SBML Model Report

Model name: “Faratian2009 - Role of PTEN in Trastuzumab resistance”

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Stuart Moodie[2] at August 18th 2011 at 12:13 a. m. and last time modified at October nineth 2014 at 5:39 p. m. Table 1 gives an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	55
events	0	constraints	0
reactions	58	function definitions	0
global parameters	114	unit definitions	0
rules	5	initial assignments	0

Model Notes

Faratian2009 - Role of PTEN in Trastuzumabresistance

This model is described in the article:Systems biology reveals new strategies for personalizing cancer medicine and confirms the role of PTEN in resistance to trastuzumab.Faratian D,

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Goltsov A, Lebedeva G, Sorokin A, Moodie S, Mullen P, Kay C, Um IH, Langdon S, Goryanin I, Harrison DJ.Cancer Res. 2009 Aug; 69(16): 6713-6720

Abstract:

Resistance to targeted cancer therapies such as trastuzumab is a frequent clinical problem not solely because of insufficient expression of HER2 receptor but also because of the overriding activation states of cell signaling pathways. Systems biology approaches lend themselves to rapid in silico testing of factors, which may confer resistance to targeted therapies. Inthis study, we aimed to develop a new kinetic model that could be interrogated to predict resistance to receptor tyrosine kinase (RTK) inhibitor therapies and directly test predictions in vitro and in clinical samples. The new mathematical model included RTK inhibitor antibody binding, HER2/HER3 dimerization and inhibition, AKT/mitogen-activated protein kinase cross-talk, and the regulatory properties of PTEN. The model was parameterized using quantitative phosphoprotein expression data from cancer cell lines using reverse-phase protein microarrays. Quantitative PTEN protein expression was found to be the key determinant of resistance to anti-HER2 therapy in silico, which was predictive of unseen experiments in vitro using the PTEN inhibitor bp(V). When measured in cancer cell lines, PTEN expression predicts sensitivity to anti-HER2 therapy; furthermore, this quantitative measurement is more predictive of response (relative risk, 3.0; 95% confidence interval, 1.6-5.5; $P < 0.0001$) than other pathway components taken in isolation and when tested by multivariate analysis in a cohort of 122 breast cancers treated with trastuzumab. For the first time, a systems biology approach has successfully been used to stratify patients for personalized therapy in cancer and is further compelling evidence that PTEN, appropriately measured in the clinical setting, refines clinical decision making in patients treated with anti-HER2 therapies.

This model is hosted on BioModels Database and identified by: BIOMD0000000424.

To cite BioModels Database, please use: BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models.

2 Unit Definitions

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

2.1 Unit `substance`

Notes Mole is the predefined SBML unit for `substance`.

Definition mol

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
`Default`		0000410	3	1	litre	⊟	

3.1 Compartment `Default`

This is a three dimensional compartment with a not constant size of one litre.

SBO:0000410 implicit compartment

4 Species

This model contains 55 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
E3		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PI3K_LY		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E3H		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E2		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E23H		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E23HP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Shc		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E23HP_Shc		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E23HP_ShcP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
GS		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E23HP_ShGS		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E2_Per		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PTEN_bpV		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RasGDP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PI3Ka_PIP3		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Raf		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
E23H_C		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEK		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEKP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PP2A		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEKP_PP2A		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
MEK_PP2A		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
Akt_PIP3_PP2A		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
MEKPP_PP2A		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
ERK		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
ERKP		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
E3H_C		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PI3K		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
E23HP_PI3K		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Akt_PIP3		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PI3Ka		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PI2		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Akt_PI_P_PP2A		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PTEN		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PIP3		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PTEN_PIP3		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PTEN_PI		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PTENP		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PTENP_PTEN		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Akt_PI_P		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Akt		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
E23HP_PI3Ka		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PTEN_PTEN		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
PI3Ka_PI		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
MEKPP		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Akt_PI_PP		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Akt_PI_PP_PP2A		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
Per		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟
ShGS		Default	$\mathrm{mol}\cdot\mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
E2Per		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ERKPP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Rafa		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
RasGTP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
ShcP		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
HRG		Default	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 114 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
mu			0.000		☐
scal			1.000		☐
scall			0.600		☐
scalll			30.000		☐
tE3P_max			65.000		☐
tERKP_max			10.000		☐
pAkt_max			91.000		☐
E3_0			0.000		☐
PI0			70.000		☐
Akt0			10.000		☐
bpV			0.000		☐
LY			0.000		☐
PI3K_CY			0.000		☐
k1			0.005		☐
Kd_1			600.000		☐
k2			10.000		☐
Kd_2			10.000		☐
k51			0.010		☐
k53			0.010		☐
k3			1.000		☐
Kd_3			0.100		☐
V4			10.000		☐
K4			50.000		☐
k5			0.060		☐
Kd_5			1.000		☐
k6			12.000		☐
k_6			3.000		☐
k7			36.000		☐
Kd_7			9.000		☐
k8			12.000		☐
Kd_8			0.100		☐
k9			35.000		☐
k_9			0.000		☐
V10			0.015		☐
K10			340.000		☐
k27			3.000		☐
Kd_27			1.000		☐

Id	Name	SBO	Value	Unit	Constant
k28			300.000		⊟
k_28			0.000		⊟
k29			13520.000		⊟
k_29			0.000		⊟
V30			900.000		⊟
k11			6.000		⊟
K11			0.180		⊟
V12			3.000		⊟
K12			0.100		⊟
k13			1.000		⊟
K13			11.700		⊟
k14			0.600		⊟
K14			50.000		⊟
E_raf			7.000		⊟
k15			2.100		⊟
K15			1.000		⊟
k16			0.060		⊟
Kd_16			1.000		⊟
k16_kat			0.600		⊟
k18			0.600		⊟
k22			0.060		⊟
k23			1.200		⊟
K23			10.000		⊟
V24			1.800		⊟
K24			10.000		⊟
k31			0.030		⊟
K_d31			100.000		⊟
k55			30.000		⊟
k56			30.000		⊟
k32			8000.000		⊟
Kd_32			0.010		⊟
k33			15.000		⊟
k34			3.600		⊟
V35			150.000		⊟
K35			2.000		⊟
k36			1.000		⊟
Kd_36			2.200		⊟
k37			150.000		⊟
k38			150.000		⊟
k39			15000.000		⊟
Kd_39			20.000		⊟
V40			15000.000		⊟

Id	Name	SBO	Value	Unit	Constant
K40			0.100		⊟
k41			3.000		⊟
Kd_41			0.100		⊟
k42			45.000		⊟
k43			30.000		⊟
k47			0.300		⊟
k48			0.001		⊟
k49			0.003		⊟
Kd_49			20000.000		⊟
k50			0.600		⊟
k_50			0.012		⊟
k57			100.000		⊟
Kd_57			10.000		⊟
k58			100.000		⊟
Kd_58			80.000		⊟
tPTEN			0.000		⊟
sens			0.000		⊟
pAkt			0.000		⊟
tE3P			0.000		⊟
tERKP			0.000		⊟
tPTENP			0.000		⊟
Pool_1_			2900.000		⊟
Pool_2_			−2920.000		⊟
Pool_3_			200.000		⊟
Pool_4_			50.000		⊟
Pool_5_			300.000		⊟
Pool_6_			0.000		⊟
Pool_7_			10.000		⊟
Pool_8_			100.000		⊟
Pool_9_			10.000		⊟
Pool_10_			10.000		⊟
Pool_11_			100.000		⊟
Pool_12_			120.000		⊟
Pool_13_			100.000		⊟
Pool_14_			100.000		⊟

6 Rules

This is an overview of five rules.

