SBML Model Report

Model name: "Kofahl2004_PheromonePathway"

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 Jacky L Snoep[2] at June eighth 2005 at 2:45 p. m. and last time modified at April eighth 2016 at 3:19 p. m. Table 1 shows an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	2
species types	0	species	37
events	0	constraints	0
reactions	47	function definitions	0
global parameters	0	unit definitions	6
rules	0	initial assignments	0

Model Notes

This a model from the article:
Modelling the dynamics of the yeast pheromone pathway.
Kofahl B, Klipp E Yeast[2004 Jul; Volume: 21 (Issue: 10)] Page info: 831-50 15300679,
Abstract:

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We present a mathematical model of the dynamics of the pheromone pathways in haploid yeast cells of mating type MATa after stimulation with pheromone alpha-factor. The model consists of a set of differential equations and describes the dynamics of signal transduction from the receptor via several steps, including a G protein and a scaffold MAP kinase cascade, up to changes in the gene expression after pheromone stimulation in terms of biochemical changes (complex formations, phosphorylations, etc.). The parameters entering the models have been taken from the literature or adapted to observed time courses or behaviour. Using this model we can follow the time course of the various complex formation processes and of the phosphorylation states of the proteins involved. Furthermore, we can explain the phenotype of more than a dozen well-characterized mutants and also the graded response of yeast cells to varying concentrations of the stimulating pheromone.

The model was updated on 21st October 2010, by Vijayalakshmi Chelliah.
The following changes were made: 1) The model has been converted to SBML l2v4.2) The model has been recurated and the curation figure was updated (units are in nanoMolar; but the publication has units in microMolar). Simulations were done using Copasi v4.6 (Build 32).3) Notes have been added.4) Annotation for one of the species has been corrected (Complex M).

SBML level 2 code generated for the JWS Online project by Jacky Snoep using PySCeS
Run this model online at http://jjj.biochem.sun.ac.za
To cite JWS Online please refer to: Olivier, B.G. and Snoep, J.L. (2004) Web-based modelling using JWS Online, Bioinformatics, 20:2143-2144

The following are the four major differences between the original publication by Kofahl et al and the model that actually is able to replicate the results as depicted in the publication (those corrections have been made in agreement with the authors):
1. Bar1 is the inactive protease present inside the cell but the publication wrongly mentions that Bar1 is also the protease that is present on the extracellular surface.
The model correctly names the protease in it's different forms by calling inactive Bar1 within the cell as Bar1, active Bar1 within the cell as Bar1a and extracellular Bar1 as Bar1aex
2. The initial amount of Alpha-factor is given as 1000nM but the model uses a value of 100nM.
3. The value of the paramenter k8 is given as 0.33 but the model uses a value of 0.033.
4. The value of the paramenter k41 is given as 0.002 but the model uses a value of 0.02.

2 Unit Definitions

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

2.1 Unit `substance`

Name nanomole (default)

Definition nmol

2.2 Unit `time`

Name minute (default)

Definition 60 s

2.3 Unit `nanoMolar`

Name nanoMolar

Definition $\mathrm{nmol} \cdot \mathrm{l}^{-1}$

2.4 Unit `min_inv`

Name min_inv

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

2.5 Unit `min_inv_nM_inv`

Name min_inv_nM_inv

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

2.6 Unit `nM_min_inv`

Name nM_min_inv

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

2.7 Unit `volume`

Notes Litre is the predefined SBML unit for `volume`.

Definition l

2.8 Unit area

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

Definition m^2

2.9 Unit length

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

Definition m

3 Compartments

This model contains two compartments.

Table 2: Properties of all compartments.

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

3.1 Compartment Extracellular

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

3.2 Compartment compartment

This is a three dimensional compartment with a constant size of one litre, which is surrounded by Extracellular.

Name cell

4 Species

This model contains 37 species. The boundary condition of one of these species is set to `true` so that this species' amount cannot be changed by any reaction. Section 6 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
alpha	-factor	Extracellular	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste2		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste2a	Ste2active	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Gabc	G	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGTP	GGTP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Gbc	G	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGDP	GGDP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexC		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexD		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste5		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste11		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexA		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste7		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Fus3		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexB		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste20		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexE		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexF		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexG		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexH		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexI		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
complexL		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Fus3PP		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexK		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste12		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Ste12a	Ste12active	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Bar1		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Bar1a	Bar1active	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Bar1aex	Bar1activeEx	Extracellular	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Far1		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Far1PP		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Far1U	Far1ubiquitin	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexM		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
complexN		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Cdc28		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Sst2		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
p		compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	☑

5 Reactions

This model contains 47 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 4: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	v1	alpha degradation	alpha $\xrightleftharpoons{\text{Bar1aex}}$ $\emptyset$	
2	v2		Ste2 $\xrightleftharpoons{\text{alpha}}$ Ste2a	
3	v3		Ste2a $\rightleftharpoons$ Ste2	
4	v4		Ste2a $\rightleftharpoons$ p	
5	v5		Ste2 $\rightleftharpoons$ $\emptyset$	
6	v6		Gabc $\xrightleftharpoons{\text{Ste2a}}$ GaGTP + Gbc	
7	v7		GaGTP $\rightleftharpoons$ GaGDP	
8	v8		GaGTP $\xrightleftharpoons{\text{Sst2}}$ GaGDP	
9	v9		GaGDP + Gbc $\rightleftharpoons$ Gabc	
10	v10		Gbc + complexC $\rightleftharpoons$ complexD	
11	v11		complexD $\rightleftharpoons$ Gbc + complexC	
12	v12		Ste11 + Ste5 $\rightleftharpoons$ complexA	
13	v13		complexA $\rightleftharpoons$ Ste11 + Ste5	
14	v14		Fus3 + Ste7 $\rightleftharpoons$ complexB	
15	v15		complexB $\rightleftharpoons$ Fus3 + Ste7	
16	v16		complexA + complexB $\rightleftharpoons$ complexC	
17	v17		complexC $\rightleftharpoons$ Fus3 + Ste11 + Ste7 + Ste5	
18	v18		complexD + Ste20 $\rightleftharpoons$ complexE	
19	v19		complexE $\rightleftharpoons$ complexD + Ste20	
20	v20		complexE $\rightleftharpoons$ complexF	

