SBML Model Report

Model name: "Ciliberto2003_Morphogenesis_Checkpoint"

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: Harish Dharuri[1] and Vijayalakshmi Chelliah[2] at February seventh 2008 at 2:15 p. m. and last time modified at January 31st 2012 at 1:52 p. m. Table 1 gives an overview of the quantities of all components of this model.

Table 1: Number of components in this model, which are described in the following sections.

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	19
events	4	constraints	0
reactions	51	function definitions	0
global parameters	81	unit definitions	2
rules	8	initial assignments	0

Model Notes

This a model from the article:
Mathematical model of the morphogenesis checkpoint in budding yeast.
Ciliberto A, Novak B, Tyson JJ J. Cell Biol. [2003 Dec; Volume: 163 (Issue: 6)] Page info: 1243-54 14691135 ,

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Abstract:
The morphogenesis checkpoint in budding yeast delays progression through the cell cycle in response to stimuli that prevent bud formation. Central to the checkpoint mechanism is Swe1 kinase: normally inactive, its activation halts cell cycle progression in G2. We propose a molecular network for Swe1 control, based on published observations of budding yeast and analogous control signals in fission yeast. The proposed Swe1 network is merged with a model of cyclin-dependent kinase regulation, converted into a set of differential equations and studied by numerical simulation. The simulations accurately reproduce the phenotypes of a dozen checkpoint mutants. Among other predictions, the model attributes a new role to Hsl1, a kinase known to play a role in Swe1 degradation: Hsl1 must also be indirectly responsible for potent inhibition of Swe1 activity. The model supports the idea that the morphogenesis checkpoint, like other checkpoints, raises the cell size threshold for progression from one phase of the cell cycle to the next.

The model reproduces Fig 3 of the paper.

2 Unit Definitions

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

2.1 Unit `time`

Name minutes

Definition 60 s

2.2 Unit `substance`

Definition item

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		0000290	3	1	litre	☑	

3.1 Compartment compartment

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

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
Trim	CDC28_Clb2_Sic1_Complex	compartment	item · l^{-1}	⊟	⊟
Clb	Clb2	compartment	item · l^{-1}	⊟	⊟
Sic	Sic1	compartment	item · l^{-1}	⊟	⊟
PTrim	Phosphorylated Cdc28_Clb2_Sic1 Complex	compartment	item · l^{-1}	⊟	⊟
PClb	Phosphorylated Clb2	compartment	item · l^{-1}	⊟	⊟
SBF	SBF	compartment	item · l^{-1}	⊟	⊟
IE	Intermediary Enzyme	compartment	item · l^{-1}	⊟	⊟
Cdc20a	Cdc20 activated	compartment	item · l^{-1}	⊟	⊟
Cdc20	Cdc20	compartment	item · l^{-1}	⊟	⊟
Cdh1	Cdh1	compartment	item · l^{-1}	⊟	⊟
Swe1	Swe1	compartment	item · l^{-1}	⊟	⊟
Swe1M	Swe1 modified	compartment	item · l^{-1}	⊟	⊟
PSwe1	Phosphorylated Swe1	compartment	item · l^{-1}	⊟	⊟
PSwe1M	Phosphorylated Swe1M	compartment	item · l^{-1}	⊟	⊟
Mih1a	Mih1a	compartment	item · l^{-1}	⊟	⊟
Mcm	Mcm	compartment	item · l^{-1}	⊟	⊟
BE	BE	compartment	item · l^{-1}	⊟	⊟
Cln	Cln	compartment	item · l^{-1}	⊟	⊟
mass	mass	compartment	item · l^{-1}	⊟	⊟

5 Parameters

This model contains 81 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kswe		0000153	0.000		☐
kswe_prime		0000153	2.000		☑
kswe_doubleprime		0000153	0.010		☑
kswe_tripleprime		0000153	0.200		☑
kmih		0000153	0.000		☐
kmih_prime		0000153	5.000		☑
Mih_ast		0000009	0.000		☑
kmih_doubleprime		0000153	0.500		☑
Mih		0000009	0.000		☑
IEin		0000360	0.000		☐
IEtot		0000360	1.000		☑
Cdh1in		0000360	0.000		☐
Cdh1tot		0000360	1.000		☑
Mih1		0000360	0.000		☐
Mih1tot		0000360	1.000		☑
Mcmin		0000360	0.000		☐
Mcmtot		0000360	1.000		☑
SBFin		0000360	0.000		☐
SBFtot		0000360	1.000		☑
kdiss		0000360	0.100		☑
kdsic_prime		0000356	1.000		☑
kdsic_doubleprime		0000356	3.000		☑
kdsic		0000356	0.010		☑
kdclb_doubleprime		0000356	1.000		☑
kdclb_tripleprime		0000356	0.100		☑
kdclb_prime		0000356	0.015		☑
kass		0000337	300.000		☑
ksclb		0000153	0.015		☑
Jm		0000009	10.000		☑
eps		0000009	0.500		☑
kisbf_prime		0000261	1.000		☑

Id	Name	SBO	Value	Unit	Constant
kisbf-_doubleprime		0000261	2.000		☑
jisbf		0000009	0.010		☑
kasbf_prime		0000337	1.000		☑
kasbf-_doubleprime		0000337	0.000		☑
jasbf		0000009	0.010		☑
kiie		0000261	0.040		☑
jiie		0000009	0.010		☑
kaie		0000337	0.100		☑
jaie		0000009	0.010		☑
kicdc20		0000261	0.250		☑
jicdc20		0000009	0.001		☑
kdcdc20		0000356	0.100		☑
kacdc20		0000337	1.000		☑
jacdc20		0000009	0.001		☑
kicdh		0000261	35.000		☑
kicdh_prime		0000261	2.000		☑
jicdh		0000009	0.010		☑
Kacdh_prime		0000336	1.000		☑
Kacdh-_doubleprime		0000336	10.000		☑
jacdh		0000009	0.010		☑
khsl1		0000153	1.000		☑
BUD			0.000		☐
Viwee		0000009	1.000		☑
Jiwee		0000009	0.050		☑
kdswe_prime		0000356	0.007		☑
khsl1r		0000153	0.010		☑
Vawee		0000009	0.300		☑
Jawee		0000009	0.050		☑
ksswe		0000393	0.003		☑
kssweC		0000393	0.000		☑
Vimih		0000009	0.300		☑
jimih		0000009	0.100		☑
Vamih		0000009	1.000		☑
Jamih		0000009	0.100		☑
kimcm		0000261	0.150		☑
jimcm		0000009	0.100		☑
kamcm		0000337	1.000		☑
jamcm		0000009	0.100		☑
kdbud		0000356	0.100		☑

Id	Name	SBO	Value	Unit	Constant
ksbud		0000393	0.100		☑
kssic		0000393	0.100		☑
kdcln		0000356	0.100		☑
kscln		0000393	0.100		☑
kscdc20-_prime		0000393	0.005		☑
kscdc20-_doubleprime		0000393	0.300		☑
jscdc20		0000009	0.300		☑
kdswe-_doubleprime		0000356	0.050		☑
mu		0000009	0.005		☑
flag			0.000		☐
Swe1T		0000360	0.000		☐

6 Rules

This is an overview of eight rules.