6.1 Rule tE3P

Rule tE3P is an assignment rule for parameter tE3P:

$$\begin{aligned}&\mathrm{tE3P} \\ &= \frac{[\mathrm{E23HP}] + [\mathrm{E23HP\_PI3K}] + [\mathrm{E23HP\_PI3Ka}] + [\mathrm{E23HP\_Shc}] + [\mathrm{E23HP\_ShcP}] + [\mathrm{E23HP\_ShGS}]}{\mathrm{tE3P\_max}}\end{aligned} \tag{1}$$

6.2 Rule tPTEN

Rule tPTEN is an assignment rule for parameter tPTEN:

$$\mathrm{tPTEN} = [\mathrm{PTENP}] + [\mathrm{PTEN}] + [\mathrm{PTENP\_PTEN}] + [\mathrm{PTEN\_PTEN}] + [\mathrm{PTEN\_PIP3}] + [\mathrm{PTEN\_PI}] \tag{2}$$

Derived unit $\mathrm{mol} \cdot \mathrm{l}^{-1}$

6.3 Rule tPTENP

Rule tPTENP is an assignment rule for parameter tPTENP:

$$\mathrm{tPTENP} = \frac{[\mathrm{PTENP}]}{7.6} \tag{3}$$

6.4 Rule pAkt

Rule pAkt is an assignment rule for parameter pAkt:

$$\mathrm{pAkt} = \frac{[\mathrm{Akt\_PI\_PP}] + [\mathrm{Akt\_PI\_P}] + [\mathrm{Akt\_PI\_PP\_PP2A}] + [\mathrm{Akt\_PI\_P\_PP2A}]}{\mathrm{pAkt\_max}} \tag{4}$$

6.5 Rule tERKP

Rule tERKP is an assignment rule for parameter tERKP:

$$\mathrm{tERKP} = \frac{[\mathrm{ERKP}] + [\mathrm{ERKPP}]}{\mathrm{tERKP\_max}} \tag{5}$$

7 Reactions

This model contains 58 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	R1	R1	$E3 + HRG \longrightarrow E3H$	
2	R2	R2	$E2 + E3H \longrightarrow E23H$	
3	R3	R3	$E23H \longrightarrow E23HP$	
4	R4	R4	$E23HP \longrightarrow E23H$	
5	R5	R5	$E23HP + Shc \longrightarrow E23HP\_Shc$	
6	R6	R6	$E23HP\_Shc \longrightarrow E23HP\_ShcP$	
7	R7	R7	$E23HP\_ShcP + GS \longrightarrow E23HP\_ShGS$	
8	R8	R8	$E23HP\_ShGS \longrightarrow E23HP + ShGS$	
9	R9	R9	$ShGS \longrightarrow GS + ShcP$	
10	R10	R10	$ShcP \longrightarrow Shc$	
11	R11	R11	$RasGDP \xrightarrow{ShGS} RasGTP$	
12	R12	R12	$RasGTP \longrightarrow RasGDP$	
13	R13	R13	$Raf \xrightarrow{RasGTP} Rafa$	
14	R14	R14	$Rafa \xrightarrow{Akt\_PI\_PP} Raf$	
15	R15	R15	$MEK \xrightarrow{Rafa} MEKP$	
16	R16_1	R16_1	$MEKP + PP2A \longrightarrow MEKP\_PP2A$	
17	R16_2	R16_2	$MEKP\_PP2A \longrightarrow MEK\_PP2A$	
18	R16_3	R16_3	$MEK\_PP2A \longrightarrow MEK + PP2A$	
19	R17_1	R17_1	$MEKP \xrightarrow{Rafa} MEKPP$	
20	R18_1	R18_1	$MEKPP + PP2A \longrightarrow MEKPP\_PP2A$	
21	R18_2	R18_2	$MEKPP\_PP2A \longrightarrow MEKP\_PP2A$	

№	Id	Name	Reaction Equation	SBO
22	R18_3	R18_3	MEKP_PP2A $\longrightarrow$ MEKP + PP2A	
23	R19	R19	ERK $\xrightarrow{\text{MEKPP}}$ ERKP	
24	R20	R20	ERKP $\longrightarrow$ ERK	
25	R21	R21	ERKP $\xrightarrow{\text{MEKPP}}$ ERKPP	
26	R22	R22	ERKPP $\longrightarrow$ ERKP	
27	R23	R23	E23HP + PI3K $\longrightarrow$ E23HP_PI3K	
28	R24	R24	E23HP_PI3K $\longrightarrow$ E23HP_PI3Ka	
29	R25	R25	E23HP_PI3Ka $\longrightarrow$ E23HP + PI3Ka	
30	R26	R26	PI3Ka $\longrightarrow$ PI3K	
31	R27_1	R27_1	PI2 + PI3Ka $\longrightarrow$ PI3Ka_PI	
32	R28_1	R28_1	PIP3 + PTEN $\longrightarrow$ PTEN_PIP3	
33	R28_2	R28_2	PTEN_PIP3 $\longrightarrow$ PTEN_PI	
34	R28_3	R28_3	PTEN_PI $\longrightarrow$ PI2 + PTEN	
35	R28_4	R28_4	PTEN $\longrightarrow$ PTENP	
36	R28_5	R28_5	PTEN + PTENP $\longrightarrow$ PTENP_PTEN	
37	R28_6	R28_6	PTENP_PTEN $\longrightarrow$ PTEN_PTEN	
38	R28_7	R28_7	PTEN_PTEN $\longrightarrow$ 2 PTEN	
39	R29	R29	Akt + PIP3 $\longrightarrow$ Akt_PIP3	
40	R30	R30	Akt_PIP3 $\longrightarrow$ Akt_PI_P	
41	R31_1	R31_1	Akt_PI_P + PP2A $\longrightarrow$ Akt_PI_P_PP2A	
42	R31_2	R31_2	Akt_PI_P_PP2A $\longrightarrow$ Akt_PIP3_PP2A	
43	R31_3	R31_3	Akt_PIP3_PP2A $\longrightarrow$ Akt_PIP3 + PP2A	
44	R32	R32	Akt_PI_P $\longrightarrow$ Akt_PI_PP	
45	R33_1	R33_1	Akt_PI_PP + PP2A $\longrightarrow$ Akt_PI_PP_PP2A	
46	R33_2	R33_2	Akt_PI_PP_PP2A $\longrightarrow$ Akt_PI_P_PP2A	
47	R33_3	R33_3	Akt_PI_P_PP2A $\longrightarrow$ Akt_PI_P + PP2A	
48	R34	R34	E23HP $\longrightarrow \emptyset$	
49	R35	R35	E2 + Per $\longrightarrow$ E2_Per	

№	Id	Name	Reaction Equation	SBO
50	R36	R36	E2_Per $\longrightarrow$ E2Per	
51	R37	R37	E3H $\longrightarrow$ E3H_C	
52	R38	R38	E2 + E3H_C $\longrightarrow$ E23H	
53	R39	R39	E23H $\longrightarrow$ E23H_C	
54	R40	R40	E23H_C $\longrightarrow$ E23HP	
55	R41	R41	PI3Ka_PI $\longrightarrow$ PI3Ka_PIP3	
56	R42	R42	PI3Ka_PIP3 $\longrightarrow$ PI3Ka + PIP3	
57	R43	R43	PTEN $\longrightarrow$ PTEN_bpV	
58	R44	R44	PI3K $\longrightarrow$ PI3K_LY	

7.1 Reaction R1

This is a fast irreversible reaction of two reactants forming one product.