№	Id	Name	Reaction Equation	SBO
21	v21		$\text{complexE} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11}$	
22	v22		$\text{complexF} \rightleftharpoons \text{complexG}$	
23	v23		$\text{complexF} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11}$	
24	v24		$\text{complexG} \rightleftharpoons \text{complexH}$	
25	v25		$\text{complexG} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11}$	
26	v26		$\text{complexH} \rightleftharpoons \text{complexI}$	
27	v27		$\text{complexH} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11}$	
28	v28		$\text{complexI} \rightleftharpoons \text{complexL} + \text{Fus3PP}$	
29	v29		$\text{complexL} + \text{Fus3} \rightleftharpoons \text{complexK}$	
30	v30		$\text{complexK} \rightleftharpoons \text{complexL} + \text{Fus3}$	
31	v31		$\text{complexK} \rightleftharpoons \text{complexI}$	
32	v32		$\text{complexL} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Ste20} + \text{Ste11}$	
33	v33		$\text{Fus3PP} \rightleftharpoons \text{Fus3}$	
34	v34		$\text{Ste12} + \text{Fus3PP} \rightleftharpoons \text{Ste12a}$	
35	v35		$\text{Ste12a} \rightleftharpoons \text{Ste12} + \text{Fus3PP}$	
36	v36		$\text{Bar1} \overset{\text{Ste12a}}{\rightleftharpoons} \text{Bar1a}$	
37	v37		$\text{Bar1a} \rightleftharpoons \text{Bar1}$	
38	v38		$\text{Bar1a} \rightleftharpoons \text{Bar1aex}$	
39	v39		$\text{Far1} \overset{\text{Fus3PP}}{\rightleftharpoons} \text{Far1PP}$	
40	v40		$\text{Far1PP} \rightleftharpoons \text{Far1}$	
41	v41		$\text{Far1} \overset{\text{Cdc28}}{\rightleftharpoons} \text{Far1U}$	
42	v42		$\text{Gbc} + \text{Far1PP} \rightleftharpoons \text{complexM}$	
43	v43		$\text{complexM} \rightleftharpoons \text{Gbc} + \text{Far1PP}$	
44	v44		$\text{complexN} \rightleftharpoons \text{Cdc28} + \text{Far1PP}$	

№	Id	Name	Reaction Equation	SBO
45	v45		$\mathrm{Cdc28} + \mathrm{Far1PP} \rightleftharpoons \mathrm{complexN}$	
46	v46		$\mathrm{p} \overset{\mathrm{Fus3PP}}{\rightleftharpoons} \mathrm{Sst2}$	
47	v47		$\mathrm{Sst2} \rightleftharpoons \mathrm{p}$	

5.1 Reaction v1

This is a reversible reaction of one reactant forming no product influenced by one modifier.

Name alpha degradation

Reaction equation

$$\text{alpha} \overset{\text{Bar1aex}}{\rightleftharpoons} \emptyset \tag{1}$$

Reactant

Table 5: Properties of each reactant.

Id	Name	SBO
alpha	-factor	

Modifier

Table 6: Properties of each modifier.

Id	Name	SBO
Bar1aex	Bar1activeEx	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (60\ \text{s})^{-1}$

$$v_1 = \text{vol}\,(\text{Extracellular}) \cdot [\text{alpha}] \cdot [\text{Bar1aex}] \cdot \text{k1} \tag{2}$$

Table 7: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1			0.03	$\text{nmol}^{-1} \cdot 1 \cdot (60\ \text{s})^{-1}$	☑

5.2 Reaction v2

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Reaction equation

$$\text{Ste2} \overset{\text{alpha}}{\rightleftharpoons} \text{Ste2a} \tag{3}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
Ste2		

Modifier

Table 9: Properties of each modifier.

Id	Name	SBO
alpha	-factor	

Product

Table 10: Properties of each product.

Id	Name	SBO
Ste2a	Ste2active	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (60\ \text{s})^{-1}$

$$v_2 = \text{vol}\,(\text{compartment}) \cdot [\text{Ste2}] \cdot [\text{alpha}] \cdot \text{k2} \tag{4}$$

Table 11: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k2			0.001	$\text{nmol}^{-1} \cdot 1 \cdot (60\ \text{s})^{-1}$	☑

5.3 Reaction v3

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

Reaction equation

$$\mathrm{Ste2a} \rightleftharpoons \mathrm{Ste2} \tag{5}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
Ste2a	Ste2active	

Product

Table 13: Properties of each product.

Id	Name	SBO
Ste2		

Kinetic Law

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

$$v_3 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste2a}] \cdot \mathrm{k3} \tag{6}$$

Table 14: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k3			0.6	$(60\ \mathrm{s})^{-1}$	☑

5.4 Reaction v4

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

Reaction equation

$$\mathrm{Ste2a} \rightleftharpoons \mathrm{p} \tag{7}$$

Reactant

Table 15: Properties of each reactant.