6.1 Rule kswe

Rule kswe is an assignment rule for parameter kswe:

$$\text{kswe} = \text{kswe\_prime} \cdot [\text{Swe1}] + \text{kswe\_doubleprime} \cdot [\text{Swe1M}] + \text{kswe\_tripleprime} \cdot [\text{PSwe1}] \quad (1)$$

6.2 Rule kmih

Rule kmih is an assignment rule for parameter kmih:

$$\text{kmih} = \text{kmih\_prime} \cdot \text{Mih\_ast} + \text{kmih\_doubleprime} \cdot \text{Mih} \quad (2)$$

6.3 Rule Swe1T

Rule Swe1T is an assignment rule for parameter Swe1T:

$$\text{Swe1T} = [\text{Swe1}] + [\text{Swe1M}] + [\text{PSwe1}] + [\text{PSwe1M}] \quad (3)$$

Derived unit $\text{item} \cdot \text{l}^{-1}$

6.4 Rule IEin

Rule IEin is an assignment rule for parameter IEin:

$$\text{IEin} = \text{IEtot} - [\text{IE}] \quad (4)$$

6.5 Rule Cdh1in

Rule Cdh1in is an assignment rule for parameter Cdh1in:

$$\text{Cdh1in} = \text{Cdh1tot} - [\text{Cdh1}] \tag{5}$$

6.6 Rule Mih1

Rule Mih1 is an assignment rule for parameter Mih1:

$$\text{Mih1} = \text{Mih1tot} - [\text{Mih1a}] \tag{6}$$

6.7 Rule Mcmin

Rule Mcmin is an assignment rule for parameter Mcmin:

$$\text{Mcmin} = \text{Mcmtot} - [\text{Mcm}] \tag{7}$$

6.8 Rule SBFin

Rule SBFin is an assignment rule for parameter SBFin:

$$\text{SBFin} = \text{SBFtot} - [\text{SBF}] \tag{8}$$

7 Events

This is an overview of four events. Each event is initiated whenever its trigger condition switches from false to true. A delay function postpones the effects of an event to a later time point. At the time of execution, an event can assign values to species, parameters or compartments if these are not set to constant.

7.1 Event event_0000002

Trigger condition

$$[\text{Clb}] > 0.2 \tag{9}$$

Assignment

$$\text{flag} = 1 \tag{10}$$

7.2 Event event_0000004

Trigger condition

$$([\text{Clb}] < 0.2) \wedge (\text{flag} > 0) \tag{11}$$

Assignments

$$\text{BE} = 0 \tag{12}$$

$$\text{mass} = 0.5 \cdot [\text{mass}] \tag{13}$$

7.3 Event event_0000003

Trigger condition

$$([\text{Clb}] \geq 0.2) \vee ([\text{BE}] \geq 0.6) \tag{14}$$

Assignment

$$\text{BUD} = 1 \tag{15}$$

7.4 Event event_0000005

Trigger condition

$$([\text{Clb}] < 0.2) \wedge ([\text{BE}] < 0.6) \tag{16}$$

Assignment

$$\text{BUD} = 0 \tag{17}$$

8 Reactions

This model contains 51 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	R1	Clb-Sic dissociation	$\text{Trim} \longrightarrow \text{Sic} + \text{Clb}$	0000180
2	R2	Clb2 removal from complex	$\text{Trim} \xrightarrow{\text{Cln}} \text{Clb}$	0000180
3	R3	Sic1 removal from complex	$\text{Trim} \xrightarrow{\text{Cdh1, Cdc20a}} \text{Sic}$	0000180
4	R4	Phosphorylation of Cdc28-Clb2-Sic1 complex	$\text{Trim} \longrightarrow \text{PTrim}$	0000216
5	R5	Complex formation	$\text{Sic} + \text{Clb} \longrightarrow \text{Trim}$	0000526
6	R6	Dephosphorylation of complex	$\text{PTrim} \longrightarrow \text{Trim}$	0000330
7	R7	Clb2 degradation	$\text{Clb} \xrightarrow{\text{Cdh1, Cdc20a}} \emptyset$	0000179
8	R8	Clb2 phosphorylation	$\text{Clb} \longrightarrow \text{PClb}$	0000216
9	R9	Clb2 synthesis	$\emptyset \xrightarrow{\text{mass, Mcm}} \text{Clb}$	0000393
10	R10	Clb2 dephosphorylation	$\text{PClb} \longrightarrow \text{Clb}$	0000330
11	R11	SBF inhibition	$\text{SBF} \xrightarrow{\text{Clb}} \emptyset$	0000169
12	R12	SBF synthesis	$\emptyset \xrightarrow{\text{mass, Cln}} \text{SBF}$	0000393
13	R13	IE inhibition	$\text{IE} \longrightarrow \emptyset$	0000169
14	R14	IE synthesis	$\emptyset \xrightarrow{\text{Clb}} \text{IE}$	0000393
15	R15	Cdc20 deactivation	$\text{Cdc20a} \longrightarrow \text{Cdc20}$	0000182
16	R16	activated Cdc20 degradation	$\text{Cdc20a} \longrightarrow \emptyset$	0000179
17	R18	Cdc20 activation	$\text{Cdc20} \xrightarrow{\text{IE}} \text{Cdc20a}$	0000182
18	R19	Cdh1inhibition	$\text{Cdh1} \xrightarrow{\text{Clb, Cln}} \emptyset$	0000169

