SBML Model Report

Model name: "Hatakeyama2003_MAPK"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by the following two authors: Enuo He[1] and Lukas Endler[2] at July 16th 2008 at one o' clock in the afternoon. and last time modified at May 26th 2014 at 11:17 p. m. Table 1 shows an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	36
events	0	constraints	0
reactions	34	function definitions	0
global parameters	75	unit definitions	1
rules	7	initial assignments	0

Model Notes

Figure4 and Figure5 can be simulated by Copasi. Figure4 can be simulated in MathSBML as well. There are some typos in the paper:K29=234, is it should k_29; Table2, reaction17, is there are „slash„ missing in between the rate equation; reaction 33,„Akt-PI-PP„ in the last term of denominator instead of „AktPI-P„ . For plotting figure4, we create another extra parameter *_percent, and use assignment rule calculate percentage of each species.

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2 Unit Definitions

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

2.1 Unit `substance`

Name nM

Definition nmol

2.2 Unit `volume`

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

Definition l

2.3 Unit `area`

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

Definition m^2

2.4 Unit `length`

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

Definition m

2.5 Unit `time`

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

Definition s

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
compartment_0000001	cell		3	1	litre	☑	

3.1 Compartment compartment_0000001

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

Name cell

4 Species

This model contains 36 species. Section 8 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
Akt		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AktPIP3		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AktPIP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AktPIPP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ERK		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ERKP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ERKPP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
GS		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
HRG		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEK		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEKP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEKPP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PI3K		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PI3Kstar		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PIP3		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
R		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RHRG		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RHRG2		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RPI3K		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RPI3Kstar		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RShGS		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
RShP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RShc		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Raf		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Rafstar		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RasGDP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RasGTP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ShGS		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ShP		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Shc		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
P_I		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
internalization		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☑	⊟
MKP3		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☑	⊟
PP2A		compartment_0000001	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☑	⊟

5 Parameters

This model contains 75 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1			0.001		☑
k2			0.010		☑
k3			1.000		☑
k5			0.100		☑
k6			20.000		☑
k7			60.000		☑
k8			2040.000		☑
k9			40.800		☑
V10			0.015		☑
k11			0.222		☑
V12			0.289		☑
k13			1.530		☑
k14			0.007		☑
k15			3.500		☑
k16			0.058		☑
k17			2.900		☑
k20			0.300		☑
k18			0.058		☑
k19			9.500		☑
k21			16.000		☑
k22			0.270		☑
k23			0.100		☑
k24			9.850		☑
k25			45.800		☑
k27			16.900		☑
V26			2620.000		☑
V28			17000.000		☑
k29			507.000		☑
V30			20000.000		☑
k31			0.107		☑
V32			20000.000		☑
k33			0.211		☑
k34			0.001		☑
k_1			$7.6 \cdot 10^{-4}$		☑
k_2			0.100		☑
k_3			0.010		☑
K4			50.000		☑

Id	Name	SBO	Value	Unit	Constant
k_5			1.000		☑
k_6			5.000		☑
k_7			546.000		☑
k_8			15700.000		☑
k_9			0.000		☑
K10			340.000		☑
K11			0.181		☑
K12			0.057		☑
K13			11.700		☑
K14			8.070		☑
K15			317.000		☑
K18			60.000		☑
K19			146000.000		☑
K20			160.000		☑
K21			146000.000		☑
K22			60.000		☑
k_23			2.000		☑
k_24			0.099		☑
k_25			0.047		☑
K26			3680.000		☑
K27			39.100		☑
K28			9.020		☑
K30			80000.000		☑
K31			4.350		☑
K32			80000.000		☑
K33			12.000		☑
k_34			0.000		☑
V4			62.500		☑
K17			317.000		☑
K16			2200.000		☑
k_29			234.000		☑
RP_percent			0.000		⊟
AktPP-_percent			0.000		⊟
MEKPP-_percent			0.000		⊟
ERKPP-_percent			0.000		⊟
Rafstar-_percent			0.000		⊟
ShP_percent			0.000		⊟

Id	Name	SBO	Value	Unit	Constant
PI3Kstar_percent			0.000		⊟

6 Rules

This is an overview of seven rules.

6.1 Rule RP_percent

Rule RP_percent is an assignment rule for parameter RP_percent:

$$\text{RP\_percent} = \frac{([\text{RP}] + [\text{RPI3K}] + [\text{RPI3Kstar}] + [\text{RShGS}] + [\text{RShP}] + [\text{RShc}]) \cdot 200}{80} \quad (1)$$