Id	Name	SBO
Ste2a	Ste2active	

Product

Table 16: Properties of each product.

Id	Name	SBO
p		

Kinetic Law

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

$$v_4 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste2a}] \cdot \mathrm{k4} \tag{8}$$

Table 17: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k4			0.24	$(60\ \mathrm{s})^{-1}$	☑

5.5 Reaction v5

This is a reversible reaction of one reactant forming no product.

Reaction equation

$$\mathrm{Ste2} \rightleftharpoons \emptyset \tag{9}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
Ste2		

Kinetic Law

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

$$v_5 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste2}] \cdot \mathrm{k5} \tag{10}$$

Table 19: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k5			0.024	$(60\ \mathrm{s})^{-1}$	☑

5.6 Reaction v6

This is a reversible reaction of one reactant forming two products influenced by one modifier.

Reaction equation

$$\mathrm{Gabc} \overset{\mathrm{Ste2a}}{\rightleftharpoons} \mathrm{GaGTP} + \mathrm{Gbc} \tag{11}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
Gabc	G	

Modifier

Table 21: Properties of each modifier.

Id	Name	SBO
Ste2a	Ste2active	

Products

Table 22: Properties of each product.

Id	Name	SBO
GaGTP	GGTP	
Gbc	G	

Id	Name	SBO

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_6 = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{Ste2a}] \cdot [\mathrm{Gabc}] \cdot \mathrm{k6} \tag{12}$$

Table 23: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k6			0.004	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.7 Reaction v7

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

Reaction equation

$$\mathrm{GaGTP} \rightleftharpoons \mathrm{GaGDP} \tag{13}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
GaGTP	GGTP	

Product

Table 25: Properties of each product.

Id	Name	SBO
GaGDP	GGDP	

Kinetic Law

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

$$v_7 = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{GaGTP}] \cdot \mathrm{k7} \tag{14}$$

Table 26: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k7			0.24	$(60\ \mathrm{s})^{-1}$	☑

5.8 Reaction v8

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Reaction equation

$$\mathrm{GaGTP} \overset{\mathrm{Sst2}}{\rightleftharpoons} \mathrm{GaGDP} \tag{15}$$

Reactant

Table 27: Properties of each reactant.

Id	Name	SBO
GaGTP	GGTP	

Modifier

Table 28: Properties of each modifier.

Id	Name	SBO
Sst2		

Product

Table 29: Properties of each product.

Id	Name	SBO
GaGDP	GGDP	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_8 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{GaGTP}] \cdot [\mathrm{Sst2}] \cdot \mathrm{k8} \tag{16}$$

Table 30: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k8			0.033	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.9 Reaction v9

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{GaGDP} + \mathrm{Gbc} \rightleftharpoons \mathrm{Gabc} \tag{17}$$

Reactants

Table 31: Properties of each reactant.

Id	Name	SBO
GaGDP	GGDP	
Gbc	G	

Product

Table 32: Properties of each product.

Id	Name	SBO
Gabc	G	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_9 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{GaGDP}] \cdot [\mathrm{Gbc}] \cdot \mathrm{k9} \tag{18}$$

Table 33: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k9			2000.0	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.10 Reaction v10

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{Gbc} + \mathrm{complexC} \rightleftharpoons \mathrm{complexD} \tag{19}$$

Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
Gbc	G	
complexC		

Product

Table 35: Properties of each product.

Id	Name	SBO
complexD		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{10} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Gbc}] \cdot [\mathrm{complexC}] \cdot \mathrm{k10} \tag{20}$$

Table 36: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k10			0.1	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.11 Reaction v11

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\mathrm{complexD} \rightleftharpoons \mathrm{Gbc} + \mathrm{complexC} \tag{21}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
complexD		

Products

Table 38: Properties of each product.

Id	Name	SBO
Gbc	G	
complexC		

Kinetic Law

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

$$v_{11} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexD}] \cdot \mathrm{k11} \tag{22}$$

Table 39: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k11			5.0	$(60\ \mathrm{s})^{-1}$	☑

5.12 Reaction v12

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{Ste11} + \mathrm{Ste5} \rightleftharpoons \mathrm{complexA} \tag{23}$$

Reactants

Table 40: Properties of each reactant.

Id	Name	SBO
Ste11		

Id	Name	SBO
Ste5		

Product

Table 41: Properties of each product.

Id	Name	SBO
complexA		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{12} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste5}] \cdot [\mathrm{Ste11}] \cdot \mathrm{k12} \tag{24}$$

Table 42: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k12			1.0	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.13 Reaction v13

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\mathrm{complexA} \rightleftharpoons \mathrm{Ste11} + \mathrm{Ste5} \tag{25}$$

Reactant

Table 43: Properties of each reactant.

Id	Name	SBO
complexA		

Products

Table 44: Properties of each product.

Id	Name	SBO
Ste11		
Ste5		

Kinetic Law

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

$$v_{13} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexA}] \cdot \mathrm{k13} \tag{26}$$

Table 45: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k13			3.0	$(60\ \mathrm{s})^{-1}$	☑

5.14 Reaction v14

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{Fus3} + \mathrm{Ste7} \rightleftharpoons \mathrm{complexB} \tag{27}$$

Reactants

Table 46: Properties of each reactant.

Id	Name	SBO
Fus3		
Ste7		

Product

Table 47: Properties of each product.