Name R1

Reaction equation

$$\mathrm{E3} + \mathrm{HRG} \longrightarrow \mathrm{E3H} \tag{6}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
E3		
HRG		

Product

Table 7: Properties of each product.

Id	Name	SBO
E3H		

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{k1} \cdot ([\mathrm{E3}] \cdot [\mathrm{HRG}] - \mathrm{Kd\_1} \cdot [\mathrm{E3H}]) \tag{7}$$

7.2 Reaction R2

This is a fast irreversible reaction of two reactants forming one product.

Name R2

Reaction equation

$$\mathrm{E2} + \mathrm{E3H} \longrightarrow \mathrm{E23H} \tag{8}$$

Reactants

Table 8: Properties of each reactant.

Id	Name	SBO
E2		
E3H		

Product

Table 9: Properties of each product.

Id	Name	SBO
E23H		

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{k2} \cdot ([\mathrm{E3H}] \cdot [\mathrm{E2}] - \mathrm{Kd\_2} \cdot [\mathrm{E23H}]) \tag{9}$$

7.3 Reaction R3

This is a fast irreversible reaction of one reactant forming one product.

Name R3

Reaction equation

$$\mathrm{E23H} \longrightarrow \mathrm{E23HP} \tag{10}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
E23H		

Product

Table 11: Properties of each product.

Id	Name	SBO
E23HP		

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{k3} \cdot (\mathrm{[E23H]} - \mathrm{Kd\_3} \cdot \mathrm{[E23HP]}) \tag{11}$$

7.4 Reaction R4

This is a fast irreversible reaction of one reactant forming one product.

Name R4

Reaction equation

$$\mathrm{E23HP} \longrightarrow \mathrm{E23H} \tag{12}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
E23HP		

Product

Table 13: Properties of each product.

Id	Name	SBO
E23H		

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \frac{\mathrm{V4} \cdot \mathrm{[E23HP]}}{\mathrm{K4} + \mathrm{[E23HP]}} \tag{13}$$

7.5 Reaction R5

This is a fast irreversible reaction of two reactants forming one product.

Name R5

Reaction equation

$$\text{E23HP} + \text{Shc} \longrightarrow \text{E23HP\_Shc} \tag{14}$$

Reactants

Table 14: Properties of each reactant.

Id	Name	SBO
E23HP		
Shc		

Product

Table 15: Properties of each product.

Id	Name	SBO
E23HP_Shc		

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{k5} \cdot ([\text{E23HP}] \cdot [\text{Shc}] - \text{Kd\_5} \cdot [\text{E23HP\_Shc}]) \tag{15}$$

7.6 Reaction R6

This is a fast irreversible reaction of one reactant forming one product.

Name R6

Reaction equation

$$\text{E23HP\_Shc} \longrightarrow \text{E23HP\_ShcP} \tag{16}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
E23HP_Shc		

Product

Table 17: Properties of each product.

Id	Name	SBO
E23HP_ShcP		

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{k6} \cdot [\mathrm{E23HP\_Shc}] - \mathrm{k\_6} \cdot [\mathrm{E23HP\_ShcP}] \tag{17}$$

7.7 Reaction R7

This is a fast irreversible reaction of two reactants forming one product.

Name R7

Reaction equation

$$\mathrm{E23HP\_ShcP} + \mathrm{GS} \longrightarrow \mathrm{E23HP\_ShGS} \tag{18}$$

Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
E23HP_ShcP		
GS		

Product

Table 19: Properties of each product.

Id	Name	SBO
E23HP_ShGS		

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{k7} \cdot ([\mathrm{E23HP\_ShcP}] \cdot [\mathrm{GS}] - \mathrm{Kd\_7} \cdot [\mathrm{E23HP\_ShGS}]) \tag{19}$$

7.8 Reaction R8

This is a fast irreversible reaction of one reactant forming two products.

Name R8

Reaction equation

$$\text{E23HP\_ShGS} \longrightarrow \text{E23HP} + \text{ShGS} \tag{20}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
E23HP_ShGS		

Products

Table 21: Properties of each product.

Id	Name	SBO
E23HP		
ShGS		

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{k8} \cdot (\text{[E23HP\_ShGS]} - \text{Kd\_8} \cdot \text{[E23HP]} \cdot \text{[ShGS]}) \tag{21}$$

7.9 Reaction R9

This is a fast irreversible reaction of one reactant forming two products.

Name R9

Reaction equation

$$\text{ShGS} \longrightarrow \text{GS} + \text{ShcP} \tag{22}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
ShGS		

Products

Table 23: Properties of each product.

Id	Name	SBO
GS		
ShcP		

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{k9} \cdot ([\mathrm{ShGS}] - \mathrm{k\_9} \cdot [\mathrm{ShcP}] \cdot [\mathrm{GS}]) \tag{23}$$

7.10 Reaction R10

This is a fast irreversible reaction of one reactant forming one product.

Name R10

Reaction equation

$$\mathrm{ShcP} \longrightarrow \mathrm{Shc} \tag{24}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
ShcP		

Product

Table 25: Properties of each product.

Id	Name	SBO
Shc		

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \frac{\mathrm{V10} \cdot [\mathrm{ShcP}]}{\mathrm{K10} + [\mathrm{ShcP}]} \tag{25}$$

7.11 Reaction R11

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

Name R11

Reaction equation

$$\mathrm{RasGDP} \xrightarrow{\mathrm{ShGS}} \mathrm{RasGTP} \tag{26}$$

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

$$v_{11} = \frac{\mathrm{k11} \cdot [\mathrm{RasGDP}] \cdot [\mathrm{ShGS}]}{\mathrm{K11} + [\mathrm{RasGDP}]} \tag{27}$$

7.12 Reaction R12

This is a fast irreversible reaction of one reactant forming one product.

Name R12

Reaction equation

$$\mathrm{RasGTP} \longrightarrow \mathrm{RasGDP} \tag{28}$$

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

$$v_{12} = \frac{\mathrm{V12} \cdot [\mathrm{RasGTP}]}{\mathrm{K12} + [\mathrm{RasGTP}]} \tag{29}$$

7.13 Reaction R13

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

Name R13

Reaction equation

$$\text{Raf} \xrightarrow{\text{RasGTP}} \text{Rafa} \tag{30}$$

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
Rafa		

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \frac{\text{k13} \cdot [\text{Raf}] \cdot [\text{RasGTP}]}{\text{K13} + [\text{Raf}]} \tag{31}$$

7.14 Reaction R14

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

Name R14

Reaction equation

$$\text{Rafa} \xrightarrow{\text{Akt\_PI\_PP}} \text{Raf} \tag{32}$$

Reactant

Table 34: Properties of each reactant.

Id	Name	SBO
Rafa		

Modifier

Table 35: Properties of each modifier.

Id	Name	SBO
Akt_PI_PP		

Product

Table 36: Properties of each product.

