_trsl\_1}\,([\text{cNI\_m}], \text{vol}\,(\text{def}), \text{p10}) = \frac{\text{p10} \cdot [\text{cNI\_m}]}{\text{vol}\,(\text{def})} \tag{163}$$

8.30 Reaction `cNI_degr`

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

Name cNI_degr

SBO:0000179 degradation

Reaction equation

$$\text{cNI} \xrightarrow{\text{cNI}} \emptyset \tag{164}$$

Reactant

Table 64: Properties of each reactant.

Id	Name	SBO
cNI	cNI	

Modifier

Table 65: Properties of each modifier.

Id	Name	SBO
cNI	cNI	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cNI\_degr\_1}\,(D, L, [\text{cNI}], \text{vol}\,(\text{def}), m17, m24) \tag{165}$$

$$\text{function\_4\_cNI\_degr\_1}\,(D, L, [\text{cNI}], \text{vol}\,(\text{def}), m17, m24) = \frac{(m17 \cdot L + m24 \cdot D) \cdot [\text{cNI}]}{\text{vol}\,(\text{def})} \tag{166}$$

$$\text{function\_4\_cNI\_degr\_1}\,(D, L, [\text{cNI}], \text{vol}\,(\text{def}), m17, m24) = \frac{(m17 \cdot L + m24 \cdot D) \cdot [\text{cNI}]}{\text{vol}\,(\text{def})} \tag{167}$$

8.31 Reaction `cG_m_trscr`

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

Name cG_m_trscr

SBO:0000183 transcription

Reaction equation

$$\emptyset \xrightarrow{\text{cL, cP, cT, cL, cP, cT}} \text{cG\_m} \tag{168}$$

Modifiers

Table 66: Properties of each modifier.

Id	Name	SBO
cL	cL	
cP	cP	
cT	cT	
cL	cL	
cP	cP	
cT	cT	

Product

Table 67: Properties of each product.

Id	Name	SBO
cG_m	cG_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cG\_m\_trscr\_1}\,(\text{L},[\text{cL}],[\text{cP}],[\text{cT}],\text{vol}\,(\text{def})\,,\text{g14},\text{g15},\text{n},\text{n12},\text{o},\text{q4}) \tag{169}$$

$$\text{function\_4\_cG\_m\_trscr\_1}\,(\text{L},[\text{cL}],[\text{cP}],[\text{cT}],\text{vol}\,(\text{def})\,,\text{g14},\text{g15},\text{n},\text{n12},\text{o},\text{q4})$$
$$= \frac{\text{L}\cdot\text{q4}\cdot[\text{cP}] + \frac{\frac{\text{n12}\cdot\text{L}\cdot\text{g15}^{\text{o}}}{[\text{cL}]^{\text{o}}+\text{g15}^{\text{o}}}\cdot\text{g14}^{\text{n}}}{[\text{cT}]^{\text{n}}+\text{g14}^{\text{n}}}}{\text{vol}\,(\text{def})} \tag{170}$$

$$\text{function\_4\_cG\_m\_trscr\_1}\,(\text{L},[\text{cL}],[\text{cP}],[\text{cT}],\text{vol}\,(\text{def})\,,\text{g14},\text{g15},\text{n},\text{n12},\text{o},\text{q4})$$
$$= \frac{\text{L}\cdot\text{q4}\cdot[\text{cP}] + \frac{\frac{\text{n12}\cdot\text{L}\cdot\text{g15}^{\text{o}}}{[\text{cL}]^{\text{o}}+\text{g15}^{\text{o}}}\cdot\text{g14}^{\text{n}}}{[\text{cT}]^{\text{n}}+\text{g14}^{\text{n}}}}{\text{vol}\,(\text{def})} \tag{171}$$

8.32 Reaction `cG_m_degr`

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

Name cG_m_degr

SBO:0000179 degradation

Reaction equation

$$\text{cG\_m} \xrightarrow{\text{cG\_m}} \emptyset \tag{172}$$

Reactant

Table 68: Properties of each reactant.

Id	Name	SBO
cG_m	cG_m	

Modifier

Table 69: Properties of each modifier.