Id	Name	SBO
complexB		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{14} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste7}] \cdot [\mathrm{Fus3}] \cdot \mathrm{k14} \tag{28}$$

Table 48: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k14			1.0	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.15 Reaction v15

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\mathrm{complexB} \rightleftharpoons \mathrm{Fus3} + \mathrm{Ste7} \tag{29}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
complexB		

Products

Table 50: Properties of each product.

Id	Name	SBO
Fus3		
Ste7		

Kinetic Law

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

$$v_{15} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexB}] \cdot \mathrm{k15} \tag{30}$$

Table 51: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k15			3.0	$(60\ \mathrm{s})^{-1}$	☑

5.16 Reaction v16

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{complexA} + \mathrm{complexB} \rightleftharpoons \mathrm{complexC} \tag{31}$$

Reactants

Table 52: Properties of each reactant.

Id	Name	SBO
complexA		
complexB		

Product

Table 53: Properties of each product.

Id	Name	SBO
complexC		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{16} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexA}] \cdot [\mathrm{complexB}] \cdot \mathrm{k16} \tag{32}$$

Table 54: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k16			3.0	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.17 Reaction v17

This is a reversible reaction of one reactant forming four products.

Reaction equation

$$\text{complexC} \rightleftharpoons \text{Fus3} + \text{Ste11} + \text{Ste7} + \text{Ste5} \tag{33}$$

Reactant

Table 55: Properties of each reactant.

Id	Name	SBO
complexC		

Products

Table 56: Properties of each product.

Id	Name	SBO
Fus3		
Ste11		
Ste7		
Ste5		

Kinetic Law

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

$$v_{17} = \text{vol}\,(\text{compartment}) \cdot [\text{complexC}] \cdot \text{k17} \tag{34}$$

Table 57: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k17			100.0	$(60\ \text{s})^{-1}$	☑

5.18 Reaction v18

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\text{complexD} + \text{Ste20} \rightleftharpoons \text{complexE} \tag{35}$$

Reactants

Table 58: Properties of each reactant.

Id	Name	SBO
complexD		
Ste20		

Product

Table 59: Properties of each product.

Id	Name	SBO
complexE		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (60\ \text{s})^{-1}$

$$v_{18} = \text{vol}(\text{compartment}) \cdot [\text{complexD}] \cdot [\text{Ste20}] \cdot \text{k18} \tag{36}$$

Table 60: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k18			5.0	$\text{nmol}^{-1} \cdot 1 \cdot (60\ \text{s})^{-1}$	☑

5.19 Reaction v19

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\text{complexE} \rightleftharpoons \text{complexD} + \text{Ste20} \tag{37}$$

Reactant

Table 61: Properties of each reactant.

Id	Name	SBO
complexE		

Products

Table 62: Properties of each product.

Id	Name	SBO
complexD		
Ste20		

Kinetic Law

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

$$v_{19} = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{complexE}] \cdot \mathrm{k19} \tag{38}$$

Table 63: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k19			1.0	$(60\ \mathrm{s})^{-1}$	☑

5.20 Reaction v20

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

Reaction equation

$$\mathrm{complexE} \rightleftharpoons \mathrm{complexF} \tag{39}$$

Reactant

Table 64: Properties of each reactant.

Id	Name	SBO
complexE		

Product

Table 65: Properties of each product.

Id	Name	SBO
complexF		

Kinetic Law

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

$$v_{20} = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{complexE}] \cdot \mathrm{k20} \tag{40}$$

Table 66: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k20			10.0	$(60\ \mathrm{s})^{-1}$	☑

5.21 Reaction v21

This is a reversible reaction of one reactant forming six products.

Reaction equation

$$\mathrm{complexE} \rightleftharpoons \mathrm{Gbc} + \mathrm{Ste7} + \mathrm{Ste5} + \mathrm{Fus3} + \mathrm{Ste20} + \mathrm{Ste11} \tag{41}$$

Reactant

Table 67: Properties of each reactant.

Id	Name	SBO
complexE		

Products

Table 68: Properties of each product.

Id	Name	SBO
Gbc	G	
Ste7		

Id	Name	SBO
Ste5		
Fus3		
Ste20		
Ste11		

Kinetic Law

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

$$v_{21} = \text{vol}(\text{compartment}) \cdot [\text{complexE}] \cdot \text{k21} \tag{42}$$

Table 69: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k21			5.0	$(60\ \text{s})^{-1}$	☑

5.22 Reaction v22

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

Reaction equation

$$\text{complexF} \rightleftharpoons \text{complexG} \tag{43}$$

Reactant

Table 70: Properties of each reactant.

Id	Name	SBO
complexF		

Product

Table 71: Properties of each product.

Id	Name	SBO
complexG		

Kinetic Law

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

$$v_{22} = \text{vol}\,(\text{compartment}) \cdot [\text{complexF}] \cdot \text{k22} \tag{44}$$

Table 72: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k22			47.0	$(60\ \text{s})^{-1}$	☑

5.23 Reaction v23

This is a reversible reaction of one reactant forming six products.

Reaction equation

$$\text{complexF} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11} \tag{45}$$

Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
complexF		

Products

Table 74: Properties of each product.

Id	Name	SBO
Gbc	G	
Ste7		
Ste5		
Fus3		
Ste20		
Ste11		

Kinetic Law

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

$$v_{23} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexF}] \cdot \mathrm{k23} \tag{46}$$

Table 75: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k23			5.0	$(60\ \mathrm{s})^{-1}$	☑

5.24 Reaction v24

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

Reaction equation

$$\mathrm{complexG} \rightleftharpoons \mathrm{complexH} \tag{47}$$

Reactant

Table 76: Properties of each reactant.