№	Id	Name	Reaction Equation	SBO
19	R20	Cdh1 synthesis	$\emptyset \xrightarrow{\text{Cdc20a}} \text{Cdh1}$	0000393
20	R21	Swe1 modification	$\text{Swe1} \longrightarrow \text{Swe1M}$	0000182
21	R22	Phosphorylated Swe1 modification	$\text{PSwe1} \longrightarrow \text{PSwe1M}$	0000182
22	R23	Swe1 phosphorylation	$\text{Swe1} \xrightarrow{\text{Clb}} \text{PSwe1}$	0000216
23	R24	Swe1M phosphorylation	$\text{Swe1M} \xrightarrow{\text{Clb}} \text{PSwe1M}$	0000216
24	R25	Swe1 degradation	$\text{Swe1} \longrightarrow \emptyset$	0000179
25	R26	Swe1 production from its modified form	$\text{Swe1M} \longrightarrow \text{Swe1}$	0000182
26	R27	PSwe1 production from its modified form	$\text{PSwe1M} \longrightarrow \text{PSwe1}$	0000182
27	R28	PSwe1 dephosphorylation	$\text{PSwe1} \longrightarrow \text{Swe1}$	0000330
28	R29	PSwe1M dephosphorylation	$\text{PSwe1M} \longrightarrow \text{Swe1M}$	0000330
29	R30	SBF dependent Swe1 synthesis	$\emptyset \xrightarrow{\text{SBF}} \text{Swe1}$	0000393
30	R31	Swe1 synthesis	$\emptyset \longrightarrow \text{Swe1}$	0000393
31	R32	PSwe1 degradation	$\text{PSwe1} \longrightarrow \emptyset$	0000179
32	R33	PTrim complex dissociation	$\text{PTrim} \longrightarrow \text{PClb} + \text{Sic}$	0000180
33	R34	Sic1 dissociation from PTrim complex	$\text{PTrim} \xrightarrow{\text{Cdh1, Cdc20a}} \text{Sic}$	0000180
34	R35	PClb dissociation from PTrim complex	$\text{PTrim} \xrightarrow{\text{Cln, Clb}} \text{PClb}$	0000180
35	R36	PTrim complex formation	$\text{Sic} + \text{PClb} \longrightarrow \text{PTrim}$	0000526
36	R37	Mih1a inhibition	$\text{Mih1a} \longrightarrow \emptyset$	0000169
37	R38	Mih1a synthesis	$\emptyset \xrightarrow{\text{Clb}} \text{Mih1a}$	0000393
38	R39	Mcm inhibition	$\text{Mcm} \longrightarrow \emptyset$	0000169
39	R40	Mcm synthesis	$\emptyset \xrightarrow{\text{Clb}} \text{Mcm}$	0000393
40	R41	BE degradation	$\text{BE} \longrightarrow \emptyset$	0000179
41	R42	BE formation	$\emptyset \xrightarrow{\text{Cln}} \text{BE}$	0000393
42	R43	Sic1 degradation	$\text{Sic} \xrightarrow{\text{Cln, Clb}} \emptyset$	0000179
43	R44	Sic1 synthesis	$\emptyset \longrightarrow \text{Sic}$	0000393

№	Id	Name	Reaction Equation	SBO
44	R45	Cln degradation	$\mathrm{Cln} \longrightarrow \emptyset$	0000179
45	R46	SBF dependent Cln synthesis	$\emptyset \xrightarrow{\mathrm{SBF}} \mathrm{Cln}$	0000393
46	R47	Swe1M degradation	$\mathrm{Swe1M} \longrightarrow \emptyset$	0000179
47	R48	Cdc20 degradation	$\mathrm{Cdc20} \longrightarrow \emptyset$	0000179
48	R49	Clb2 dependent Cdc20 synthesis	$\emptyset \xrightarrow{\mathrm{Clb}} \mathrm{Cdc20}$	0000393
49	R50	PSwe1M degradation	$\mathrm{PSwe1M} \longrightarrow \emptyset$	0000179
50	R51	PClb degradation	$\mathrm{PClb} \xrightarrow{\mathrm{Cdh1,\ Cdc20a}} \emptyset$	0000179
51	R52	cell mass	$\emptyset \longrightarrow \mathrm{mass}$	0000375

8.1 Reaction R1

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

Name Clb-Sic dissociation

SBO:0000180 dissociation

Reaction equation

$$\text{Trim} \longrightarrow \text{Sic} + \text{Clb} \tag{18}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
Trim	CDC28_Clb2_Sic1_Complex	

Products

Table 7: Properties of each product.

Id	Name	SBO
Sic	Sic1	
Clb	Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{kdiss} \cdot [\text{Trim}] \tag{19}$$

8.2 Reaction R2

This is an irreversible reaction of one reactant forming one product influenced by one modifier.

Name Clb2 removal from complex

SBO:0000180 dissociation

Reaction equation

$$\text{Trim} \xrightarrow{\text{Cln}} \text{Clb} \tag{20}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
`Trim`	CDC28_Clb2_Sic1_Complex	

Modifier

Table 9: Properties of each modifier.

Id	Name	SBO
`Cln`	Cln	

Product

Table 10: Properties of each product.

Id	Name	SBO
`Clb`	Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = [\text{Trim}] \cdot (\text{kdsic\_prime} \cdot [\text{Cln}] + \text{kdsic\_doubleprime} \cdot [\text{Clb}] + \text{kdsic}) \tag{21}$$

8.3 Reaction `R3`

This is an irreversible reaction of one reactant forming one product influenced by two modifiers.

Name Sic1 removal from complex

SBO:0000180 dissociation

Reaction equation

$$\text{Trim} \xrightarrow{\text{Cdh1, Cdc20a}} \text{Sic} \tag{22}$$

Reactant

Table 11: Properties of each reactant.

Id	Name	SBO
Trim	CDC28_Clb2_Sic1_Complex	

Modifiers

Table 12: Properties of each modifier.

Id	Name	SBO
Cdh1	Cdh1	
Cdc20a	Cdc20 activated	

Product

Table 13: Properties of each product.

Id	Name	SBO
Sic	Sic1	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = [\text{Trim}] \cdot (\text{kdclb\_doubleprime} \cdot [\text{Cdh1}] + \text{kdclb\_tripleprime} \cdot [\text{Cdc20a}] + \text{kdclb\_prime}) \quad (23)$$

8.4 Reaction R4

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

Name Phosphorylation of Cdc28-Clb2-Sic1 complex

SBO:0000216 phosphorylation

Reaction equation

$$\text{Trim} \longrightarrow \text{PTrim} \quad (24)$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
Trim	CDC28_Clb2_Sic1_Complex	

Product

Table 15: Properties of each product.