Notes RP%

6.2 Rule ERKPP_percent

Rule ERKPP_percent is an assignment rule for parameter ERKPP_percent:

$$\text{ERKPP\_percent} = \frac{[\text{ERKPP}] \cdot 100}{1000} \quad (2)$$

Notes ERKPP%

6.3 Rule AktPP_percent

Rule AktPP_percent is an assignment rule for parameter AktPP_percent:

$$\text{AktPP\_percent} = \frac{[\text{AktPIPP}] \cdot 100}{10} \quad (3)$$

Notes AktPP%

6.4 Rule MEKPP_percent

Rule MEKPP_percent is an assignment rule for parameter MEKPP_percent:

$$\text{MEKPP\_percent} = \frac{[\text{MEKPP}] \cdot 100}{120} \quad (4)$$

Notes MEKPP%

6.5 Rule ShP_percent

Rule ShP_percent is an assignment rule for parameter ShP_percent:

$$\text{ShP\_percent} = \frac{[\text{ShP}] \cdot 100}{1000} \tag{5}$$

Notes ShP%

6.6 Rule PI3Kstar_percent

Rule PI3Kstar_percent is an assignment rule for parameter PI3Kstar_percent:

$$\text{PI3Kstar\_percent} = \frac{[\text{PI3Kstar}] \cdot 100}{10} \tag{6}$$

Notes PI3Kstar%

6.7 Rule Rafstar_percent

Rule Rafstar_percent is an assignment rule for parameter Rafstar_percent:

$$\text{Rafstar\_percent} = \frac{[\text{Rafstar}] \cdot 100}{100} \tag{7}$$

Notes Rafstar%

7 Reactions

This model contains 34 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	reaction_0000001		$R + HRG \rightleftharpoons RHRG$	
2	reaction_0000002		$2\,RHRG \rightleftharpoons RHRG2$	
3	reaction_0000003		$RHRG2 \rightleftharpoons RP$	
4	reaction_0000004		$RP \longrightarrow RHRG2$	
5	reaction_0000005		$RP + Shc \rightleftharpoons RShc$	
6	reaction_0000006		$RShc \rightleftharpoons RShP$	
7	reaction_0000007		$RShP + GS \rightleftharpoons RShGS$	
8	reaction_0000008		$RShGS \rightleftharpoons ShGS + RP$	
9	reaction_0000009		$ShGS \rightleftharpoons GS + ShP$	
10	reaction_0000010		$ShP \longrightarrow Shc$	
11	reaction_0000011		$RasGDP \xrightarrow{ShGS} RasGTP$	

№	Id	Name	Reaction Equation	SBO
12	reaction_0000012		$\mathrm{RasGTP} \longrightarrow \mathrm{RasGDP}$	
13	reaction_0000013		$\mathrm{Raf} \xrightarrow{\mathrm{RasGTP}} \mathrm{Rafstar}$	
14	reaction_0000014		$\mathrm{Rafstar} \xrightarrow{\mathrm{AktPIPP,\ E}} \mathrm{Raf}$	
15	reaction_0000015		$\mathrm{MEK} \xrightarrow{\mathrm{Rafstar}} \mathrm{MEKP}$	
16	reaction_0000016		$\mathrm{MEKP} \xrightarrow{\mathrm{MEKPP,\ AktPIP,\ AktPIPP,\ PP2A}} \mathrm{MEK}$	
17	reaction_0000017		$\mathrm{MEKP} \xrightarrow{\mathrm{MEK,\ Rafstar}} \mathrm{MEKPP}$	
18	reaction_0000018		$\mathrm{MEKPP} \xrightarrow{\mathrm{AktPIP,\ AktPIPP,\ PP2A}} \mathrm{MEKP}$	
19	reaction_0000019		$\mathrm{ERK} \xrightarrow{\mathrm{MEKPP}} \mathrm{ERKP}$	
20	reaction_0000020		$\mathrm{ERKP} \xrightarrow{\mathrm{ERKPP,\ MKP3}} \mathrm{ERK}$	
21	reaction_0000021		$\mathrm{ERKP} \xrightarrow{\mathrm{MEKPP,\ ERK}} \mathrm{ERKPP}$	
22	reaction_0000022		$\mathrm{ERKPP} \xrightarrow{\mathrm{MKP3}} \mathrm{ERKP}$	
23	reaction_0000023		$\mathrm{RP} + \mathrm{PI3K} \rightleftharpoons \mathrm{RPI3K}$	

№	Id	Name	Reaction Equation	SBO
24	reaction_0000024		$\mathrm{RPI3K} \rightleftharpoons \mathrm{RPI3Kstar}$	
25	reaction_0000025		$\mathrm{RPI3Kstar} \rightleftharpoons \mathrm{RP} + \mathrm{PI3Kstar}$	
26	reaction_0000026		$\mathrm{PI3Kstar} \longrightarrow \mathrm{PI3K}$	
27	reaction_0000029		$\mathrm{PIP3} + \mathrm{Akt} \rightleftharpoons \mathrm{AktPIP3}$	
28	reaction_0000028		$\mathrm{PIP3} \longrightarrow \mathrm{P\_I}$	
29	reaction_0000027		$\mathrm{P\_I} \xrightarrow{\mathrm{PI3Kstar}} \mathrm{PIP3}$	
30	reaction_0000030		$\mathrm{AktPIP3} \longrightarrow \mathrm{AktPIP}$	
31	reaction_0000031		$\mathrm{AktPIP} \xrightarrow{\mathrm{MEKP,\ MEKPP,\ AktPIPP,\ PP2A}} \mathrm{AktPIP3}$	
32	reaction_0000032		$\mathrm{AktPIP} \xrightarrow{\mathrm{AktPIP3}} \mathrm{AktPIPP}$	
33	reaction_0000033		$\mathrm{AktPIPP} \xrightarrow{\mathrm{MEKP,\ MEKPP,\ PP2A}} \mathrm{AktPIP}$	
34	reaction_0000034		$\mathrm{RP} \rightleftharpoons \mathrm{internalization}$	