Id	Name	SBO
Raf		

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \frac{\mathrm{k14} \cdot [\mathrm{Rafa}] \cdot ([\mathrm{Akt\_PI\_PP}] + \mathrm{E\_raf})}{[\mathrm{Rafa}] + \mathrm{K14}} \tag{33}$$

7.15 Reaction R15

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

Name R15

Reaction equation

$$\mathrm{MEK} \xrightarrow{\mathrm{Rafa}} \mathrm{MEKP} \tag{34}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
MEK		

Modifier

Table 38: Properties of each modifier.

Id	Name	SBO
Rafa		

Product

Table 39: Properties of each product.

Id	Name	SBO
MEKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \frac{\mathrm{k15} \cdot [\mathrm{MEK}] \cdot [\mathrm{Rafa}]}{\mathrm{K15} + [\mathrm{MEK}]} \tag{35}$$

7.16 Reaction R16_1

This is a fast irreversible reaction of two reactants forming one product.

Name R16_1

Reaction equation

$$\mathrm{MEKP} + \mathrm{PP2A} \longrightarrow \mathrm{MEKP\_PP2A} \tag{36}$$

Reactants

Table 40: Properties of each reactant.

Id	Name	SBO
MEKP		
PP2A		

Product

Table 41: Properties of each product.

Id	Name	SBO
MEKP_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{k16} \cdot [\text{MEKP}] \cdot [\text{PP2A}] \tag{37}$$

7.17 Reaction R16_2

This is a fast irreversible reaction of one reactant forming one product.

Name R16_2

Reaction equation

$$\text{MEKP\_PP2A} \longrightarrow \text{MEK\_PP2A} \tag{38}$$

Reactant

Table 42: Properties of each reactant.

Id	Name	SBO
MEKP_PP2A		

Product

Table 43: Properties of each product.

Id	Name	SBO
MEK_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \text{k16\_kat} \cdot [\text{MEKP\_PP2A}] \tag{39}$$

7.18 Reaction R16_3

This is a fast irreversible reaction of one reactant forming two products.

Name R16_3

Reaction equation

$$\text{MEK\_PP2A} \longrightarrow \text{MEK} + \text{PP2A} \tag{40}$$

Reactant

Table 44: Properties of each reactant.

Id	Name	SBO
MEK_PP2A		

Products

Table 45: Properties of each product.

Id	Name	SBO
MEK		
PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{k18} \cdot [\text{MEK\_PP2A}] \tag{41}$$

7.19 Reaction R17_1

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

Name R17_1

Reaction equation

$$\text{MEKP} \xrightarrow{\text{Rafa}} \text{MEKPP} \tag{42}$$

Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
MEKP		

Modifier

Table 47: Properties of each modifier.

Id	Name	SBO
Rafa		

Product

Table 48: Properties of each product.

Id	Name	SBO
MEKPP		

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \frac{\mathrm{k15} \cdot [\mathrm{MEKP}] \cdot [\mathrm{Rafa}]}{\mathrm{K15} + [\mathrm{MEKP}]} \tag{43}$$

7.20 Reaction R18_1

This is a fast irreversible reaction of two reactants forming one product.

Name R18_1

Reaction equation

$$\mathrm{MEKPP} + \mathrm{PP2A} \longrightarrow \mathrm{MEKPP\_PP2A} \tag{44}$$

Reactants

Table 49: Properties of each reactant.

Id	Name	SBO
MEKPP		
PP2A		

Product

Table 50: Properties of each product.

Id	Name	SBO
MEKPP_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{k16} \cdot (\text{[PP2A]} \cdot \text{[MEKPP]} - \text{Kd\_16} \cdot \text{[MEKPP\_PP2A]}) \tag{45}$$

7.21 Reaction R18_2

This is a fast irreversible reaction of one reactant forming one product.

Name R18_2

Reaction equation

$$\text{MEKPP\_PP2A} \longrightarrow \text{MEKP\_PP2A} \tag{46}$$

Reactant

Table 51: Properties of each reactant.

Id	Name	SBO
MEKPP_PP2A		

Product

Table 52: Properties of each product.

Id	Name	SBO
MEKP_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{k16\_kat} \cdot \text{[MEKPP\_PP2A]} \tag{47}$$

7.22 Reaction R18_3

This is a fast irreversible reaction of one reactant forming two products.

Name R18_3

Reaction equation

$$\text{MEKP\_PP2A} \longrightarrow \text{MEKP} + \text{PP2A} \tag{48}$$

Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
MEKP_PP2A		

Products

Table 54: Properties of each product.

Id	Name	SBO
MEKP		
PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{k22} \cdot [\text{MEKP\_PP2A}] \tag{49}$$

7.23 Reaction R19

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

Name R19

Reaction equation

$$\text{ERK} \xrightarrow{\text{MEKPP}} \text{ERKP} \tag{50}$$

Reactant

Table 55: Properties of each reactant.

Id	Name	SBO
ERK		

Modifier

Table 56: Properties of each modifier.

Id	Name	SBO
MEKPP		

Product

Table 57: Properties of each product.

Id	Name	SBO
ERKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \frac{\mathrm{k23} \cdot [\mathrm{ERK}] \cdot [\mathrm{MEKPP}]}{\mathrm{K23} + [\mathrm{ERK}]} \tag{51}$$

7.24 Reaction R20

This is a fast irreversible reaction of one reactant forming one product.

Name R20

Reaction equation

$$\mathrm{ERKP} \longrightarrow \mathrm{ERK} \tag{52}$$

Reactant

Table 58: Properties of each reactant.

Id	Name	SBO
ERKP		

Product

Table 59: Properties of each product.

Id	Name	SBO
ERK		

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \frac{\mathrm{V24} \cdot [\mathrm{ERKP}]}{\mathrm{K24} + [\mathrm{ERKP}]} \tag{53}$$

7.25 Reaction R21

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

Name R21

Reaction equation

$$\mathrm{ERKP} \xrightarrow{\mathrm{MEKPP}} \mathrm{ERKPP} \tag{54}$$

Reactant

Table 60: Properties of each reactant.

Id	Name	SBO
ERKP		

Modifier

Table 61: Properties of each modifier.

Id	Name	SBO
MEKPP		

Product

Table 62: Properties of each product.

Id	Name	SBO
ERKPP		

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \frac{\mathrm{k23} \cdot [\mathrm{ERKP}] \cdot [\mathrm{MEKPP}]}{\mathrm{K23} + [\mathrm{ERKP}]} \tag{55}$$

7.26 Reaction R22

This is a fast irreversible reaction of one reactant forming one product.

Name R22

Reaction equation

$$\mathrm{ERKPP} \longrightarrow \mathrm{ERKP} \tag{56}$$

Reactant

Table 63: Properties of each reactant.

Id	Name	SBO
ERKPP		

Product

Table 64: Properties of each product.

Id	Name	SBO
ERKP		

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \frac{\mathrm{V24} \cdot [\mathrm{ERKPP}]}{\mathrm{K24} + [\mathrm{ERKPP}]} \tag{57}$$

7.27 Reaction R23

This is a fast irreversible reaction of two reactants forming one product.

Name R23

Reaction equation

$$\mathrm{E23HP} + \mathrm{PI3K} \longrightarrow \mathrm{E23HP\_PI3K} \tag{58}$$

Reactants

Table 65: Properties of each reactant.