Id	Name	SBO
PTrim	Phosphorylated Cdc28_Clb2_Sic1 Complex	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = [\text{Trim}] \cdot \text{kswe} \tag{25}$$

8.5 Reaction R5

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

Name Complex formation

SBO:0000526 protein complex formation

Reaction equation

$$\text{Sic} + \text{Clb} \longrightarrow \text{Trim} \tag{26}$$

Reactants

Table 16: Properties of each reactant.

Id	Name	SBO
Sic	Sic1	
Clb	Clb2	

Product

Table 17: Properties of each product.

Id	Name	SBO
`Trim`	CDC28_Clb2_Sic1_Complex	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{kass} \cdot [\text{Sic}] \cdot [\text{Clb}] \tag{27}$$

8.6 Reaction `R6`

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

Name Dephosphorylation of complex

SBO:0000330 dephosphorylation

Reaction equation

$$\text{PTrim} \longrightarrow \text{Trim} \tag{28}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
`PTrim`	Phosphorylated Cdc28_Clb2_Sic1 Complex	

Product

Table 19: Properties of each product.

Id	Name	SBO
`Trim`	CDC28_Clb2_Sic1_Complex	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = [\text{PTrim}] \cdot \text{kmih} \tag{29}$$

8.7 Reaction R7

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

Name Clb2 degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{Clb} \xrightarrow{\mathrm{Cdh1,\ Cdc20a}} \emptyset \tag{30}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
Clb	Clb2	

Modifiers

Table 21: Properties of each modifier.

Id	Name	SBO
Cdh1	Cdh1	
Cdc20a	Cdc20 activated	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = [\mathrm{Clb}] \cdot (\mathrm{kdclb\_doubleprime} \cdot [\mathrm{Cdh1}] + \mathrm{kdclb\_tripleprime} \cdot [\mathrm{Cdc20a}] + \mathrm{kdclb\_prime}) \tag{31}$$

8.8 Reaction R8

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

Name Clb2 phosphorylation

SBO:0000216 phosphorylation

Reaction equation

$$\mathrm{Clb} \longrightarrow \mathrm{PClb} \tag{32}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
`Clb`	Clb2	

Product

Table 23: Properties of each product.

Id	Name	SBO
`PClb`	Phosphorylated Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{kswe} \cdot [\text{Clb}] \tag{33}$$

8.9 Reaction `R9`

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

Name Clb2 synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{mass, Mcm}} \text{Clb} \tag{34}$$

Modifiers

Table 24: Properties of each modifier.

Id	Name	SBO
`mass`	mass	
`Mcm`	Mcm	

Product

Table 25: Properties of each product.

Id	Name	SBO
Clb	Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \frac{\text{ksclb} \cdot [\text{mass}] \cdot \text{Jm} \cdot (\text{eps} + [\text{Mcm}])}{[\text{mass}] + \text{Jm}} \tag{35}$$

8.10 Reaction R10

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

Name Clb2 dephosphorylation

SBO:0000330 dephosphorylation

Reaction equation

$$\text{PClb} \longrightarrow \text{Clb} \tag{36}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
PClb	Phosphorylated Clb2	

Product

Table 27: Properties of each product.

Id	Name	SBO
Clb	Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{kmih} \cdot [\text{PClb}] \tag{37}$$

8.11 Reaction R11

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

Name SBF inhibition

SBO:0000169 inhibition

Reaction equation

$$\mathrm{SBF} \xrightarrow{\mathrm{Clb}} \emptyset \tag{38}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
SBF	SBF	

Modifier

Table 29: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \frac{[\mathrm{SBF}] \cdot (\mathrm{kisbf\_prime} + \mathrm{kisbf\_doubleprime} \cdot [\mathrm{Clb}])}{\mathrm{jisbf} + [\mathrm{SBF}]} \tag{39}$$

8.12 Reaction R12

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

Name SBF synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\mathrm{mass,\ Cln}} \mathrm{SBF} \tag{40}$$

Modifiers

Table 30: Properties of each modifier.

Id	Name	SBO
mass	mass	
Cln	Cln	

Product

Table 31: Properties of each product.

Id	Name	SBO
SBF	SBF	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \frac{\text{SBFin} \cdot (\text{kasbf\_prime} \cdot [\text{mass}] + \text{kasbf\_doubleprime} \cdot [\text{Cln}])}{\text{jasbf} + \text{SBFin}} \tag{41}$$

8.13 Reaction R13

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

Name IE inhibition

SBO:0000169 inhibition

Reaction equation

$$\text{IE} \longrightarrow \emptyset \tag{42}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
IE	Intermediary Enzyme	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \frac{[\mathrm{IE}] \cdot \mathrm{kiie}}{\mathrm{jiie} + [\mathrm{IE}]} \tag{43}$$

8.14 Reaction R14

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

Name IE synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\mathrm{Clb}} \mathrm{IE} \tag{44}$$

Modifier

Table 33: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Product

Table 34: Properties of each product.

Id	Name	SBO
IE	Intermediary Enzyme	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \frac{\mathrm{kaie} \cdot \mathrm{IEin} \cdot [\mathrm{Clb}]}{\mathrm{jaie} + \mathrm{IEin}} \tag{45}$$

8.15 Reaction R15

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

Name Cdc20 deactivation

SBO:0000182 conversion

Reaction equation

$$\text{Cdc20a} \longrightarrow \text{Cdc20} \tag{46}$$

Reactant

Table 35: Properties of each reactant.

Id	Name	SBO
Cdc20a	Cdc20 activated	

Product

Table 36: Properties of each product.

Id	Name	SBO
Cdc20	Cdc20	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \frac{[\text{Cdc20a}] \cdot \text{kicdc20}}{\text{jicdc20} + [\text{Cdc20a}]} \tag{47}$$

8.16 Reaction R16

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

Name activated Cdc20 degradation

SBO:0000179 degradation

Reaction equation

$$\text{Cdc20a} \longrightarrow \emptyset \tag{48}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
Cdc20a	Cdc20 activated	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{kdcdc20} \cdot [\text{Cdc20a}] \tag{49}$$

8.17 Reaction R18

This is an irreversible reaction of one reactant forming one product influenced by one modifier.

Name Cdc20 activation

SBO:0000182 conversion

Reaction equation

$$\text{Cdc20} \xrightarrow{\text{IE}} \text{Cdc20a} \tag{50}$$

Reactant

Table 38: Properties of each reactant.

Id	Name	SBO
Cdc20	Cdc20	

Modifier

Table 39: Properties of each modifier.

Id	Name	SBO
IE	Intermediary Enzyme	

Product

Table 40: Properties of each product.