7.1 Reaction reaction_0000001

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

Reaction equation

$$\mathrm{R} + \mathrm{HRG} \rightleftharpoons \mathrm{RHRG} \tag{8}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
R		
HRG		

Product

Table 7: Properties of each product.

Id	Name	SBO
RHRG		

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k1} \cdot [\mathrm{R}] \cdot [\mathrm{HRG}] - \mathrm{k\_1} \cdot [\mathrm{RHRG}]\right) \tag{9}$$

7.2 Reaction reaction_0000002

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

Reaction equation

$$2\,\mathrm{RHRG} \rightleftharpoons \mathrm{RHRG2} \tag{10}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
RHRG		

Product

Table 9: Properties of each product.

Id	Name	SBO
RHRG2		

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k2} \cdot [\mathrm{RHRG}]^2 - \mathrm{k\_2} \cdot [\mathrm{RHRG2}]\right) \tag{11}$$

7.3 Reaction reaction_0000003

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

Reaction equation

$$\mathrm{RHRG2} \rightleftharpoons \mathrm{RP} \tag{12}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
RHRG2		

Product

Table 11: Properties of each product.

Id	Name	SBO
RP		

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k3} \cdot [\mathrm{RHRG2}] - \mathrm{k\_3} \cdot [\mathrm{RP}]\right) \tag{13}$$

7.4 Reaction reaction_0000004

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

Reaction equation

$$\mathrm{RP} \longrightarrow \mathrm{RHRG2} \tag{14}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
RP		

Product

Table 13: Properties of each product.

Id	Name	SBO
RHRG2		

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{V4} \cdot [\mathrm{RP}]}{\mathrm{K4} + [\mathrm{RP}]} \tag{15}$$

7.5 Reaction reaction_0000005

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

Reaction equation

$$\mathrm{RP} + \mathrm{Shc} \rightleftharpoons \mathrm{RShc} \tag{16}$$

Reactants

Table 14: Properties of each reactant.

Id	Name	SBO
RP		

Id	Name	SBO
Shc		

Product

Table 15: Properties of each product.

Id	Name	SBO
RShc		

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k5} \cdot [\mathrm{RP}] \cdot [\mathrm{Shc}] - \mathrm{k\_5} \cdot [\mathrm{RShc}]\right) \tag{17}$$

7.6 Reaction reaction_0000006

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

Reaction equation

$$\mathrm{RShc} \rightleftharpoons \mathrm{RShP} \tag{18}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
RShc		

Product

Table 17: Properties of each product.

Id	Name	SBO
RShP		

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot (\mathrm{k6} \cdot [\mathrm{RShc}] - \mathrm{k\_6} \cdot [\mathrm{RShP}]) \tag{19}$$

7.7 Reaction reaction_0000007

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

Reaction equation

$$\mathrm{RShP} + \mathrm{GS} \rightleftharpoons \mathrm{RShGS} \tag{20}$$

Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
RShP		
GS		

Product

Table 19: Properties of each product.

Id	Name	SBO
RShGS		

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot (\mathrm{k7} \cdot [\mathrm{RShP}] \cdot [\mathrm{GS}] - \mathrm{k\_7} \cdot [\mathrm{RShGS}]) \tag{21}$$

7.8 Reaction reaction_0000008

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

Reaction equation

$$\mathrm{RShGS} \rightleftharpoons \mathrm{ShGS} + \mathrm{RP} \tag{22}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
RShGS		

Products

Table 21: Properties of each product.

Id	Name	SBO
ShGS		
RP		

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k8} \cdot [\mathrm{RShGS}] - \mathrm{k\_8} \cdot [\mathrm{ShGS}] \cdot [\mathrm{RP}]\right) \tag{23}$$

7.9 Reaction reaction_0000009

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

Reaction equation

$$\mathrm{ShGS} \rightleftharpoons \mathrm{GS} + \mathrm{ShP} \tag{24}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
ShGS		

Products

Table 23: Properties of each product.

Id	Name	SBO
GS		
ShP		

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k9} \cdot [\mathrm{ShGS}] - \mathrm{k\_9} \cdot [\mathrm{GS}] \cdot [\mathrm{ShP}]\right) \tag{25}$$

7.10 Reaction `reaction_0000010`

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

Reaction equation

$$\mathrm{ShP} \longrightarrow \mathrm{Shc} \tag{26}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
ShP		

Product

Table 25: Properties of each product.