Id	Name	SBO
complexG		

Product

Table 77: Properties of each product.

Id	Name	SBO
complexH		

Kinetic Law

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

$$v_{24} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexG}] \cdot \mathrm{k24} \tag{48}$$

Table 78: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k24			345.0	$(60\ \mathrm{s})^{-1}$	☑

5.25 Reaction v25

This is a reversible reaction of one reactant forming six products.

Reaction equation

$$\text{complexG} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11} \tag{49}$$

Reactant

Table 79: Properties of each reactant.

Id	Name	SBO
complexG		

Products

Table 80: Properties of each product.

Id	Name	SBO
Gbc	G	
Ste7		
Ste5		
Fus3		
Ste20		
Ste11		

Kinetic Law

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

$$v_{25} = \text{vol}(\text{compartment}) \cdot [\text{complexG}] \cdot \text{k25} \tag{50}$$

Table 81: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k25			5.0	$(60\ \text{s})^{-1}$	☑

5.26 Reaction v26

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

Reaction equation

$$\text{complexH} \rightleftharpoons \text{complexI} \tag{51}$$

Reactant

Table 82: Properties of each reactant.

Id	Name	SBO
complexH		

Product

Table 83: Properties of each product.

Id	Name	SBO
complexI		

Kinetic Law

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

$$v_{26} = \text{vol}\,(\text{compartment}) \cdot [\text{complexH}] \cdot \text{k26} \tag{52}$$

Table 84: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k26			50.0	$(60\ \text{s})^{-1}$	☑

5.27 Reaction v27

This is a reversible reaction of one reactant forming six products.

Reaction equation

$$\text{complexH} \rightleftharpoons \text{Gbc} + \text{Ste7} + \text{Ste5} + \text{Fus3} + \text{Ste20} + \text{Ste11} \tag{53}$$

Reactant

Table 85: Properties of each reactant.

Id	Name	SBO
complexH		

Products

Table 86: Properties of each product.

Id	Name	SBO
Gbc	G	
Ste7		
Ste5		
Fus3		
Ste20		
Ste11		

Kinetic Law

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

$$v_{27} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexH}] \cdot \mathrm{k27} \tag{54}$$

Table 87: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k27			5.0	$(60\ \mathrm{s})^{-1}$	☑

5.28 Reaction v28

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\mathrm{complexI} \rightleftharpoons \mathrm{complexL} + \mathrm{Fus3PP} \tag{55}$$

Reactant

Table 88: Properties of each reactant.

Id	Name	SBO
complexI		

Products

Table 89: Properties of each product.

Id	Name	SBO
complexL		
Fus3PP		

Kinetic Law

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

$$v_{28} = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{complexI}] \cdot \mathrm{k28} \tag{56}$$

Table 90: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k28			140.0	$(60\ \mathrm{s})^{-1}$	☑

5.29 Reaction v29

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{complexL} + \mathrm{Fus3} \rightleftharpoons \mathrm{complexK} \tag{57}$$

Reactants

Table 91: Properties of each reactant.

Id	Name	SBO
complexL		
Fus3		

Product

Table 92: Properties of each product.

Id	Name	SBO
complexK		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{29} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexL}] \cdot [\mathrm{Fus3}] \cdot \mathrm{k29} \tag{58}$$

Table 93: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k29			10.0	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.30 Reaction v30

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\mathrm{complexK} \rightleftharpoons \mathrm{complexL} + \mathrm{Fus3} \tag{59}$$

Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
complexK		

Products

Table 95: Properties of each product.

Id	Name	SBO
complexL		
Fus3		

Kinetic Law

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

$$v_{30} = \text{vol}\,(\text{compartment}) \cdot [\text{complexK}] \cdot \text{k30} \tag{60}$$

Table 96: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k30			1.0	$(60\ \text{s})^{-1}$	☑

5.31 Reaction v31

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

Reaction equation

$$\text{complexK} \rightleftharpoons \text{complexI} \tag{61}$$

Reactant

Table 97: Properties of each reactant.

Id	Name	SBO
complexK		

Product

Table 98: Properties of each product.

Id	Name	SBO
complexI		

Kinetic Law

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

$$v_{31} = \text{vol}\,(\text{compartment}) \cdot [\text{complexK}] \cdot \text{k31} \tag{62}$$

Table 99: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k31			250.0	$(60\ \mathrm{s})^{-1}$	☑

5.32 Reaction v32

This is a reversible reaction of one reactant forming five products.

Reaction equation

$$\mathrm{complexL} \rightleftharpoons \mathrm{Gbc} + \mathrm{Ste7} + \mathrm{Ste5} + \mathrm{Ste20} + \mathrm{Ste11} \tag{63}$$

Reactant

Table 100: Properties of each reactant.

Id	Name	SBO
complexL		

Products

Table 101: Properties of each product.

Id	Name	SBO
Gbc	G	
Ste7		
Ste5		
Ste20		
Ste11		

Kinetic Law

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

$$v_{32} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexL}] \cdot \mathrm{k32} \tag{64}$$

Table 102: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k32			5.0	$(60\ \mathrm{s})^{-1}$	☑

5.33 Reaction v33

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

Reaction equation

$$\text{Fus3PP} \rightleftharpoons \text{Fus3} \tag{65}$$

Reactant

Table 103: Properties of each reactant.

Id	Name	SBO
Fus3PP		

Product

Table 104: Properties of each product.