Id	Name	SBO
Cdc20a	Cdc20 activated	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \frac{\text{kacdc20} \cdot [\text{Cdc20}] \cdot [\text{IE}]}{\text{jacdc20} + [\text{Cdc20}]} \tag{51}$$

8.18 Reaction R19

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

Name Cdh1inhibition

SBO:0000169 inhibition

Reaction equation

$$\text{Cdh1} \xrightarrow{\text{Clb, Cln}} \emptyset \tag{52}$$

Reactant

Table 41: Properties of each reactant.

Id	Name	SBO
Cdh1	Cdh1	

Modifiers

Table 42: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	
Cln	Cln	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \frac{[\text{Cdh1}] \cdot (\text{kicdh} \cdot [\text{Clb}] + \text{kicdh\_prime} \cdot [\text{Cln}])}{\text{jicdh} + [\text{Cdh1}]} \tag{53}$$

8.19 Reaction R20

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

Name Cdh1 synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{Cdc20a}} \text{Cdh1} \tag{54}$$

Modifier

Table 43: Properties of each modifier.

Id	Name	SBO
Cdc20a	Cdc20 activated	

Product

Table 44: Properties of each product.

Id	Name	SBO
Cdh1	Cdh1	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \frac{\text{Cdh1in} \cdot (\text{Kacdh\_prime} + \text{Kacdh\_doubleprime} \cdot [\text{Cdc20a}])}{\text{jacdh} + \text{Cdh1in}} \tag{55}$$

8.20 Reaction R21

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

Name Swe1 modification

SBO:0000182 conversion

Reaction equation

$$\text{Swe1} \longrightarrow \text{Swe1M} \tag{56}$$

Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
Swe1	Swe1	

Product

Table 46: Properties of each product.

Id	Name	SBO
Swe1M	Swe1 modified	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{khsl1} \cdot \text{BUD} \cdot [\text{Swe1}] \tag{57}$$

8.21 Reaction R22

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

Name Phosphorylated Swe1 modification

SBO:0000182 conversion

Reaction equation

$$\text{PSwe1} \longrightarrow \text{PSwe1M} \tag{58}$$

Reactant

Table 47: Properties of each reactant.

Id	Name	SBO
PSwe1	Phosphorylated Swe1	

Product

Table 48: Properties of each product.

Id	Name	SBO
PSwe1M	Phosphorylated Swe1M	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{khsl1} \cdot \text{BUD} \cdot [\text{PSwe1}] \tag{59}$$

8.22 Reaction R23

This is an irreversible reaction of one reactant forming one product influenced by one modifier.

Name Swe1 phosphorylation

SBO:0000216 phosphorylation

Reaction equation

$$\text{Swe1} \xrightarrow{\text{Clb}} \text{PSwe1} \tag{60}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
Swe1	Swe1	

Modifier

Table 50: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Product

Table 51: Properties of each product.

Id	Name	SBO
PSwe1	Phosphorylated Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \frac{\text{Viwee} \cdot [\text{Swe1}] \cdot [\text{Clb}]}{\text{Jiwee} + [\text{Swe1}]} \tag{61}$$

8.23 Reaction R24

This is an irreversible reaction of one reactant forming one product influenced by one modifier.

Name Swe1M phosphorylation

SBO:0000216 phosphorylation

Reaction equation

$$\text{Swe1M} \xrightarrow{\text{Clb}} \text{PSwe1M} \tag{62}$$

Reactant

Table 52: Properties of each reactant.

Id	Name	SBO
Swe1M	Swe1 modified	

Modifier

Table 53: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Product

Table 54: Properties of each product.

Id	Name	SBO
PSwe1M	Phosphorylated Swe1M	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \frac{\text{Viwee} \cdot [\text{Swe1M}] \cdot [\text{Clb}]}{\text{Jiwee} + [\text{Swe1M}]} \tag{63}$$

8.24 Reaction R25

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

Name Swe1 degradation

SBO:0000179 degradation

Reaction equation

$$\text{Swe1} \longrightarrow \emptyset \tag{64}$$

Reactant

Table 55: Properties of each reactant.

Id	Name	SBO
Swe1	Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{kdswe\_prime} \cdot [\text{Swe1}] \tag{65}$$

8.25 Reaction R26

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

Name Swe1 production from its modified form

SBO:0000182 conversion

Reaction equation

$$\text{Swe1M} \longrightarrow \text{Swe1} \tag{66}$$

Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
Swe1M	Swe1 modified	

Product

Table 57: Properties of each product.

Id	Name	SBO
Swe1	Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{khsl1r} \cdot [\text{Swe1M}] \tag{67}$$

8.26 Reaction R27

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

Name PSwe1 production from its modified form

SBO:0000182 conversion

Reaction equation

$$\text{PSwe1M} \longrightarrow \text{PSwe1} \tag{68}$$

Reactant

Table 58: Properties of each reactant.

Id	Name	SBO
PSwe1M	Phosphorylated Swe1M	

Product

Table 59: Properties of each product.

Id	Name	SBO
PSwe1	Phosphorylated Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{khsl1r} \cdot [\text{PSwe1M}] \tag{69}$$

8.27 Reaction R28

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

Name PSwe1 dephosphorylation

SBO:0000330 dephosphorylation

Reaction equation

$$\text{PSwe1} \longrightarrow \text{Swe1} \tag{70}$$

Reactant

Table 60: Properties of each reactant.

Id	Name	SBO
PSwe1	Phosphorylated Swe1	

Product

Table 61: Properties of each product.

Id	Name	SBO
Swe1	Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \frac{[\text{PSwe1}] \cdot \text{Vawee}}{\text{Jawee} + [\text{PSwe1}]} \tag{71}$$

8.28 Reaction R29

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

Name PSwe1M dephosphorylation

SBO:0000330 dephosphorylation

Reaction equation

$$\text{PSwe1M} \longrightarrow \text{Swe1M} \tag{72}$$

Reactant

Table 62: Properties of each reactant.

Id	Name	SBO
PSwe1M	Phosphorylated Swe1M	

Product

Table 63: Properties of each product.

Id	Name	SBO
Swe1M	Swe1 modified	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \frac{[\text{PSwe1M}] \cdot \text{Vawee}}{\text{Jawee} + [\text{PSwe1M}]} \tag{73}$$

8.29 Reaction R30

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

Name SBF dependent Swe1 synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{SBF}} \text{Swe1} \tag{74}$$

Modifier

Table 64: Properties of each modifier.

Id	Name	SBO
SBF	SBF	

Product

Table 65: Properties of each product.