Id	Name	SBO
Shc		

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{V10} \cdot [\mathrm{ShP}]}{\mathrm{K10} + [\mathrm{ShP}]} \tag{27}$$

7.11 Reaction `reaction_0000011`

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

Reaction equation

$$\mathrm{RasGDP} \xrightarrow{\mathrm{ShGS}} \mathrm{RasGTP} \tag{28}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
RasGDP		

Modifier

Table 27: Properties of each modifier.

Id	Name	SBO
ShGS		

Product

Table 28: Properties of each product.

Id	Name	SBO
RasGTP		

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \frac{\mathrm{k11} \cdot [\mathrm{ShGS}] \cdot [\mathrm{RasGDP}]}{\mathrm{K11} + [\mathrm{RasGDP}]} \tag{29}$$

7.12 Reaction reaction_0000012

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

Reaction equation

$$\mathrm{RasGTP} \longrightarrow \mathrm{RasGDP} \tag{30}$$

Reactant

Table 29: Properties of each reactant.

Id	Name	SBO
RasGTP		

Product

Table 30: Properties of each product.

Id	Name	SBO
RasGDP		

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \frac{\mathrm{V12} \cdot [\mathrm{RasGTP}]}{\mathrm{K12} + [\mathrm{RasGTP}]} \tag{31}$$

7.13 Reaction reaction_0000013

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

Reaction equation

$$\mathrm{Raf} \xrightarrow{\mathrm{RasGTP}} \mathrm{Rafstar} \tag{32}$$

Reactant

Table 31: Properties of each reactant.

Id	Name	SBO
Raf		

Modifier

Table 32: Properties of each modifier.

Id	Name	SBO
RasGTP		

Product

Table 33: Properties of each product.

Id	Name	SBO
Rafstar		

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \frac{\mathrm{k13} \cdot [\mathrm{RasGTP}] \cdot [\mathrm{Raf}]}{\mathrm{K13} + [\mathrm{Raf}]} \tag{33}$$

7.14 Reaction reaction_0000014

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

Reaction equation

$$\mathrm{Rafstar} \xrightarrow{\mathrm{AktPIPP,\ E}} \mathrm{Raf} \tag{34}$$

Reactant

Table 34: Properties of each reactant.

Id	Name	SBO
Rafstar		

Modifiers

Table 35: Properties of each modifier.

Id	Name	SBO
AktPIPP		
E		

Product

Table 36: Properties of each product.

Id	Name	SBO
Raf		

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \frac{\mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot \mathrm{k14} \cdot ([\mathrm{AktPIPP}] + [\mathrm{E}]) \cdot [\mathrm{Rafstar}]}{\mathrm{K14} + [\mathrm{Rafstar}]} \tag{35}$$

7.15 Reaction reaction_0000015

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

Reaction equation

$$\mathrm{MEK} \xrightarrow{\mathrm{Rafstar}} \mathrm{MEKP} \tag{36}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
MEK		

Modifier

Table 38: Properties of each modifier.

Id	Name	SBO
Rafstar		

Product

Table 39: Properties of each product.

Id	Name	SBO
MEKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k15} \cdot [\mathrm{Rafstar}] \cdot [\mathrm{MEK}]}{\mathrm{K15} \cdot \left(1 + \frac{[\mathrm{MEKP}]}{\mathrm{K17}}\right) + [\mathrm{MEK}]} \tag{37}$$

7.16 Reaction `reaction_0000016`

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

Reaction equation

$$\mathrm{MEKP} \xrightarrow{\mathrm{MEKPP,\ AktPIP,\ AktPIPP,\ PP2A}} \mathrm{MEK} \tag{38}$$

Reactant

Table 40: Properties of each reactant.

Id	Name	SBO
MEKP		

Modifiers

Table 41: Properties of each modifier.

Id	Name	SBO
MEKPP		
AktPIP		
AktPIPP		
PP2A		

Product

Table 42: Properties of each product.

Id	Name	SBO
MEK		

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k16} \cdot [\mathrm{PP2A}] \cdot [\mathrm{MEKP}]}{\mathrm{K16} \cdot \left(1 + \frac{[\mathrm{MEKPP}]}{\mathrm{K18}} + \frac{[\mathrm{AktPIP}]}{\mathrm{K31}} + \frac{[\mathrm{AktPIPP}]}{\mathrm{K33}}\right) + [\mathrm{MEKP}]} \tag{39}$$

7.17 Reaction `reaction_0000017`

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

Reaction equation

$$\mathrm{MEKP} \xrightarrow{\mathrm{MEK,\ Rafstar}} \mathrm{MEKPP} \tag{40}$$

Reactant

Table 43: Properties of each reactant.

Id	Name	SBO
MEKP		

Modifiers

Table 44: Properties of each modifier.

Id	Name	SBO
MEK		
Rafstar		

Product

Table 45: Properties of each product.