Id	Name	SBO
cG_m	cG_m	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cG\_m\_degr\_1}\,([\text{cG\_m}], \text{vol}\,(\text{def}), \text{m18}) \tag{173}$$

$$\text{function\_4\_cG\_m\_degr\_1}\,([\text{cG\_m}], \text{vol}\,(\text{def}), \text{m18}) = \frac{\text{m18} \cdot [\text{cG\_m}]}{\text{vol}\,(\text{def})} \tag{174}$$

$$\text{function\_4\_cG\_m\_degr\_1}\,([\text{cG\_m}], \text{vol}\,(\text{def}), \text{m18}) = \frac{\text{m18} \cdot [\text{cG\_m}]}{\text{vol}\,(\text{def})} \tag{175}$$

8.33 Reaction `cG_trsl`

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

Name cG_trsl

SBO:0000184 translation

Reaction equation

$$\emptyset \xrightarrow{\text{cG\_m, cG\_m}} \text{cG} \tag{176}$$

Modifiers

Table 70: Properties of each modifier.

Id	Name	SBO
cG_m	cG_m	
cG_m	cG_m	

Product

Table 71: Properties of each product.

Id	Name	SBO
cG	cG	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \text{vol}(\text{def}) \cdot \text{function\_4\_cG\_trsl\_1}([\text{cG\_m}], \text{vol}(\text{def}), \text{p11}) \tag{177}$$

$$\text{function\_4\_cG\_trsl\_1}([\text{cG\_m}], \text{vol}(\text{def}), \text{p11}) = \frac{\text{p11} \cdot [\text{cG\_m}]}{\text{vol}(\text{def})} \tag{178}$$

$$\text{function\_4\_cG\_trsl\_1}([\text{cG\_m}], \text{vol}(\text{def}), \text{p11}) = \frac{\text{p11} \cdot [\text{cG\_m}]}{\text{vol}(\text{def})} \tag{179}$$

8.34 Reaction `cG_degr`

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

Name cG_degr

SBO:0000179 degradation

Reaction equation

$$\text{cG} \xrightarrow{\text{cG}} \emptyset \tag{180}$$

Reactant

Table 72: Properties of each reactant.

Id	Name	SBO
cG	cG	

Modifier

Table 73: Properties of each modifier.

Id	Name	SBO
cG	cG	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cG\_degr\_1}\,([cG], \text{vol}\,(\text{def}), m19) \tag{181}$$

$$\text{function\_4\_cG\_degr\_1}\,([cG], \text{vol}\,(\text{def}), m19) = \frac{m19 \cdot [cG]}{\text{vol}\,(\text{def})} \tag{182}$$

$$\text{function\_4\_cG\_degr\_1}\,([cG], \text{vol}\,(\text{def}), m19) = \frac{m19 \cdot [cG]}{\text{vol}\,(\text{def})} \tag{183}$$

8.35 Reaction `cG_cZTL_assoc`

This is a reversible reaction of two reactants forming one product influenced by three modifiers.

Name cG_cZTL_assoc

SBO:0000526 protein complex formation

Reaction equation

$$cG + cZTL \xrightleftharpoons{\text{cG, cZG, cZTL}} cZG \tag{184}$$

Reactants

Table 74: Properties of each reactant.

Id	Name	SBO
cG	cG	
cZTL	cZTL	

Modifiers

Table 75: Properties of each modifier.

Id	Name	SBO
cG	cG	
cZG	cZG	

Id	Name	SBO
cZTL	cZTL	

Product

Table 76: Properties of each product.

Id	Name	SBO
cZG	cZG	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \text{vol}(\text{def}) \cdot \text{function\_4\_cG\_cZTL\_assoc\_1}(D,L,[cG],[cZG],[cZTL],\text{vol}(\text{def}),p12,p13) \tag{185}$$

$$\begin{aligned}
&\text{function\_4\_cG\_cZTL\_assoc\_1}(D,L,[cG],[cZG],[cZTL],\text{vol}(\text{def}),p12,p13) \\
&= \frac{p12 \cdot L \cdot [cZTL] \cdot [cG] - p13 \cdot D \cdot [cZG]}{\text{vol}(\text{def})}
\end{aligned} \tag{186}$$

$$\begin{aligned}
&\text{function\_4\_cG\_cZTL\_assoc\_1}(D,L,[cG],[cZG],[cZTL],\text{vol}(\text{def}),p12,p13) \\
&= \frac{p12 \cdot L \cdot [cZTL] \cdot [cG] - p13 \cdot D \cdot [cZG]}{\text{vol}(\text{def})}
\end{aligned} \tag{187}$$