Id	Name	SBO
Fus3		

Kinetic Law

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

$$v_{33} = \text{vol}\,(\text{compartment}) \cdot [\text{Fus3PP}] \cdot \text{k33} \tag{66}$$

Table 105: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k33			50.0	$(60\ \text{s})^{-1}$	☑

5.34 Reaction v34

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\text{Ste12} + \text{Fus3PP} \rightleftharpoons \text{Ste12a} \tag{67}$$

Reactants

Table 106: Properties of each reactant.

Id	Name	SBO
Ste12		
Fus3PP		

Product

Table 107: Properties of each product.

Id	Name	SBO
Ste12a	Ste12active	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{34} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste12}] \cdot [\mathrm{Fus3PP}] \cdot \mathrm{k34} \tag{68}$$

Table 108: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k34			18.0	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.35 Reaction v35

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\mathrm{Ste12a} \rightleftharpoons \mathrm{Ste12} + \mathrm{Fus3PP} \tag{69}$$

Reactant

Table 109: Properties of each reactant.

Id	Name	SBO
Ste12a	Ste12active	

Products

Table 110: Properties of each product.

Id	Name	SBO
Ste12		
Fus3PP		

Kinetic Law

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

$$v_{35} = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{Ste12a}] \cdot \mathrm{k35} \tag{70}$$

Table 111: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k35			10.0	$(60\ \mathrm{s})^{-1}$	☑

5.36 Reaction v36

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Reaction equation

$$\mathrm{Bar1} \overset{\mathrm{Ste12a}}{\rightleftharpoons} \mathrm{Bar1a} \tag{71}$$

Reactant

Table 112: Properties of each reactant.

Id	Name	SBO
Bar1		

Modifier

Table 113: Properties of each modifier.

Id	Name	SBO
Ste12a	Ste12active	

Id	Name	SBO

Product

Table 114: Properties of each product.

Id	Name	SBO
Bar1a	Bar1active	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{36} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Ste12a}] \cdot [\mathrm{Bar1}] \cdot \mathrm{k36} \tag{72}$$

Table 115: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k36			0.1	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.37 Reaction v37

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

Reaction equation

$$\mathrm{Bar1a} \rightleftharpoons \mathrm{Bar1} \tag{73}$$

Reactant

Table 116: Properties of each reactant.

Id	Name	SBO
Bar1a	Bar1active	

Product

Table 117: Properties of each product.

Id	Name	SBO
Bar1		

Kinetic Law

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

$$v_{37} = \text{vol}\,(\text{compartment}) \cdot [\text{Bar1a}] \cdot \text{k37} \tag{74}$$

Table 118: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k37			0.1	$(60\ \text{s})^{-1}$	☑

5.38 Reaction v38

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

Reaction equation

$$\text{Bar1a} \rightleftharpoons \text{Bar1aex} \tag{75}$$

Reactant

Table 119: Properties of each reactant.

Id	Name	SBO
Bar1a	Bar1active	

Product

Table 120: Properties of each product.

Id	Name	SBO
Bar1aex	Bar1activeEx	

Kinetic Law

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

$$v_{38} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Bar1a}] \cdot \mathrm{k38} \tag{76}$$

Table 121: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k38			0.01	$(60\ \mathrm{s})^{-1}$	☑

5.39 Reaction v39

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Reaction equation

$$\mathrm{Far1} \overset{\mathrm{Fus3PP}}{\rightleftharpoons} \mathrm{Far1PP} \tag{77}$$

Reactant

Table 122: Properties of each reactant.

Id	Name	SBO
Far1		

Modifier

Table 123: Properties of each modifier.

Id	Name	SBO
Fus3PP		

Product

Table 124: Properties of each product.

Id	Name	SBO
Far1PP		

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \frac{[\mathrm{Far1}] \cdot [\mathrm{Fus3PP}] \cdot [\mathrm{Fus3PP}]}{100 \cdot 100 + [\mathrm{Fus3PP}] \cdot [\mathrm{Fus3PP}]} \cdot \mathrm{k39} \tag{78}$$

Table 125: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k39			18.0	$(60\ \mathrm{s})^{-1}$	☑

5.40 Reaction v40

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

Reaction equation

$$\mathrm{Far1PP} \rightleftharpoons \mathrm{Far1} \tag{79}$$

Reactant

Table 126: Properties of each reactant.

Id	Name	SBO
Far1PP		

Product

Table 127: Properties of each product.

Id	Name	SBO
Far1		

Kinetic Law

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

$$v_{40} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Far1PP}] \cdot \mathrm{k40} \tag{80}$$

Table 128: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k40			1.0	$(60\ \mathrm{s})^{-1}$	☑

5.41 Reaction v41

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Reaction equation

$$\mathrm{Far1} \overset{\mathrm{Cdc28}}{\rightleftharpoons} \mathrm{Far1U} \tag{81}$$

Reactant

Table 129: Properties of each reactant.

Id	Name	SBO
Far1		

Modifier

Table 130: Properties of each modifier.

Id	Name	SBO
Cdc28		

Product

Table 131: Properties of each product.

Id	Name	SBO
Far1U	Far1ubiquitin	

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{41} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Far1}] \cdot [\mathrm{Cdc28}] \cdot \mathrm{k41} \tag{82}$$

Table 132: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k41			0.02	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.42 Reaction v42

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{Gbc} + \mathrm{Far1PP} \rightleftharpoons \mathrm{complexM} \tag{83}$$

Reactants

Table 133: Properties of each reactant.