Id	Name	SBO
E23HP		
PI3K		

Product

Table 66: Properties of each product.

Id	Name	SBO
E23HP_PI3K		

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \mathrm{k27} \cdot ([\mathrm{E23HP}] \cdot [\mathrm{PI3K}] - \mathrm{Kd\_27} \cdot [\mathrm{E23HP\_PI3K}]) \tag{59}$$

7.28 Reaction R24

This is a fast irreversible reaction of one reactant forming one product.

Name R24

Reaction equation

$$\mathrm{E23HP\_PI3K} \longrightarrow \mathrm{E23HP\_PI3Ka} \tag{60}$$

Reactant

Table 67: Properties of each reactant.

Id	Name	SBO
E23HP_PI3K		

Product

Table 68: Properties of each product.

Id	Name	SBO
E23HP_PI3Ka		

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \text{k28} \cdot ([\text{E23HP\_PI3K}] - \text{k\_28} \cdot [\text{E23HP\_PI3Ka}]) \tag{61}$$

7.29 Reaction R25

This is a fast irreversible reaction of one reactant forming two products.

Name R25

Reaction equation

$$\text{E23HP\_PI3Ka} \longrightarrow \text{E23HP} + \text{PI3Ka} \tag{62}$$

Reactant

Table 69: Properties of each reactant.

Id	Name	SBO
E23HP_PI3Ka		

Products

Table 70: Properties of each product.

Id	Name	SBO
E23HP		
PI3Ka		

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{k29} \cdot [\text{E23HP\_PI3Ka}] - \text{k\_29} \cdot [\text{E23HP}] \cdot [\text{PI3Ka}] \tag{63}$$

7.30 Reaction R26

This is a fast irreversible reaction of one reactant forming one product.

Name R26

Reaction equation

$$\text{PI3Ka} \longrightarrow \text{PI3K} \tag{64}$$

Reactant

Table 71: Properties of each reactant.

Id	Name	SBO
PI3Ka		

Product

Table 72: Properties of each product.

Id	Name	SBO
PI3K		

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \text{V30} \cdot [\text{PI3Ka}] \tag{65}$$

7.31 Reaction R27_1

This is a fast irreversible reaction of two reactants forming one product.

Name R27_1

Reaction equation

$$\mathrm{PI2} + \mathrm{PI3Ka} \longrightarrow \mathrm{PI3Ka\_PI} \tag{66}$$

Reactants

Table 73: Properties of each reactant.

Id	Name	SBO
PI2		
PI3Ka		

Product

Table 74: Properties of each product.

Id	Name	SBO
PI3Ka_PI		

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \mathrm{k31} \cdot (\mathrm{[PI2]} \cdot \mathrm{[PI3Ka]} - \mathrm{K\_d31} \cdot \mathrm{[PI3Ka\_PI]}) \tag{67}$$

7.32 Reaction R28_1

This is a fast irreversible reaction of two reactants forming one product.

Name R28_1

Reaction equation

$$\mathrm{PIP3} + \mathrm{PTEN} \longrightarrow \mathrm{PTEN\_PIP3} \tag{68}$$

Reactants

Table 75: Properties of each reactant.

Id	Name	SBO
PIP3		
PTEN		

Product

Table 76: Properties of each product.

Id	Name	SBO
PTEN_PIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \text{k32} \cdot (\text{[PIP3]} \cdot \text{[PTEN]} - \text{Kd\_32} \cdot \text{[PTEN\_PIP3]}) \tag{69}$$

7.33 Reaction R28_2

This is a fast irreversible reaction of one reactant forming one product.

Name R28_2

Reaction equation

$$\text{PTEN\_PIP3} \longrightarrow \text{PTEN\_PI} \tag{70}$$

Reactant

Table 77: Properties of each reactant.

Id	Name	SBO
PTEN_PIP3		

Product

Table 78: Properties of each product.

Id	Name	SBO
PTEN_PI		

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \text{k33} \cdot \text{[PTEN\_PIP3]} \tag{71}$$

7.34 Reaction R28_3

This is a fast irreversible reaction of one reactant forming two products.

Name R28_3

Reaction equation

$$\text{PTEN\_PI} \longrightarrow \text{PI2} + \text{PTEN} \tag{72}$$

Reactant

Table 79: Properties of each reactant.

Id	Name	SBO
PTEN_PI		

Products

Table 80: Properties of each product.

Id	Name	SBO
PI2		
PTEN		

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \text{k34} \cdot [\text{PTEN\_PI}] \tag{73}$$

7.35 Reaction R28_4

This is a fast irreversible reaction of one reactant forming one product.

Name R28_4

Reaction equation

$$\text{PTEN} \longrightarrow \text{PTENP} \tag{74}$$

Reactant

Table 81: Properties of each reactant.

Id	Name	SBO
PTEN		

Product

Table 82: Properties of each product.

Id	Name	SBO
PTENP		

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \frac{\mathrm{V35} \cdot [\mathrm{PTEN}]}{\mathrm{K35} + [\mathrm{PTEN}]} \tag{75}$$

7.36 Reaction R28_5

This is a fast irreversible reaction of two reactants forming one product.

Name R28_5

Reaction equation

$$\mathrm{PTEN} + \mathrm{PTENP} \longrightarrow \mathrm{PTENP\_PTEN} \tag{76}$$

Reactants

Table 83: Properties of each reactant.

Id	Name	SBO
PTEN		
PTENP		

Product

Table 84: Properties of each product.

Id	Name	SBO
PTENP_PTEN		

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \text{k36} \cdot ([\text{PTEN}] \cdot [\text{PTENP}] - \text{Kd\_36} \cdot [\text{PTENP\_PTEN}]) \tag{77}$$

7.37 Reaction R28_6

This is a fast irreversible reaction of one reactant forming one product.

Name R28_6

Reaction equation

$$\text{PTENP\_PTEN} \longrightarrow \text{PTEN\_PTEN} \tag{78}$$

Reactant

Table 85: Properties of each reactant.

Id	Name	SBO
PTENP_PTEN		

Product

Table 86: Properties of each product.

Id	Name	SBO
PTEN_PTEN		

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \text{k37} \cdot [\text{PTENP\_PTEN}] \tag{79}$$

7.38 Reaction R28_7

This is a fast irreversible reaction of one reactant forming one product.

Name R28_7

Reaction equation

$$\text{PTEN\_PTEN} \longrightarrow 2\,\text{PTEN} \tag{80}$$

Reactant

Table 87: Properties of each reactant.

Id	Name	SBO
PTEN_PTEN		

Product

Table 88: Properties of each product.

Id	Name	SBO
PTEN		

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \text{k38} \cdot [\text{PTEN\_PTEN}] \tag{81}$$

7.39 Reaction R29

This is a fast irreversible reaction of two reactants forming one product.

Name R29

Reaction equation

$$\text{Akt} + \text{PIP3} \longrightarrow \text{Akt\_PIP3} \tag{82}$$

Reactants

Table 89: Properties of each reactant.

Id	Name	SBO
Akt		
PIP3		

Product

Table 90: Properties of each product.

Id	Name	SBO
Akt_PIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \mathrm{k39} \cdot ([\mathrm{PIP3}] \cdot [\mathrm{Akt}] - \mathrm{Kd\_39} \cdot [\mathrm{Akt\_PIP3}]) \tag{83}$$

7.40 Reaction R30

This is a fast irreversible reaction of one reactant forming one product.