8.36 Reaction `cZTL_trsl`

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

Name cZTL_trsl

SBO:0000183 transcription

Reaction equation

$$\emptyset \longrightarrow cZTL \tag{188}$$

Product

Table 77: Properties of each product.

Id	Name	SBO
cZTL	cZTL	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cZTL\_trsl\_1}\,(\text{vol}\,(\text{def})\,,\text{p14}) \tag{189}$$

$$\text{function\_4\_cZTL\_trsl\_1}\,(\text{vol}\,(\text{def})\,,\text{p14}) = \frac{\text{p14}}{\text{vol}\,(\text{def})} \tag{190}$$

$$\text{function\_4\_cZTL\_trsl\_1}\,(\text{vol}\,(\text{def})\,,\text{p14}) = \frac{\text{p14}}{\text{vol}\,(\text{def})} \tag{191}$$

8.37 Reaction `cZTL_degr`

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

Name cZTL_degr

SBO:0000179 degradation

Reaction equation

$$\text{cZTL} \xrightarrow{\text{cZTL}} \emptyset \tag{192}$$

Reactant

Table 78: Properties of each reactant.

Id	Name	SBO
cZTL	cZTL	

Modifier

Table 79: Properties of each modifier.

Id	Name	SBO
cZTL	cZTL	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cZTL\_degr\_1}\,([\text{cZTL}], \text{vol}\,(\text{def}), \text{m20}) \tag{193}$$

$$\text{function\_4\_cZTL\_degr\_1}\,([\text{cZTL}], \text{vol}\,(\text{def}), \text{m20}) = \frac{\text{m20} \cdot [\text{cZTL}]}{\text{vol}\,(\text{def})} \tag{194}$$

$$\text{function\_4\_cZTL\_degr\_1}\,([\text{cZTL}], \text{vol}\,(\text{def}), \text{m20}) = \frac{\text{m20} \cdot [\text{cZTL}]}{\text{vol}\,(\text{def})} \tag{195}$$

8.38 Reaction `cZG_degr`

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

Name cZG_degr

SBO:0000179 degradation

Reaction equation

$$\text{cZG} \xrightarrow{\text{cZG}} \emptyset \tag{196}$$

Reactant

Table 80: Properties of each reactant.

Id	Name	SBO
cZG	cZG	

Modifier

Table 81: Properties of each modifier.

Id	Name	SBO
cZG	cZG	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \text{vol}\,(\text{def}) \cdot \text{function\_4\_cZG\_degr\_1}\,([\text{cZG}], \text{vol}\,(\text{def}), \text{m21}) \tag{197}$$

$$\text{function\_4\_cZG\_degr\_1}\,([\text{cZG}], \text{vol}\,(\text{def}), \text{m21}) = \frac{\text{m21} \cdot [\text{cZG}]}{\text{vol}\,(\text{def})} \tag{198}$$

$$\text{function\_4\_cZG\_degr\_1}\,([\text{cZG}], \text{vol}\,(\text{def}), \text{m21}) = \frac{\text{m21} \cdot [\text{cZG}]}{\text{vol}\,(\text{def})} \tag{199}$$

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 cG

Name cG

SBO:0000245 macromolecule

Initial concentration $0.0238 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in five reactions (as a reactant in `cG_degr`, `cG_cZTL_assoc` and as a product in `cG_trsl` and as a modifier in `cG_degr`, `cG_cZTL_assoc`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cG} = v_{33} - v_{34} - v_{35} \tag{200}$$

9.2 Species cG_m

Name cG_m

SBO:0000278 messenger RNA

Initial concentration $0.119 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in five reactions (as a reactant in `cG_m_degr` and as a product in `cG_m_trscr` and as a modifier in `cG_m_degr`, `cG_trsl`, `cG_trsl`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cG\_m} = v_{31} - v_{32} \tag{201}$$