Id	Name	SBO
Gbc	G	
Far1PP		

Product

Table 134: Properties of each product.

Id	Name	SBO
complexM		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{42} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Gbc}] \cdot [\mathrm{Far1PP}] \cdot \mathrm{k42} \tag{84}$$

Table 135: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k42			0.1	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.43 Reaction v43

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\text{complexM} \rightleftharpoons \text{Gbc} + \text{Far1PP} \tag{85}$$

Reactant

Table 136: Properties of each reactant.

Id	Name	SBO
complexM		

Products

Table 137: Properties of each product.

Id	Name	SBO
Gbc	G	
Far1PP		

Kinetic Law

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

$$v_{43} = \text{vol}(\text{compartment}) \cdot [\text{complexM}] \cdot \text{k43} \tag{86}$$

Table 138: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k43			0.01	$(60\ \text{s})^{-1}$	☑

5.44 Reaction v44

This is a reversible reaction of one reactant forming two products.

Reaction equation

$$\text{complexN} \rightleftharpoons \text{Cdc28} + \text{Far1PP} \tag{87}$$

Reactant

Table 139: Properties of each reactant.

Id	Name	SBO
complexN		

Products

Table 140: Properties of each product.

Id	Name	SBO
Cdc28		
Far1PP		

Kinetic Law

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

$$v_{44} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{complexN}] \cdot \mathrm{k44} \tag{88}$$

Table 141: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k44			0.01	$(60\ \mathrm{s})^{-1}$	☑

5.45 Reaction v45

This is a reversible reaction of two reactants forming one product.

Reaction equation

$$\mathrm{Cdc28} + \mathrm{Far1PP} \rightleftharpoons \mathrm{complexN} \tag{89}$$

Reactants

Table 142: Properties of each reactant.

Id	Name	SBO
Cdc28		

Id	Name	SBO
Far1PP		

Product

Table 143: Properties of each product.

Id	Name	SBO
complexN		

Kinetic Law

Derived unit $9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (60\ \mathrm{s})^{-1}$

$$v_{45} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Far1PP}] \cdot [\mathrm{Cdc28}] \cdot \mathrm{k45} \tag{90}$$

Table 144: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k45			0.1	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

5.46 Reaction v46

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Reaction equation

$$\mathrm{p} \underset{\text{Fus3PP}}{\rightleftharpoons} \mathrm{Sst2} \tag{91}$$

Reactant

Table 145: Properties of each reactant.

Id	Name	SBO
p		

Modifier

Table 146: Properties of each modifier.

Id	Name	SBO
Fus3PP		

Product

Table 147: Properties of each product.

Id	Name	SBO
Sst2		

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \mathrm{vol}\,(\mathrm{compartment}) \cdot \frac{[\mathrm{Fus3PP}]^2}{4^2 + [\mathrm{Fus3PP}]^2} \cdot \mathrm{k46} \tag{92}$$

Table 148: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k46			200.0	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot (60\ \mathrm{s})^{-1}$	☑

5.47 Reaction v47

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

Reaction equation

$$\mathrm{Sst2} \rightleftharpoons \mathrm{p} \tag{93}$$

Reactant

Table 149: Properties of each reactant.

Id	Name	SBO
Sst2		

Product

Table 150: Properties of each product.

Id	Name	SBO
p		

Kinetic Law

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

$$v_{47} = \text{vol}(\text{compartment}) \cdot [\text{Sst2}] \cdot \text{k47} \tag{94}$$

Table 151: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k47			1.0	$(60\ \text{s})^{-1}$	☑

6 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.

6.1 Species alpha

Name -factor

Initial concentration $100\ \text{nmol} \cdot \text{l}^{-1}$

This species takes part in two reactions (as a reactant in v1 and as a modifier in v2).

$$\frac{\text{d}}{\text{d}t}\text{alpha} = -v_1 \tag{95}$$

6.2 Species Ste2

Initial concentration $1666.6666667\ \text{nmol} \cdot \text{l}^{-1}$

This species takes part in three reactions (as a reactant in v2, v5 and as a product in v3).

$$\frac{\text{d}}{\text{d}t}\text{Ste2} = v_3 - v_2 - v_5 \tag{96}$$

6.3 Species Ste2a

Name Ste2active

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v3, v4 and as a product in v2 and as a modifier in v6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste2a} = v_2 - v_3 - v_4 \tag{97}$$

6.4 Species Gabc

Name G

Initial concentration $1666.6666667\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in v6 and as a product in v9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gabc} = v_9 - v_6 \tag{98}$$

6.5 Species GaGTP

Name GGTP

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v7, v8 and as a product in v6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGTP} = v_6 - v_7 - v_8 \tag{99}$$

6.6 Species Gbc

Name G

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in eleven reactions (as a reactant in v9, v10, v42 and as a product in v6, v11, v21, v23, v25, v27, v32, v43).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gbc} = v_6 + v_{11} + v_{21} + v_{23} + v_{25} + v_{27} + v_{32} + v_{43} - v_9 - v_{10} - v_{42} \tag{100}$$

6.7 Species GaGDP

Name GGDP

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v9 and as a product in v7, v8).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGDP} = v_7 + v_8 - v_9 \tag{101}$$

6.8 Species complexC

Initial concentration $235.724935791903\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v10, v17 and as a product in v11, v16).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexC} = v_{11} + v_{16} - v_{10} - v_{17} \tag{102}$$

6.9 Species complexD

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v11, v18 and as a product in v10, v19).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexD} = v_{10} + v_{19} - v_{11} - v_{18} \tag{103}$$