Name R30

Reaction equation

$$\mathrm{Akt\_PIP3} \longrightarrow \mathrm{Akt\_PI\_P} \tag{84}$$

Reactant

Table 91: Properties of each reactant.

Id	Name	SBO
Akt_PIP3		

Product

Table 92: Properties of each product.

Id	Name	SBO
Akt_PI_P		

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \frac{\mathrm{V40} \cdot [\mathrm{Akt\_PIP3}]}{\mathrm{K40} + [\mathrm{Akt\_PIP3}]} \tag{85}$$

7.41 Reaction R31_1

This is a fast irreversible reaction of two reactants forming one product.

Name R31_1

Reaction equation

$$\mathrm{Akt\_PI\_P} + \mathrm{PP2A} \longrightarrow \mathrm{Akt\_PI\_P\_PP2A} \tag{86}$$

Reactants

Table 93: Properties of each reactant.

Id	Name	SBO
Akt_PI_P		
PP2A		

Product

Table 94: Properties of each product.

Id	Name	SBO
Akt_PI_P_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \mathrm{k41} \cdot [\mathrm{Akt\_PI\_P}] \cdot [\mathrm{PP2A}] \tag{87}$$

7.42 Reaction R31_2

This is a fast irreversible reaction of one reactant forming one product.

Name R31_2

Reaction equation

$$\text{Akt\_PI\_P\_PP2A} \longrightarrow \text{Akt\_PIP3\_PP2A} \tag{88}$$

Reactant

Table 95: Properties of each reactant.

Id	Name	SBO
Akt_PI_P_PP2A		

Product

Table 96: Properties of each product.

Id	Name	SBO
Akt_PIP3_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = \text{k42} \cdot [\text{Akt\_PI\_P\_PP2A}] \tag{89}$$

7.43 Reaction R31_3

This is a fast irreversible reaction of one reactant forming two products.

Name R31_3

Reaction equation

$$\text{Akt\_PIP3\_PP2A} \longrightarrow \text{Akt\_PIP3} + \text{PP2A} \tag{90}$$

Reactant

Table 97: Properties of each reactant.

Id	Name	SBO
Akt_PIP3_PP2A		

Products

Table 98: Properties of each product.

Id	Name	SBO
Akt_PIP3_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{43} = \mathrm{k43} \cdot [\mathrm{Akt\_PIP3\_PP2A}] \tag{91}$$

7.44 Reaction R32

This is a fast irreversible reaction of one reactant forming one product.

Name R32

Reaction equation

$$\mathrm{Akt\_PI\_P} \longrightarrow \mathrm{Akt\_PI\_PP} \tag{92}$$

Reactant

Table 99: Properties of each reactant.

Id	Name	SBO
Akt_PI_P		

Product

Table 100: Properties of each product.

Id	Name	SBO
Akt_PI_PP		

Kinetic Law

Derived unit contains undeclared units

$$v_{44} = \frac{\mathrm{V40} \cdot [\mathrm{Akt\_PI\_P}]}{\mathrm{K40} + [\mathrm{Akt\_PI\_P}]} \tag{93}$$

7.45 Reaction R33_1

This is a fast irreversible reaction of two reactants forming one product.

Name R33_1

Reaction equation

$$\mathrm{Akt\_PI\_PP} + \mathrm{PP2A} \longrightarrow \mathrm{Akt\_PI\_PP\_PP2A} \tag{94}$$

Reactants

Table 101: Properties of each reactant.

Id	Name	SBO
Akt_PI_PP		
PP2A		

Product

Table 102: Properties of each product.

Id	Name	SBO
Akt_PI_PP_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{45} = \mathrm{k41} \cdot ([\mathrm{Akt\_PI\_PP}] \cdot [\mathrm{PP2A}] - \mathrm{Kd\_41} \cdot [\mathrm{Akt\_PI\_PP\_PP2A}]) \tag{95}$$

7.46 Reaction R33_2

This is a fast irreversible reaction of one reactant forming one product.

Name R33_2

Reaction equation

$$\mathrm{Akt\_PI\_PP\_PP2A} \longrightarrow \mathrm{Akt\_PI\_P\_PP2A} \tag{96}$$

Reactant

Table 103: Properties of each reactant.

Id	Name	SBO
Akt_PI_PP_PP2A		

Product

Table 104: Properties of each product.

Id	Name	SBO
Akt_PI_P_PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \mathrm{k42} \cdot [\mathrm{Akt\_PI\_PP\_PP2A}] \tag{97}$$

7.47 Reaction R33_3

This is a fast irreversible reaction of one reactant forming two products.

Name R33_3

Reaction equation

$$\mathrm{Akt\_PI\_P\_PP2A} \longrightarrow \mathrm{Akt\_PI\_P} + \mathrm{PP2A} \tag{98}$$

Reactant

Table 105: Properties of each reactant.

Id	Name	SBO
Akt_PI_P_PP2A		

Products

Table 106: Properties of each product.

Id	Name	SBO
Akt_PI_P		
PP2A		

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = \text{k47} \cdot [\text{Akt\_PI\_P\_PP2A}] \tag{99}$$

7.48 Reaction R34

This is a fast irreversible reaction of one reactant forming no product.

Name R34

Reaction equation

$$\text{E23HP} \longrightarrow \emptyset \tag{100}$$

Reactant

Table 107: Properties of each reactant.

Id	Name	SBO
E23HP		

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = \text{k48} \cdot [\text{E23HP}] \tag{101}$$

7.49 Reaction R35

This is a fast irreversible reaction of two reactants forming one product.

Name R35

Reaction equation

$$\text{E2} + \text{Per} \longrightarrow \text{E2\_Per} \tag{102}$$

Reactants

Table 108: Properties of each reactant.

Id	Name	SBO
E2		
Per		

Product

Table 109: Properties of each product.

Id	Name	SBO
E2_Per		

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = \mathrm{k49} \cdot ([\mathrm{Per}] \cdot [\mathrm{E2}] - \mathrm{Kd\_49} \cdot [\mathrm{E2\_Per}]) \tag{103}$$

7.50 Reaction R36

This is a fast irreversible reaction of one reactant forming one product.

Name R36

Reaction equation

$$\mathrm{E2\_Per} \longrightarrow \mathrm{E2Per} \tag{104}$$

Reactant

Table 110: Properties of each reactant.

Id	Name	SBO
E2_Per		

Product

Table 111: Properties of each product.

Id	Name	SBO
E2Per		

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = \text{k50} \cdot [\text{E2\_Per}] - \text{k\_50} \cdot [\text{E2Per}] \tag{105}$$

7.51 Reaction R37

This is a fast irreversible reaction of one reactant forming one product.

Name R37

Reaction equation

$$\text{E3H} \longrightarrow \text{E3H\_C} \tag{106}$$

Reactant

Table 112: Properties of each reactant.

Id	Name	SBO
E3H		

Product

Table 113: Properties of each product.

Id	Name	SBO
E3H_C		

Kinetic Law

Derived unit contains undeclared units

$$v_{51} = \text{k51} \cdot [\text{E3H}] \tag{107}$$

7.52 Reaction R38

This is a fast irreversible reaction of two reactants forming one product.