Id	Name	SBO
MEKPP		

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k17} \cdot [\mathrm{Rafstar}] \cdot [\mathrm{MEKP}]}{\mathrm{K17} \cdot \left(1 + \frac{[\mathrm{MEK}]}{\mathrm{K15}}\right) + [\mathrm{MEKP}]} \tag{41}$$

7.18 Reaction `reaction_0000018`

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

Reaction equation

$$\mathrm{MEKPP} \xrightarrow{\mathrm{AktPIP,\ AktPIPP,\ PP2A}} \mathrm{MEKP} \tag{42}$$

Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
MEKPP		

Modifiers

Table 47: Properties of each modifier.

Id	Name	SBO
AktPIP		
AktPIPP		
PP2A		

Product

Table 48: Properties of each product.

Id	Name	SBO
MEKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k18} \cdot [\mathrm{PP2A}] \cdot [\mathrm{MEKPP}]}{\mathrm{K18} \cdot \left(1 + \frac{[\mathrm{MEKP}]}{\mathrm{K16}} + \frac{[\mathrm{AktPIPP}]}{\mathrm{K31}} + \frac{[\mathrm{AktPIPP}]}{\mathrm{K33}}\right) + [\mathrm{MEKPP}]} \tag{43}$$

7.19 Reaction reaction_0000019

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

Reaction equation

$$\mathrm{ERK} \xrightarrow{\mathrm{MEKPP}} \mathrm{ERKP} \tag{44}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
ERK		

Modifier

Table 50: Properties of each modifier.

Id	Name	SBO
MEKPP		

Product

Table 51: Properties of each product.

Id	Name	SBO
ERKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k19} \cdot [\mathrm{MEKPP}] \cdot [\mathrm{ERK}]}{\mathrm{K19} \cdot \left(1 + \frac{[\mathrm{ERKP}]}{\mathrm{K21}}\right) + [\mathrm{ERK}]} \tag{45}$$

7.20 Reaction reaction_0000020

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

Reaction equation

$$\text{ERKP} \xrightarrow{\text{ERKPP, MKP3}} \text{ERK} \tag{46}$$

Reactant

Table 52: Properties of each reactant.

Id	Name	SBO
ERKP		

Modifiers

Table 53: Properties of each modifier.

Id	Name	SBO
ERKPP		
MKP3		

Product

Table 54: Properties of each product.

Id	Name	SBO
ERK		

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \frac{\text{vol}\left(\text{compartment\_0000001}\right) \cdot \text{k20} \cdot [\text{MKP3}] \cdot [\text{ERKP}]}{\text{K20} \cdot \left(1 + \frac{[\text{ERKPP}]}{\text{K22}}\right) + [\text{ERKP}]} \tag{47}$$

7.21 Reaction reaction_0000021

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

Reaction equation

$$\text{ERKP} \xrightarrow{\text{MEKPP, ERK}} \text{ERKPP} \tag{48}$$

Reactant

Table 55: Properties of each reactant.

Id	Name	SBO
ERKP		

Modifiers

Table 56: Properties of each modifier.

Id	Name	SBO
MEKPP		
ERK		

Product

Table 57: Properties of each product.

Id	Name	SBO
ERKPP		

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k21} \cdot [\mathrm{MEKPP}] \cdot [\mathrm{ERKP}]}{\mathrm{K21} \cdot \left(1 + \frac{[\mathrm{ERK}]}{\mathrm{K19}}\right) + [\mathrm{ERKP}]} \tag{49}$$

7.22 Reaction reaction_0000022

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

Reaction equation

$$\mathrm{ERKPP} \xrightarrow{\mathrm{MKP3}} \mathrm{ERKP} \tag{50}$$

Reactant

Table 58: Properties of each reactant.

Id	Name	SBO
ERKPP		

Modifier

Table 59: Properties of each modifier.

Id	Name	SBO
MKP3		

Product

Table 60: Properties of each product.

Id	Name	SBO
ERKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k22} \cdot [\mathrm{MKP3}] \cdot [\mathrm{ERKPP}]}{\mathrm{K22} \cdot \left(1 + \frac{[\mathrm{ERKP}]}{\mathrm{K20}}\right) + [\mathrm{ERKPP}]} \tag{51}$$

7.23 Reaction reaction_0000023

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

Reaction equation

$$\mathrm{RP} + \mathrm{PI3K} \rightleftharpoons \mathrm{RPI3K} \tag{52}$$

Reactants

Table 61: Properties of each reactant.

Id	Name	SBO
RP		
PI3K		

Product

Table 62: Properties of each product.

Id	Name	SBO
RPI3K		

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot (\mathrm{k23} \cdot [\mathrm{RP}] \cdot [\mathrm{PI3K}] - \mathrm{k\_23} \cdot [\mathrm{RPI3K}]) \tag{53}$$

7.24 Reaction reaction_0000024

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

Reaction equation

$$\mathrm{RPI3K} \rightleftharpoons \mathrm{RPI3Kstar} \tag{54}$$

Reactant

Table 63: Properties of each reactant.

Id	Name	SBO
RPI3K		

Product

Table 64: Properties of each product.