6.10 Species Ste5

Initial concentration $158.33176608789\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in v12 and as a product in v13, v17, v21, v23, v25, v27, v32).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste5} = v_{13} + v_{17} + v_{21} + v_{23} + v_{25} + v_{27} + v_{32} - v_{12} \tag{104}$$

6.11 Species Ste11

Initial concentration $158.33176608789\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in v12 and as a product in v13, v17, v21, v23, v25, v27, v32).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste11} = v_{13} + v_{17} + v_{21} + v_{23} + v_{25} + v_{27} + v_{32} - v_{12} \tag{105}$$

6.12 Species complexA

Initial concentration 105.943298120207 nmol · l^{-1}

This species takes part in three reactions (as a reactant in v13, v16 and as a product in v12).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexA} = v_{12} - v_{13} - v_{16} \tag{106}$$

6.13 Species Ste7

Initial concentration 36.3997016405141 nmol · l^{-1}

This species takes part in eight reactions (as a reactant in v14 and as a product in v15, v17, v21, v23, v25, v27, v32).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste7} = v_{15} + v_{17} + v_{21} + v_{23} + v_{25} + v_{27} + v_{32} - v_{14} \tag{107}$$

6.14 Species Fus3

Initial concentration 686.399701640513 nmol · l^{-1}

This species takes part in ten reactions (as a reactant in v14, v29 and as a product in v15, v17, v21, v23, v25, v27, v30, v33).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Fus3} = v_{15} + v_{17} + v_{21} + v_{23} + v_{25} + v_{27} + v_{30} + v_{33} - v_{14} - v_{29} \tag{108}$$

6.15 Species complexB

Initial concentration 77.8753625675829 nmol · l^{-1}

This species takes part in three reactions (as a reactant in v15, v16 and as a product in v14).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexB} = v_{14} - v_{15} - v_{16} \tag{109}$$

6.16 Species Ste20

Initial concentration 1000 nmol · l^{-1}

This species takes part in seven reactions (as a reactant in v18 and as a product in v19, v21, v23, v25, v27, v32).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste20} = v_{19} + v_{21} + v_{23} + v_{25} + v_{27} + v_{32} - v_{18} \tag{110}$$

6.17 Species complexE

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v19, v20, v21 and as a product in v18).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexE} = v_{18} - v_{19} - v_{20} - v_{21} \tag{111}$$

6.18 Species complexF

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v22, v23 and as a product in v20).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexF} = v_{20} - v_{22} - v_{23} \tag{112}$$

6.19 Species complexG

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v24, v25 and as a product in v22).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexG} = v_{22} - v_{24} - v_{25} \tag{113}$$

6.20 Species complexH

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v26, v27 and as a product in v24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexH} = v_{24} - v_{26} - v_{27} \tag{114}$$

6.21 Species complexI

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v28 and as a product in v26, v31).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexI} = v_{26} + v_{31} - v_{28} \tag{115}$$

6.22 Species complexL

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v29, v32 and as a product in v28, v30).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexL} = v_{28} + v_{30} - v_{29} - v_{32} \tag{116}$$

6.23 Species Fus3PP

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in v33, v34 and as a product in v28, v35 and as a modifier in v39, v46).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Fus3PP} = v_{28} + v_{35} - v_{33} - v_{34} \tag{117}$$

6.24 Species complexK

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v30, v31 and as a product in v29).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexK} = v_{29} - v_{30} - v_{31} \tag{118}$$

6.25 Species Ste12

Initial concentration $200\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in v34 and as a product in v35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste12} = v_{35} - v_{34} \tag{119}$$

6.26 Species Ste12a

Name Ste12active

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v35 and as a product in v34 and as a modifier in v36).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ste12a} = v_{34} - v_{35} \tag{120}$$

6.27 Species Bar1

Initial concentration $200\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in v36 and as a product in v37).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Bar1} = v_{37} - v_{36} \tag{121}$$

6.28 Species Bar1a

Name Bar1active

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v37, v38 and as a product in v36).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Bar1a} = v_{36} - v_{37} - v_{38} \tag{122}$$

6.29 Species Bar1aex

Name Bar1activeEx

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a product in v38 and as a modifier in v1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Bar1aex} = v_{38} \tag{123}$$

6.30 Species Far1

Initial concentration $500\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v39, v41 and as a product in v40).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Far1} = v_{40} - v_{39} - v_{41} \tag{124}$$

6.31 Species Far1PP

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in v40, v42, v45 and as a product in v39, v43, v44).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Far1PP} = v_{39} + v_{43} + v_{44} - v_{40} - v_{42} - v_{45} \tag{125}$$

6.32 Species Far1U

Name Far1ubiquitin

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a product in v41).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Far1U} = v_{41} \tag{126}$$

6.33 Species complexM

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in v43 and as a product in v42).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexM} = v_{42} - v_{43} \tag{127}$$

6.34 Species complexN

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in v44 and as a product in v45).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{complexN} = v_{45} - v_{44} \tag{128}$$

6.35 Species Cdc28

Initial concentration $300\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v45 and as a product in v44 and as a modifier in v41).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Cdc28} = v_{44} - v_{45} \tag{129}$$

6.36 Species Sst2

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v47 and as a product in v46 and as a modifier in v8).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Sst2} = v_{46} - v_{47} \tag{130}$$

6.37 Species p

Initial concentration $0\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v46 and as a product in v4, v47), which do not influence its rate of change because this species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{p} = 0 \tag{131}$$

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