Name R38

Reaction equation

$$\mathrm{E2} + \mathrm{E3H\_C} \longrightarrow \mathrm{E23H} \tag{108}$$

Reactants

Table 114: Properties of each reactant.

Id	Name	SBO
E2		
E3H_C		

Product

Table 115: Properties of each product.

Id	Name	SBO
E23H		

Kinetic Law

Derived unit contains undeclared units

$$v_{52} = \mathrm{k2} \cdot (\mathrm{[E3H\_C]} \cdot \mathrm{[E2]} - \mathrm{Kd\_2} \cdot \mathrm{[E23H]}) \tag{109}$$

7.53 Reaction R39

This is a fast irreversible reaction of one reactant forming one product.

Name R39

Reaction equation

$$\mathrm{E23H} \longrightarrow \mathrm{E23H\_C} \tag{110}$$

Reactant

Table 116: Properties of each reactant.

Id	Name	SBO
E23H		

Product

Table 117: Properties of each product.

Id	Name	SBO
E23H_C		

Kinetic Law

Derived unit contains undeclared units

$$v_{53} = \text{k53} \cdot [\text{E23H}] \tag{111}$$

7.54 Reaction R40

This is a fast irreversible reaction of one reactant forming one product.

Name R40

Reaction equation

$$\text{E23H\_C} \longrightarrow \text{E23HP} \tag{112}$$

Reactant

Table 118: Properties of each reactant.

Id	Name	SBO
E23H_C		

Product

Table 119: Properties of each product.

Id	Name	SBO
E23HP		

Kinetic Law

Derived unit contains undeclared units

$$v_{54} = \text{k3} \cdot ([\text{E23H\_C}] - \text{Kd\_3} \cdot [\text{E23HP}]) \tag{113}$$

7.55 Reaction R41

This is a fast irreversible reaction of one reactant forming one product.

Name R41

Reaction equation

$$\text{PI3Ka\_PI} \longrightarrow \text{PI3Ka\_PIP3} \tag{114}$$

Reactant

Table 120: Properties of each reactant.

Id	Name	SBO
PI3Ka_PI		

Product

Table 121: Properties of each product.

Id	Name	SBO
PI3Ka_PIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{55} = \text{k55} \cdot [\text{PI3Ka\_PI}] \tag{115}$$

7.56 Reaction R42

This is a fast irreversible reaction of one reactant forming two products.

Name R42

Reaction equation

$$\text{PI3Ka\_PIP3} \longrightarrow \text{PI3Ka} + \text{PIP3} \tag{116}$$

Reactant

Table 122: Properties of each reactant.

Id	Name	SBO
PI3Ka_PIP3		

Products

Table 123: Properties of each product.

Id	Name	SBO
PI3Ka		
PIP3		

Kinetic Law

Derived unit contains undeclared units

$$v_{56} = \text{k56} \cdot [\text{PI3Ka\_PIP3}] \tag{117}$$

7.57 Reaction R43

This is a fast irreversible reaction of one reactant forming one product.

Name R43

Reaction equation

$$\text{PTEN} \longrightarrow \text{PTEN\_bpV} \tag{118}$$

Reactant

Table 124: Properties of each reactant.

Id	Name	SBO
PTEN		

Product

Table 125: Properties of each product.

Id	Name	SBO
PTEN_bpV		

Kinetic Law

Derived unit contains undeclared units

$$v_{57} = \mathrm{k57} \cdot ([\mathrm{PTEN}] \cdot \mathrm{bpV} - \mathrm{Kd\_57} \cdot [\mathrm{PTEN\_bpV}]) \tag{119}$$

7.58 Reaction R44

This is a fast irreversible reaction of one reactant forming one product.

Name R44

Reaction equation

$$\mathrm{PI3K} \longrightarrow \mathrm{PI3K\_LY} \tag{120}$$

Reactant

Table 126: Properties of each reactant.

Id	Name	SBO
PI3K		

Product

Table 127: Properties of each product.

Id	Name	SBO
PI3K_LY		

Kinetic Law

Derived unit contains undeclared units

$$v_{58} = \mathrm{k58} \cdot ([\mathrm{PI3K}] \cdot \mathrm{LY} - \mathrm{Kd\_58} \cdot [\mathrm{PI3K\_LY}]) \tag{121}$$

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 E3

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

This species takes part in one reaction (as a reactant in R1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E3} = -v_1 \tag{122}$$

8.2 Species PI3K_LY

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

This species takes part in one reaction (as a product in R44).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3K\_LY} = v_{58} \tag{123}$$

8.3 Species E3H

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

This species takes part in three reactions (as a reactant in R2, R37 and as a product in R1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E3H} = v_1 - v_2 - v_{51} \tag{124}$$

8.4 Species E2

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

This species takes part in three reactions (as a reactant in R2, R35, R38).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E2} = -v_2 - v_{49} - v_{52} \tag{125}$$

8.5 Species E23H

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

This species takes part in five reactions (as a reactant in R3, R39 and as a product in R2, R4, R38).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23H} = v_2 + v_4 + v_{52} - v_3 - v_{53} \tag{126}$$

8.6 Species E23HP

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

This species takes part in eight reactions (as a reactant in R4, R5, R23, R34 and as a product in R3, R8, R25, R40).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23HP} = v_3 + v_8 + v_{29} + v_{54} - v_4 - v_5 - v_{27} - v_{48} \tag{127}$$

8.7 Species Shc

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

This species takes part in two reactions (as a reactant in R5 and as a product in R10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Shc} = v_{10} - v_5 \tag{128}$$

8.8 Species E23HP_Shc

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

This species takes part in two reactions (as a reactant in R6 and as a product in R5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23HP\_Shc} = v_5 - v_6 \tag{129}$$

8.9 Species E23HP_ShcP

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

This species takes part in two reactions (as a reactant in R7 and as a product in R6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23HP\_ShcP} = v_6 - v_7 \tag{130}$$

8.10 Species GS

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

This species takes part in two reactions (as a reactant in R7 and as a product in R9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GS} = v_9 - v_7 \tag{131}$$

8.11 Species E23HP_ShGS

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

This species takes part in two reactions (as a reactant in R8 and as a product in R7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23HP\_ShGS} = v_7 - v_8 \tag{132}$$

8.12 Species E2_Per

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

This species takes part in two reactions (as a reactant in R36 and as a product in R35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E2\_Per} = v_{49} - v_{50} \tag{133}$$

8.13 Species PTEN_bpV

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

This species takes part in one reaction (as a product in R43).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTEN\_bpV} = v_{57} \tag{134}$$

8.14 Species RasGDP

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

This species takes part in two reactions (as a reactant in R11 and as a product in R12).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RasGDP} = v_{12} - v_{11} \tag{135}$$

8.15 Species PI3Ka_PIP3

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3Ka\_PIP3} = v_{55} - v_{56} \tag{136}$$

8.16 Species Raf

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Raf} = v_{14} - v_{13} \tag{137}$$

8.17 Species E23H_C

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23H\_C} = v_{53} - v_{54} \tag{138}$$

8.18 Species MEK

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

This species takes part in two reactions (as a reactant in R15 and as a product in R16_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEK} = v_{18} - v_{15} \tag{139}$$

8.19 Species MEKP

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

This species takes part in four reactions (as a reactant in R16_1, R17_1 and as a product in R15, R18_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEKP} = v_{15} + v_{22} - v_{16} - v_{19} \tag{140}$$