Id	Name	SBO
Swe1	Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{ksswe} \cdot [\text{SBF}] \tag{75}$$

8.30 Reaction R31

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

Name Swe1 synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \longrightarrow \text{Swe1} \tag{76}$$

Product

Table 66: Properties of each product.

Id	Name	SBO
Swe1	Swe1	

Kinetic Law

Derived unit not available

$$v_{30} = \text{kssweC} \tag{77}$$

8.31 Reaction R32

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

Name PSwe1 degradation

SBO:0000179 degradation

Reaction equation

$$\text{PSwe1} \longrightarrow \emptyset \tag{78}$$

Reactant

Table 67: Properties of each reactant.

Id	Name	SBO
PSwe1	Phosphorylated Swe1	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{kdswe\_prime} \cdot [\text{PSwe1}] \tag{79}$$

8.32 Reaction R33

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

Name PTrim complex dissociation

SBO:0000180 dissociation

Reaction equation

$$\text{PTrim} \longrightarrow \text{PClb} + \text{Sic} \tag{80}$$

Reactant

Table 68: Properties of each reactant.

Id	Name	SBO
PTrim	Phosphorylated Cdc28_Clb2_Sic1 Complex	

Products

Table 69: Properties of each product.

Id	Name	SBO
PClb	Phosphorylated Clb2	
Sic	Sic1	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \text{kdiss} \cdot [\text{PTrim}] \tag{81}$$

8.33 Reaction R34

This is an irreversible reaction of one reactant forming one product influenced by two modifiers.

Name Sic1 dissociation from PTrim complex

SBO:0000180 dissociation

Reaction equation

$$\text{PTrim} \xrightarrow{\text{Cdh1, Cdc20a}} \text{Sic} \tag{82}$$

Reactant

Table 70: Properties of each reactant.

Id	Name	SBO
PTrim	Phosphorylated Cdc28_Clb2_Sic1 Complex	

Modifiers

Table 71: Properties of each modifier.

Id	Name	SBO
Cdh1	Cdh1	
Cdc20a	Cdc20 activated	

Product

Table 72: Properties of each product.

Id	Name	SBO
Sic	Sic1	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = [\text{PTrim}] \cdot (\text{kdclb\_doubleprime} \cdot [\text{Cdh1}] + \text{kdclb\_tripleprime} \cdot [\text{Cdc20a}] + \text{kdclb\_prime}) \quad (83)$$

8.34 Reaction R35

This is an irreversible reaction of one reactant forming one product influenced by two modifiers.

Name PClb dissociation from PTrim complex

SBO:0000180 dissociation

Reaction equation

$$\text{PTrim} \xrightarrow{\text{Cln, Clb}} \text{PClb} \quad (84)$$

Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
PTrim	Phosphorylated Cdc28_Clb2_Sic1 Complex	

Modifiers

Table 74: Properties of each modifier.

Id	Name	SBO
Cln	Cln	
Clb	Clb2	

Product

Table 75: Properties of each product.

Id	Name	SBO
PClb	Phosphorylated Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = [\text{PTrim}] \cdot (\text{kdsic\_prime} \cdot [\text{Cln}] + \text{kdsic\_doubleprime} \cdot [\text{Clb}] + \text{kdsic}) \tag{85}$$

8.35 Reaction R36

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

Name PTrim complex formation

SBO:0000526 protein complex formation

Reaction equation

$$\text{Sic} + \text{PClb} \longrightarrow \text{PTrim} \tag{86}$$

Reactants

Table 76: Properties of each reactant.

Id	Name	SBO
Sic	Sic1	
PClb	Phosphorylated Clb2	

Product

Table 77: Properties of each product.

Id	Name	SBO
PTrim	Phosphorylated Cdc28_Clb2_Sic1 Complex	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \text{kass} \cdot [\text{PClb}] \cdot [\text{Sic}] \tag{87}$$

8.36 Reaction R37

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

Name Mih1a inhibition

SBO:0000169 inhibition

Reaction equation

$$\text{Mih1a} \longrightarrow \emptyset \tag{88}$$

Reactant

Table 78: Properties of each reactant.

Id	Name	SBO
Mih1a	Mih1a	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \frac{[\text{Mih1a}] \cdot \text{Vimih}}{\text{jimih} + [\text{Mih1a}]} \tag{89}$$

8.37 Reaction R38

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

Name Mih1a synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{Clb}} \text{Mih1a} \tag{90}$$

Modifier

Table 79: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Product

Table 80: Properties of each product.

Id	Name	SBO
Mih1a	Mih1a	

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \frac{\text{Vamih} \cdot \text{Mih1} \cdot [\text{Clb}]}{\text{Jamih} + \text{Mih1}} \tag{91}$$

8.38 Reaction R39

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

Name Mcm inhibition

SBO:0000169 inhibition

Reaction equation

$$\text{Mcm} \longrightarrow \emptyset \tag{92}$$

Reactant

Table 81: Properties of each reactant.

Id	Name	SBO
Mcm	Mcm	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \frac{[\text{Mcm}] \cdot \text{kimcm}}{\text{jimcm} + [\text{Mcm}]} \tag{93}$$

8.39 Reaction R40

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

Name Mcm synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{Clb}} \text{Mcm} \tag{94}$$

Modifier

Table 82: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Product

Table 83: Properties of each product.

Id	Name	SBO
Mcm	Mcm	

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \frac{\text{Mcmin} \cdot [\text{Clb}] \cdot \text{kamcm}}{\text{jamcm} + \text{Mcmin}} \tag{95}$$

8.40 Reaction R41

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

Name BE degradation

SBO:0000179 degradation

Reaction equation

$$\mathrm{BE} \longrightarrow \emptyset \tag{96}$$

Reactant

Table 84: Properties of each reactant.

Id	Name	SBO
BE	BE	

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \mathrm{kdbud} \cdot [\mathrm{BE}] \tag{97}$$

8.41 Reaction R42

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

Name BE formation

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\mathrm{Cln}} \mathrm{BE} \tag{98}$$

Modifier

Table 85: Properties of each modifier.

Id	Name	SBO
Cln	Cln	

Product

Table 86: Properties of each product.

Id	Name	SBO
BE	BE	

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \text{ksbud} \cdot [\text{Cln}] \tag{99}$$

8.42 Reaction R43

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

Name Sic1 degradation

SBO:0000179 degradation

Reaction equation

$$\text{Sic} \xrightarrow{\text{Cln, Clb}} \emptyset \tag{100}$$

Reactant

Table 87: Properties of each reactant.