9.3 Species cL

Name cL

SBO:0000245 macromolecule

Initial concentration $0.416 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in 15 reactions (as a reactant in cL_degr and as a product in cL_trsl and as a modifier in cL_degr, cL_modif, cL_modif, cT_m_trscr, cT_m_trscr, cY_m_trscr, cY_m_-trscr, cP9_m_trscr, cP9_m_trscr, cP7_m_trscr, cP7_m_trscr, cG_m_trscr, cG_m_trscr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cL} = v_3 - v_4 \tag{202}$$

9.4 Species cL_m

Name cL_m

SBO:0000278 messenger RNA

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

This species takes part in five reactions (as a reactant in cL_m_degr and as a product in cL_m_-trscr and as a modifier in cL_m_degr, cL_trsl, cL_trsl).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cL\_m} = v_1 - v_2 \tag{203}$$

9.5 Species cLm

Name cLm

SBO:0000245 macromolecule

Initial concentration $0.054 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in seven reactions (as a reactant in cLm_degr and as a product in cL_-modif and as a modifier in cLm_degr, cP7_m_trscr, cP7_m_trscr, cNI_m_trscr, cNI_m_-trscr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cLm} = v_5 - v_6 \tag{204}$$

9.6 Species cNI

Name cNI

SBO:0000020 inhibitor

Initial concentration $0.044 \, \text{item} \cdot 1^{-1}$

This species takes part in five reactions (as a reactant in cNI_degr and as a product in cNI_trsl and as a modifier in cL_m_trscr, cL_m_trscr, cNI_degr).

$$\frac{\text{d}}{\text{d}t}\text{cNI} = v_{29} - v_{30} \tag{205}$$

9.7 Species cNI_m

Name cNI_m

SBO:0000278 messenger RNA

Initial concentration $0.0065 \, \text{item} \cdot 1^{-1}$

This species takes part in five reactions (as a reactant in cNI_m_degr and as a product in cNI_m_trscr and as a modifier in cNI_m_degr, cNI_trsl, cNI_trsl).

$$\frac{\text{d}}{\text{d}t}\text{cNI\_m} = v_{27} - v_{28} \tag{206}$$

9.8 Species cP

Name cP

SBO:0000245 macromolecule

Initial concentration $0.825 \, \text{item} \cdot 1^{-1}$

This species takes part in twelve reactions (as a reactant in cP_degr and as a product in cP_trsl and as a modifier in cL_m_trscr, cL_m_trscr, cY_m_trscr, cY_m_trscr, cP_trsl, cP_degr, cP9_m_trscr, cP9_m_trscr, cG_m_trscr, cG_m_trscr).

$$\frac{\text{d}}{\text{d}t}\text{cP} = v_{17} - v_{18} \tag{207}$$

9.9 Species cP7

Name cP7

SBO:0000245 macromolecule

Initial concentration $0.019 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in seven reactions (as a reactant in cP7_degr and as a product in cP7_trsl and as a modifier in cL_m_trscr, cL_m_trscr, cP7_degr, cNI_m_trscr, cNI_m_trscr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cP7} = v_{25} - v_{26} \tag{208}$$

9.10 Species cP7_m

Name cP7_m

SBO:0000278 messenger RNA

Initial concentration $0.075 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in five reactions (as a reactant in cP7_m_degr and as a product in cP7_m_trscr and as a modifier in cP7_m_degr, cP7_trsl, cP7_trsl).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cP7\_m} = v_{23} - v_{24} \tag{209}$$

9.11 Species cP9

Name cP9

SBO:0000245 macromolecule

Initial concentration $0.056 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in seven reactions (as a reactant in cP9_degr and as a product in cP9_trsl and as a modifier in cL_m_trscr, cL_m_trscr, cP9_degr, cP7_m_trscr, cP7_m_trscr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cP9} = v_{21} - v_{22} \tag{210}$$