Id	Name	SBO
RPI3Kstar		

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \mathrm{vol}\,(\mathrm{compartment\_0000001}) \cdot (\mathrm{k24} \cdot [\mathrm{RPI3K}] - \mathrm{k\_24} \cdot [\mathrm{RPI3Kstar}]) \tag{55}$$

7.25 Reaction reaction_0000025

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

Reaction equation

$$\text{RPI3Kstar} \rightleftharpoons \text{RP} + \text{PI3Kstar} \tag{56}$$

Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
RPI3Kstar		

Products

Table 66: Properties of each product.

Id	Name	SBO
RP		
PI3Kstar		

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{vol}\left(\text{compartment\_0000001}\right) \cdot \left(\text{k25} \cdot [\text{RPI3Kstar}] - \text{k\_25} \cdot [\text{RP}] \cdot [\text{PI3Kstar}]\right) \tag{57}$$

7.26 Reaction reaction_0000026

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

Reaction equation

$$\text{PI3Kstar} \longrightarrow \text{PI3K} \tag{58}$$

Reactant

Table 67: Properties of each reactant.

Id	Name	SBO
PI3Kstar		

Product

Table 68: Properties of each product.

Id	Name	SBO
PI3K		

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{V26} \cdot [\mathrm{PI3Kstar}]}{\mathrm{K26} + [\mathrm{PI3Kstar}]} \tag{59}$$

7.27 Reaction reaction_0000029

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

Reaction equation

$$\mathrm{PIP3} + \mathrm{Akt} \rightleftharpoons \mathrm{AktPIP3} \tag{60}$$

Reactants

Table 69: Properties of each reactant.

Id	Name	SBO
PIP3		
Akt		

Product

Table 70: Properties of each product.

Id	Name	SBO
AktPIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k29} \cdot [\mathrm{PIP3}] \cdot [\mathrm{Akt}] - \mathrm{k\_29} \cdot [\mathrm{AktPIP3}]\right) \tag{61}$$

7.28 Reaction reaction_0000028

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

Reaction equation

$$\mathrm{PIP3} \longrightarrow \mathrm{P\_I} \tag{62}$$

Reactant

Table 71: Properties of each reactant.

Id	Name	SBO
PIP3		

Product

Table 72: Properties of each product.

Id	Name	SBO
P_I		

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \frac{\mathrm{V28} \cdot [\mathrm{PIP3}]}{\mathrm{K28} + [\mathrm{PIP3}]} \tag{63}$$

7.29 Reaction reaction_0000027

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

Reaction equation

$$\mathrm{P\_I} \xrightarrow{\mathrm{PI3Kstar}} \mathrm{PIP3} \tag{64}$$

Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
P_I		

Modifier

Table 74: Properties of each modifier.

Id	Name	SBO
PI3Kstar		

Product

Table 75: Properties of each product.

Id	Name	SBO
PIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k27} \cdot [\mathrm{PI3Kstar}] \cdot [\mathrm{P\_I}]}{\mathrm{K27} + [\mathrm{P\_I}]} \tag{65}$$

7.30 Reaction reaction_0000030

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

Reaction equation

$$\mathrm{AktPIP3} \longrightarrow \mathrm{AktPIP} \tag{66}$$

Reactant

Table 76: Properties of each reactant.

Id	Name	SBO
AktPIP3		

Product

Table 77: Properties of each product.

Id	Name	SBO
AktPIP		

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{V30} \cdot [\mathrm{AktPIP3}]}{\mathrm{K30} \cdot \left(1 + \frac{[\mathrm{AktPIP}]}{\mathrm{K32}}\right) + [\mathrm{AktPIP3}]} \tag{67}$$

7.31 Reaction reaction_0000031

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

Reaction equation

$$\mathrm{AktPIP} \xrightarrow{\mathrm{MEKP,\ MEKPP,\ AktPIPP,\ PP2A}} \mathrm{AktPIP3} \tag{68}$$

Reactant

Table 78: Properties of each reactant.

Id	Name	SBO
AktPIP		

Modifiers

Table 79: Properties of each modifier.

Id	Name	SBO
MEKP		
MEKPP		
AktPIPP		
PP2A		

Product

Table 80: Properties of each product.

Id	Name	SBO
AktPIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k31} \cdot [\mathrm{PP2A}] \cdot [\mathrm{AktPIP}]}{\mathrm{K31} \cdot \left(1 + \frac{[\mathrm{MEKP}]}{\mathrm{K16}} + \frac{[\mathrm{MEKPP}]}{\mathrm{K18}} + \frac{[\mathrm{AktPIPP}]}{\mathrm{K33}}\right) + [\mathrm{AktPIP}]} \tag{69}$$

7.32 Reaction reaction_0000032

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

Reaction equation

$$\mathrm{AktPIP} \xrightarrow{\mathrm{AktPIP3}} \mathrm{AktPIPP} \tag{70}$$

Reactant

Table 81: Properties of each reactant.

Id	Name	SBO
AktPIP		

Modifier

Table 82: Properties of each modifier.

Id	Name	SBO
AktPIP3		

Product

Table 83: Properties of each product.