Id	Name	SBO
Sic	Sic1	

Modifiers

Table 88: Properties of each modifier.

Id	Name	SBO
Cln	Cln	
Clb	Clb2	

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = [\text{Sic}] \cdot (\text{kdsic\_prime} \cdot [\text{Cln}] + \text{kdsic\_doubleprime} \cdot [\text{Clb}] + \text{kdsic}) \tag{101}$$

8.43 Reaction R44

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

Name Sic1 synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \longrightarrow \text{Sic} \tag{102}$$

Product

Table 89: Properties of each product.

Id	Name	SBO
Sic	Sic1	

Kinetic Law

Derived unit not available

$$v_{43} = \text{kssic} \tag{103}$$

8.44 Reaction R45

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

Name Cln degradation

SBO:0000179 degradation

Reaction equation

$$\text{Cln} \longrightarrow \emptyset \tag{104}$$

Reactant

Table 90: Properties of each reactant.

Id	Name	SBO
Cln	Cln	

Kinetic Law

Derived unit contains undeclared units

$$v_{44} = \text{kdcln} \cdot [\text{Cln}] \tag{105}$$

8.45 Reaction R46

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

Name SBF dependent Cln synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{SBF}} \text{Cln} \tag{106}$$

Modifier

Table 91: Properties of each modifier.

Id	Name	SBO
SBF	SBF	

Product

Table 92: Properties of each product.

Id	Name	SBO
Cln	Cln	

Kinetic Law

Derived unit contains undeclared units

$$v_{45} = \text{kscln} \cdot [\text{SBF}] \tag{107}$$

8.46 Reaction R47

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

Name Swe1M degradation

SBO:0000179 degradation

Reaction equation

$$\text{Swe1M} \longrightarrow \emptyset \tag{108}$$

Reactant

Table 93: Properties of each reactant.

Id	Name	SBO
Swe1M	Swe1 modified	

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \text{kdswe\_prime} \cdot [\text{Swe1M}] \tag{109}$$

8.47 Reaction R48

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

Name Cdc20 degradation

SBO:0000179 degradation

Reaction equation

$$\text{Cdc20} \longrightarrow \emptyset \tag{110}$$

Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
Cdc20	Cdc20	

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = \text{kdcdc20} \cdot [\text{Cdc20}] \tag{111}$$

8.48 Reaction R49

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

Name Clb2 dependent Cdc20 synthesis

SBO:0000393 production

Reaction equation

$$\emptyset \xrightarrow{\text{Clb}} \text{Cdc20} \tag{112}$$

Modifier

Table 95: Properties of each modifier.

Id	Name	SBO
Clb	Clb2	

Product

Table 96: Properties of each product.

Id	Name	SBO
Cdc20	Cdc20	

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = \text{kscdc20\_prime} + \frac{\text{kscdc20\_doubleprime} \cdot [\text{Clb}]^4}{\text{jscdc20}^4 + [\text{Clb}]^4} \tag{113}$$

8.49 Reaction R50

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

Name PSwe1M degradation

SBO:0000179 degradation

Reaction equation

$$\text{PSwe1M} \longrightarrow \emptyset \tag{114}$$

Reactant

Table 97: Properties of each reactant.

Id	Name	SBO
PSwe1M	Phosphorylated Swe1M	

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = \text{kdswe\_doubleprime} \cdot [\text{PSwe1M}] \tag{115}$$

8.50 Reaction R51

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

Name PClb degradation

SBO:0000179 degradation

Reaction equation

$$\text{PClb} \xrightarrow{\text{Cdh1, Cdc20a}} \emptyset \tag{116}$$

Reactant

Table 98: Properties of each reactant.

Id	Name	SBO
PClb	Phosphorylated Clb2	

Modifiers

Table 99: Properties of each modifier.

Id	Name	SBO
Cdh1	Cdh1	
Cdc20a	Cdc20 activated	

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = [\text{PClb}] \cdot (\text{kdclb\_doubleprime} \cdot [\text{Cdh1}] + \text{kdclb\_tripleprime} \cdot [\text{Cdc20a}] + \text{kdclb\_prime}) \tag{117}$$

8.51 Reaction R52

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

Name cell mass

SBO:0000375 process

Reaction equation

$$\emptyset \longrightarrow \text{mass} \tag{118}$$

Product

Table 100: Properties of each product.

Id	Name	SBO
mass	mass	

Kinetic Law

Derived unit contains undeclared units

$$v_{51} = \text{mu} \cdot [\text{mass}] \tag{119}$$

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 Trim

Name CDC28_Clb2_Sic1_Complex

SBO:0000296 macromolecular complex

Initial concentration $0.084410675\ \text{item} \cdot \text{l}^{-1}$

This species takes part in six reactions (as a reactant in R1, R2, R3, R4 and as a product in R5, R6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Trim} = v_5 + v_6 - v_1 - v_2 - v_3 - v_4 \tag{120}$$

9.2 Species Clb

Name Clb2

SBO:0000245 macromolecule

Initial concentration $0.18453673\ \mathrm{item}\cdot\mathrm{l}^{-1}$

This species takes part in 17 reactions (as a reactant in R5, R7, R8 and as a product in R1, R2, R9, R10 and as a modifier in R11, R14, R19, R23, R24, R35, R38, R40, R43, R49).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Clb} = v_1 + v_2 + v_9 + v_{10} - v_5 - v_7 - v_8 \tag{121}$$

9.3 Species Sic

Name Sic1

SBO:0000245 macromolecule

Initial concentration $0.0035491784\ \mathrm{item}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in R5, R36, R43 and as a product in R1, R3, R33, R34, R44).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Sic} = v_1 + v_3 + v_{32} + v_{33} + v_{43} - v_5 - v_{35} - v_{42} \tag{122}$$

9.4 Species PTrim

Name Phosphorylated Cdc28_Clb2_Sic1 Complex

SBO:0000296 macromolecular complex

Initial concentration $1.402314\cdot 10^{-5}\ \mathrm{item}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in R6, R33, R34, R35 and as a product in R4, R36).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTrim} = v_4 + v_{35} - v_6 - v_{32} - v_{33} - v_{34} \tag{123}$$

9.5 Species PClb

Name Phosphorylated Clb2

SBO:0000245 macromolecule

Initial concentration $3.0203049 \cdot 10^{-5}$ item $\cdot l^{-1}$

This species takes part in six reactions (as a reactant in R10, R36, R51 and as a product in R8, R33, R35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PClb} = v_8 + v_{32} + v_{34} - v_{10} - v_{35} - v_{50} \tag{124}$$