9.12 Species cP9_m

Name cP9_m

SBO:0000278 messenger RNA

Initial concentration $0.35 \, \text{item} \cdot \text{l}^{-1}$

This species takes part in five reactions (as a reactant in cP9_m_degr and as a product in cP9_m_trscr and as a modifier in cP9_m_degr, cP9_trsl, cP9_trsl).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{cP9\_m} = v_{19} - v_{20} \tag{211}$$

9.13 Species `cT`

Name cT

SBO:0000245 macromolecule

Initial concentration 0.393 item $\cdot$ l^{-1}

This species takes part in eleven reactions (as a reactant in `cT_degr` and as a product in `cT_trsl` and as a modifier in `cT_degr`, `cT_modif`, `cT_modif`, `cY_m_trscr`, `cY_m_trscr`, `cP9_m_trscr`, `cP9_m_trscr`, `cG_m_trscr`, `cG_m_trscr`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cT} = v_9 - v_{10} \tag{212}$$

9.14 Species `cT_m`

Name cT_m

SBO:0000278 messenger RNA

Initial concentration 0.25 item $\cdot$ l^{-1}

This species takes part in five reactions (as a reactant in `cT_m_degr` and as a product in `cT_m_-trscr` and as a modifier in `cT_m_degr`, `cT_trsl`, `cT_trsl`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cT\_m} = v_7 - v_8 \tag{213}$$

9.15 Species `cTm`

Name cTm

SBO:0000245 macromolecule

Initial concentration 0.24 item $\cdot$ l^{-1}

This species takes part in five reactions (as a reactant in `cTm_degr` and as a product in `cT_modif` and as a modifier in `cL_m_trscr`, `cL_m_trscr`, `cTm_degr`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cTm} = v_{11} - v_{12} \tag{214}$$

9.16 Species cY

Name cY

SBO:0000245 macromolecule

Initial concentration 0.1 item$\cdot$l^{-1}

This species takes part in five reactions (as a reactant in cY_degr and as a product in cY_trsl and as a modifier in cT_m_trscr, cT_m_trscr, cY_degr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cY} = v_{15} - v_{16} \tag{215}$$

9.17 Species cY_m

Name cY_m

SBO:0000278 messenger RNA

Initial concentration 0.093 item$\cdot$l^{-1}

This species takes part in five reactions (as a reactant in cY_m_degr and as a product in cY_m_trscr and as a modifier in cY_m_degr, cY_trsl, cY_trsl).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cY\_m} = v_{13} - v_{14} \tag{216}$$

9.18 Species cZG

Name cZG

SBO:0000296 macromolecular complex

Initial concentration 0.0774 item$\cdot$l^{-1}

This species takes part in six reactions (as a reactant in cZG_degr and as a product in cG_cZTL_assoc and as a modifier in cT_degr, cT_degr, cG_cZTL_assoc, cZG_degr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cZG} = v_{35} - v_{38} \tag{217}$$

9.19 Species cZTL

Name cZTL

SBO:0000245 macromolecule

Initial concentration 0.323 item$\cdot$l^{-1}

This species takes part in seven reactions (as a reactant in cG_cZTL_assoc, cZTL_degr and as a product in cZTL_trsl and as a modifier in cT_degr, cT_degr, cG_cZTL_assoc, cZTL_degr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cZTL} = v_{36} - v_{35} - v_{37} \tag{218}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000009 kinetic constant: Numerical parameter that quantifies the velocity of a chemical reaction

SBO:0000020 inhibitor: Substance that decreases the probability of a chemical reaction without itself being consumed or transformed by the reaction

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:0000176 biochemical reaction: An event involving one or more chemical entities that modifies the electrochemical structure of at least one of the participants.

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:0000191 Hill constant: Empirical constant 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). Different from a microscopic dissociation constant, it has the dimension of concentration to the power of the Hill coefficient

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

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:0000296 macromolecular complex: Non-covalent complex of one or more macromolecules and zero or more simple chemicals

SBO:0000356 decay constant: Kinetic constant characterising a mono-exponential decay. It is the inverse of the mean lifetime of the continuant being decayed. Its unit is"per tim".

SBO:0000526 protein complex formation: The process by which two or more proteins interact non-covalently to form a protein complex (SBO:0000297)