Id	Name	SBO
AktPIPP		

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{V32} \cdot [\mathrm{AktPIP}]}{\mathrm{K32} \cdot \left(1 + \frac{[\mathrm{AktPIP3}]}{\mathrm{K30}}\right) + [\mathrm{AktPIP}]} \tag{71}$$

7.33 Reaction `reaction_0000033`

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

Reaction equation

$$\mathrm{AktPIPP} \xrightarrow{\mathrm{MEKP,\ MEKPP,\ PP2A}} \mathrm{AktPIP} \tag{72}$$

Reactant

Table 84: Properties of each reactant.

Id	Name	SBO
AktPIPP		

Modifiers

Table 85: Properties of each modifier.

Id	Name	SBO
MEKP		
MEKPP		
PP2A		

Product

Table 86: Properties of each product.

Id	Name	SBO
AktPIP		

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \frac{\mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \mathrm{k33} \cdot [\mathrm{PP2A}] \cdot [\mathrm{AktPIPP}]}{\mathrm{K33} \cdot \left(1 + \frac{[\mathrm{MEKP}]}{\mathrm{K16}} + \frac{[\mathrm{MEKPP}]}{\mathrm{K18}} + \frac{[\mathrm{AktPIP}]}{\mathrm{K31}}\right) + [\mathrm{AktPIPP}]} \tag{73}$$

7.34 Reaction `reaction_0000034`

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

Reaction equation

$$\mathrm{RP} \rightleftharpoons \mathrm{internalization} \tag{74}$$

Reactant

Table 87: Properties of each reactant.

Id	Name	SBO
RP		

Product

Table 88: Properties of each product.

Id	Name	SBO
internalization		

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \mathrm{vol}\left(\mathrm{compartment\_0000001}\right) \cdot \left(\mathrm{k34} \cdot [\mathrm{RP}] - \mathrm{k\_34} \cdot [\mathrm{internalization}]\right) \tag{75}$$

8 Derived Rate Equations

When interpreted as an ordinary differential equation framework, this model implies the following set of equations for the rates of change of each species.

Identifiers for kinetic laws highlighted in gray cannot be verified to evaluate to units of SBML `substance` per `time`. As a result, some SBML interpreters may not be able to verify the consistency of the units on quantities in the model. Please check if

- parameters without an unit definition are involved or
- volume correction is necessary because the `hasOnlySubstanceUnits` flag may be set to `false` and `spacialDimensions`> 0 for certain species.

8.1 Species Akt

Initial concentration $10\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a reactant in reaction_0000029).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt} = -v_{27} \tag{76}$$

8.2 Species AktPIP3

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

This species takes part in four reactions (as a reactant in reaction_0000030 and as a product in reaction_0000029, reaction_0000031 and as a modifier in reaction_0000032).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AktPIP3} = v_{27} + v_{31} - v_{30} \tag{77}$$

8.3 Species AktPIP

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

This species takes part in six reactions (as a reactant in reaction_0000031, reaction_0000032 and as a product in reaction_0000030, reaction_0000033 and as a modifier in reaction_0000016, reaction_0000018).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AktPIP} = v_{30} + v_{33} - v_{31} - v_{32} \tag{78}$$

8.4 Species AktPIPP

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

This species takes part in six reactions (as a reactant in reaction_0000033 and as a product in reaction_0000032 and as a modifier in reaction_0000014, reaction_0000016, reaction_0000018, reaction_0000031).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AktPIPP} = v_{32} - v_{33} \tag{79}$$

8.5 Species ERK

Initial concentration $1000\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_0000019 and as a product in reaction_0000020 and as a modifier in reaction_0000021).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ERK} = v_{20} - v_{19} \tag{80}$$

8.6 Species ERKP

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

This species takes part in four reactions (as a reactant in reaction_0000020, reaction_0000021 and as a product in reaction_0000019, reaction_0000022).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ERKP} = v_{19} + v_{22} - v_{20} - v_{21} \tag{81}$$

8.7 Species ERKPP

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

This species takes part in three reactions (as a reactant in reaction_0000022 and as a product in reaction_0000021 and as a modifier in reaction_0000020).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ERKPP} = v_{21} - v_{22} \tag{82}$$

8.8 Species GS

Initial concentration $10\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in reaction_0000007 and as a product in reaction_0000009).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GS} = v_{9} - v_{7} \tag{83}$$

8.9 Species HRG

Notes The value comes from the author of the paper

Initial concentration $330\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a reactant in reaction_0000001).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{HRG} = -v_{1} \tag{84}$$

8.10 Species MEK

Initial concentration $120\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in reaction_0000015 and as a product in reaction_0000016 and as a modifier in reaction_0000017).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEK} = v_{16} - v_{15} \tag{85}$$

8.11 Species MEKP

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

This species takes part in six reactions (as a reactant in reaction_0000016, reaction_0000017 and as a product in reaction_0000015, reaction_0000018 and as a modifier in reaction_0000031, reaction_0000033).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEKP} = v_{15} + v_{18} - v_{16} - v_{17} \tag{86}$$