9.6 Species SBF

Name SBF

SBO:0000245 macromolecule

Initial concentration 0.12405464 item $\cdot l^{-1}$

This species takes part in four reactions (as a reactant in R11 and as a product in R12 and as a modifier in R30, R46).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{SBF} = v_{12} - v_{11} \tag{125}$$

9.7 Species IE

Name Intermediary Enzyme

SBO:0000014 enzyme

Initial concentration 0.52220768 item $\cdot l^{-1}$

This species takes part in three reactions (as a reactant in R13 and as a product in R14 and as a modifier in R18).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IE} = v_{14} - v_{13} \tag{126}$$

9.8 Species Cdc20a

Name Cdc20 activated

SBO:0000245 macromolecule

Initial concentration 1.4384692 item $\cdot l^{-1}$

This species takes part in eight reactions (as a reactant in R15, R16 and as a product in R18 and as a modifier in R3, R7, R20, R34, R51).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Cdc20a} = v_{17} - v_{15} - v_{16} \tag{127}$$

9.9 Species Cdc20

Name Cdc20

SBO:0000245 macromolecule

Initial concentration $1.1722378\ \text{item} \cdot \text{l}^{-1}$

This species takes part in four reactions (as a reactant in R18, R48 and as a product in R15, R49).

$$\frac{\text{d}}{\text{d}t}\text{Cdc20} = v_{15} + v_{48} - v_{17} - v_{47} \tag{128}$$

9.10 Species Cdh1

Name Cdh1

SBO:0000245 macromolecule

Initial concentration $0.99263656\ \text{item} \cdot \text{l}^{-1}$

This species takes part in six reactions (as a reactant in R19 and as a product in R20 and as a modifier in R3, R7, R34, R51).

$$\frac{\text{d}}{\text{d}t}\text{Cdh1} = v_{19} - v_{18} \tag{129}$$

9.11 Species Swe1

Name Swe1

SBO:0000245 macromolecule

Initial concentration $3.1588585 \cdot 10^{-4}\ \text{item} \cdot \text{l}^{-1}$

This species takes part in seven reactions (as a reactant in R21, R23, R25 and as a product in R26, R28, R30, R31).

$$\frac{\text{d}}{\text{d}t}\text{Swe1} = v_{25} + v_{27} + v_{29} + v_{30} - v_{20} - v_{22} - v_{24} \tag{130}$$

9.12 Species Swe1M

Name Swe1 modified

SBO:0000245 macromolecule

Initial concentration $0.018360127\ \text{item} \cdot \text{l}^{-1}$

This species takes part in five reactions (as a reactant in R24, R26, R47 and as a product in R21, R29).

$$\frac{\text{d}}{\text{d}t}\text{Swe1M} = v_{20} + v_{28} - v_{23} - v_{25} - v_{46} \tag{131}$$

9.13 Species PSwe1

Name Phosphorylated Swe1

SBO:0000245 macromolecule

Initial concentration $2.0500785 \cdot 10^{-4}$ item $\cdot$ l^{-1}

This species takes part in five reactions (as a reactant in R22, R28, R32 and as a product in R23, R27).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PSwe1} = v_{22} + v_{26} - v_{21} - v_{27} - v_{31} \tag{132}$$

9.14 Species PSwe1M

Name Phosphorylated Swe1M

SBO:0000245 macromolecule

Initial concentration 0.013336782 item $\cdot$ l^{-1}

This species takes part in five reactions (as a reactant in R27, R29, R50 and as a product in R22, R24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PSwe1M} = v_{21} + v_{23} - v_{26} - v_{28} - v_{49} \tag{133}$$

9.15 Species Mih1a

Name Mih1a

SBO:0000245 macromolecule

Initial concentration 0.80809075 item $\cdot$ l^{-1}

This species takes part in two reactions (as a reactant in R37 and as a product in R38).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Mih1a} = v_{37} - v_{36} \tag{134}$$

9.16 Species Mcm

Name Mcm

SBO:0000245 macromolecule

Initial concentration 0.93289256 item $\cdot$ l^{-1}

This species takes part in three reactions (as a reactant in R39 and as a product in R40 and as a modifier in R9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Mcm} = v_{39} - v_{38} \tag{135}$$

9.17 Species BE

Name BE

SBO:0000236 physical entity representation

Initial concentration $2.4296179 \cdot 10^{-4}$ item $\cdot$ l^{-1}

Involved in event event_0000004

This species takes part in two reactions (as a reactant in R41 and as a product in R42).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{BE} = v_{41} - v_{40} \tag{136}$$

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

9.18 Species Cln

Name Cln

SBO:0000245 macromolecule

Initial concentration 0.053600963 item $\cdot$ l^{-1}

This species takes part in eight reactions (as a reactant in R45 and as a product in R46 and as a modifier in R2, R12, R19, R35, R42, R43).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Cln} = v_{45} - v_{44} \tag{137}$$

9.19 Species mass

Name mass

SBO:0000236 physical entity representation

Initial concentration 0.80224854 item $\cdot$ l^{-1}

Involved in event event_0000004

This species takes part in three reactions (as a product in R52 and as a modifier in R9, R12).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{mass} = v_{51} \tag{138}$$

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

A Glossary of Systems Biology Ontology Terms

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

SBO:0000014 enzyme: A protein that catalyzes a chemical reaction. The word comes from en “a” or“i”) and simo “leave” or“yeas”)

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:0000169 inhibition: Negative modulation of the execution of a process

SBO:0000179 degradation: Complete disappearance of a physical entity

SBO:0000180 dissociation: Transformation of a non-covalent complex that results in the formation of several independent biochemical entitie

SBO:0000182 conversion: Biochemical reaction that results in the modification of some covalent bonds

SBO:0000216 phosphorylation: Addition of a phosphate group (-H2PO4) to a chemical entity

SBO:0000236 physical entity representation: Representation of an entity that may participate in an interaction, a process or relationship of significance.

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: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:0000330 dephosphorylation: Removal of a phosphate group (-H2PO4) from a chemical entity.

SBO:0000336 interactor: Entity participating in a physical or functional interaction

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: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:0000360 quantity of an entity pool: The enumeration of co-localised, identical biochemical entities of a specific state, which constitute a pool. The form of enumeration may be purely numerical, or may be given in relation to another dimension such as length or volume

SBO:0000375 process: A sequential series of actions, motions, or occurrences, such as chemical reactions, that affect one or more entities in a phenomenologically characteristic manner

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

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

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