8.12 Species MEKPP

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

This species takes part in seven reactions (as a reactant in reaction_0000018 and as a product in reaction_0000017 and as a modifier in reaction_0000016, reaction_0000019, reaction_0000021, reaction_0000031, reaction_0000033).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEKPP} = v_{17} - v_{18} \tag{87}$$

8.13 Species PI3K

Initial concentration $10\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in reaction_0000023 and as a product in reaction_0000026).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3K} = v_{26} - v_{23} \tag{88}$$

8.14 Species PI3Kstar

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

This species takes part in three reactions (as a reactant in reaction_0000026 and as a product in reaction_0000025 and as a modifier in reaction_0000027).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3Kstar} = v_{25} - v_{26} \tag{89}$$

8.15 Species PIP3

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

This species takes part in three reactions (as a reactant in reaction_0000029, reaction_0000028 and as a product in reaction_0000027).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PIP3} = v_{29} - v_{27} - v_{28} \tag{90}$$

8.16 Species R

Initial concentration $80\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a reactant in reaction_0000001).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R} = -v_1 \tag{91}$$

8.17 Species RP

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

This species takes part in seven reactions (as a reactant in reaction_0000004, reaction_0000005, reaction_0000023, reaction_0000034 and as a product in reaction_0000003, reaction_0000008, reaction_0000025).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RP} = v_3 + v_8 + v_{25} - v_4 - v_5 - v_{23} - v_{34} \tag{92}$$

8.18 Species RHRG

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

This species takes part in two reactions (as a reactant in reaction_0000002 and as a product in reaction_0000001).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RHRG} = v_1 - 2\,v_2 \tag{93}$$

8.19 Species RHRG2

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

This species takes part in three reactions (as a reactant in reaction_0000003 and as a product in reaction_0000002, reaction_0000004).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RHRG2} = v_2 + v_4 - v_3 \tag{94}$$

8.20 Species RPI3K

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

This species takes part in two reactions (as a reactant in reaction_0000024 and as a product in reaction_0000023).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RPI3K} = v_{23} - v_{24} \tag{95}$$

8.21 Species RPI3Kstar

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

This species takes part in two reactions (as a reactant in reaction_0000025 and as a product in reaction_0000024).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RPI3Kstar} = v_{24} - v_{25} \tag{96}$$

8.22 Species RShGS

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

This species takes part in two reactions (as a reactant in reaction_0000008 and as a product in reaction_0000007).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RShGS} = v_{7} - v_{8} \tag{97}$$

8.23 Species RShP

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

This species takes part in two reactions (as a reactant in reaction_0000007 and as a product in reaction_0000006).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RShP} = v_{6} - v_{7} \tag{98}$$

8.24 Species RShc

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

This species takes part in two reactions (as a reactant in reaction_0000006 and as a product in reaction_0000005).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RShc} = v_{5} - v_{6} \tag{99}$$

8.25 Species Raf

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

This species takes part in two reactions (as a reactant in reaction_0000013 and as a product in reaction_0000014).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Raf} = v_{14} - v_{13} \tag{100}$$

8.26 Species Rafstar

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

This species takes part in four reactions (as a reactant in reaction_0000014 and as a product in reaction_0000013 and as a modifier in reaction_0000015, reaction_0000017).

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

8.27 Species RasGDP

Initial concentration $120\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in reaction_0000011 and as a product in reaction_0000012).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RasGDP} = v_{12} - v_{11} \tag{102}$$

8.28 Species RasGTP

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

This species takes part in three reactions (as a reactant in reaction_0000012 and as a product in reaction_0000011 and as a modifier in reaction_0000013).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RasGTP} = v_{11} - v_{12} \tag{103}$$

8.29 Species ShGS

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

This species takes part in three reactions (as a reactant in reaction_0000009 and as a product in reaction_0000008 and as a modifier in reaction_0000011).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ShGS} = v_{8} - v_{9} \tag{104}$$

8.30 Species ShP

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

This species takes part in two reactions (as a reactant in reaction_0000010 and as a product in reaction_0000009).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ShP} = v_{9} - v_{10} \tag{105}$$

8.31 Species Shc

Initial concentration $1000\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in reaction_0000005 and as a product in reaction_0000010).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Shc} = v_{10} - v_5 \tag{106}$$

8.32 Species P_I

Initial concentration $800\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in reaction_0000027 and as a product in reaction_0000028).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{P\_I} = v_{28} - v_{29} \tag{107}$$

8.33 Species internalization

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

This species takes part in one reaction (as a product in reaction_0000034).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{internalization} = v_{34} \tag{108}$$

8.34 Species E

Initial concentration $7\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a modifier in reaction_0000014).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E} = 0 \tag{109}$$

8.35 Species MKP3

Initial concentration $2.4\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a modifier in reaction_0000020, reaction_0000022).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MKP3} = 0 \tag{110}$$

8.36 Species PP2A

Initial concentration $11.4\ \mathrm{nmol \cdot l^{-1}}$

This species takes part in four reactions (as a modifier in reaction_0000016, reaction_0000018, reaction_0000031, reaction_0000033).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PP2A} = 0 \tag{111}$$

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