8.20 Species PP2A

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

This species takes part in eight reactions (as a reactant in R16_1, R18_1, R31_1, R33_1 and as a product in R16_3, R18_3, R31_3, R33_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PP2A} = v_{18} + v_{22} + v_{43} + v_{47} - v_{16} - v_{20} - v_{41} - v_{45} \tag{141}$$

8.21 Species MEKP_PP2A

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

This species takes part in four reactions (as a reactant in R16_2, R18_3 and as a product in R16_1, R18_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEKP\_PP2A} = v_{16} + v_{21} - v_{17} - v_{22} \tag{142}$$

8.22 Species MEK_PP2A

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

This species takes part in two reactions (as a reactant in R16_3 and as a product in R16_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEK\_PP2A} = v_{17} - v_{18} \tag{143}$$

8.23 Species Akt_PIP3_PP2A

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

This species takes part in two reactions (as a reactant in R31_3 and as a product in R31_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt\_PIP3\_PP2A} = v_{42} - v_{43} \tag{144}$$

8.24 Species MEKPP_PP2A

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

This species takes part in two reactions (as a reactant in R18_2 and as a product in R18_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEKPP\_PP2A} = v_{20} - v_{21} \tag{145}$$

8.25 Species ERK

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

This species takes part in two reactions (as a reactant in R19 and as a product in R20).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ERK} = v_{24} - v_{23} \tag{146}$$

8.26 Species ERKP

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

This species takes part in four reactions (as a reactant in R20, R21 and as a product in R19, R22).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ERKP} = v_{23} + v_{26} - v_{24} - v_{25} \tag{147}$$

8.27 Species E3H_C

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E3H\_C} = v_{51} - v_{52} \tag{148}$$

8.28 Species PI3K

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

This species takes part in three reactions (as a reactant in R23, R44 and as a product in R26).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3K} = v_{30} - v_{27} - v_{58} \tag{149}$$

8.29 Species E23HP_PI3K

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

This species takes part in two reactions (as a reactant in R24 and as a product in R23).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23HP\_PI3K} = v_{27} - v_{28} \tag{150}$$

8.30 Species Akt_PIP3

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

This species takes part in three reactions (as a reactant in R30 and as a product in R29, R31_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt\_PIP3} = v_{39} + v_{43} - v_{40} \tag{151}$$

8.31 Species PI3Ka

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

This species takes part in four reactions (as a reactant in R26, R27_1 and as a product in R25, R42).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3Ka} = v_{29} + v_{56} - v_{30} - v_{31} \tag{152}$$

8.32 Species PI2

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

This species takes part in two reactions (as a reactant in R27_1 and as a product in R28_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI2} = v_{34} - v_{31} \tag{153}$$

8.33 Species Akt_PI_P_PP2A

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

This species takes part in four reactions (as a reactant in R31_2, R33_3 and as a product in R31_1, R33_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt\_PI\_P\_PP2A} = v_{41} + v_{46} - v_{42} - v_{47} \tag{154}$$

8.34 Species PTEN

Initial concentration $42.7798\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in R28_1, R28_4, R28_5, R43 and as a product in R28_3, R28_7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTEN} = v_{34} + 2\,v_{38} - v_{32} - v_{35} - v_{36} - v_{57} \tag{155}$$

8.35 Species PIP3

Initial concentration $8.05772\cdot 10^{-12}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in R28_1, R29 and as a product in R42).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PIP3} = v_{56} - v_{32} - v_{39} \tag{156}$$

8.36 Species PTEN_PIP3

Initial concentration $3.14554\cdot 10^{-8}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in R28_2 and as a product in R28_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTEN\_PIP3} = v_{32} - v_{33} \tag{157}$$

8.37 Species PTEN_PI

Initial concentration $5.02914 \cdot 10^{-8}\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in R28_3 and as a product in R28_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTEN\_PI} = v_{33} - v_{34} \tag{158}$$

8.38 Species PTENP

Initial concentration $3.39885\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in R28_5 and as a product in R28_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTENP} = v_{35} - v_{36} \tag{159}$$

8.39 Species PTENP_PTEN

Initial concentration $0.955337\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in R28_6 and as a product in R28_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTENP\_PTEN} = v_{36} - v_{37} \tag{160}$$

8.40 Species Akt_PI_P

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

This species takes part in four reactions (as a reactant in R31_1, R32 and as a product in R30, R33_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt\_PI\_P} = v_{40} + v_{47} - v_{41} - v_{44} \tag{161}$$

8.41 Species Akt

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

This species takes part in one reaction (as a reactant in R29).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt} = -v_{39} \tag{162}$$

8.42 Species E23HP_PI3Ka

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

This species takes part in two reactions (as a reactant in R25 and as a product in R24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E23HP\_PI3Ka} = v_{28} - v_{29} \tag{163}$$

8.43 Species PTEN_PTEN

Initial concentration $0.955337\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in R28_7 and as a product in R28_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PTEN\_PTEN} = v_{37} - v_{38} \tag{164}$$

8.44 Species PI3Ka_PI

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

This species takes part in two reactions (as a reactant in R41 and as a product in R27_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PI3Ka\_PI} = v_{31} - v_{55} \tag{165}$$

8.45 Species MEKPP

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

This species takes part in four reactions (as a reactant in R18_1 and as a product in R17_1 and as a modifier in R19, R21).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MEKPP} = v_{19} - v_{20} \tag{166}$$

8.46 Species Akt_PI_PP

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

This species takes part in three reactions (as a reactant in R33_1 and as a product in R32 and as a modifier in R14).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt\_PI\_PP} = v_{44} - v_{45} \tag{167}$$

8.47 Species Akt_PI_PP_PP2A

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

This species takes part in two reactions (as a reactant in R33_2 and as a product in R33_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Akt\_PI\_PP\_PP2A} = v_{45} - v_{46} \tag{168}$$

8.48 Species Per

Notes Kinetic equations are usually written in terms of concentrations (not of mole numbers), since the reaction rates are functions of concentrations. If the same compound participates in reactions taking place in different compartments with different volumes, the effective concentration of that compound will be different depending on the volume of the corresponding compartment. Step 1 (EGF binding to EGFR) could be considered as taking place in the extracellular compartment with a given initial concentration of EGF. The concentration of EGFR in the extracellular compartment would then be calculated as the number of the receptors on the cell surface divided by the (average) volume of incubation medium per cell (V m). In step 2, association and dissociation of the receptor monomers occurs in the cell membrane. All other steps are considered as taking place in the cytosolic compartment. Therefore, the same mole number of EGFR would give rise to three EGFR concentrations (representing the different compartments). However, for computational purposes, it is more convenient to deal only with a single concentration of EGFR related to the cytoplasmic water volume (V cw) of the cell. This requires rescaling the rate constants of steps 1 and 2. For the purpose of this rescaling, the EGF concentration in the model was also related to the cytoplasmic water volume; i.e. [EGF] in the experimental medium was multiplied by the ratio Vm/V cw (see TableII). Typically, there were 107cells/ml in our experiments (see Cell Preparation and Incubation Conditions); therefore, Vm = 107 ml. Assuming the diameter of a hepatocyte of 20 m and a cytoplasmic water volume of about 70% of total intracellular volume, Vm/Vcw = 33.3. [taken from Kholodenko 1999; http://www.jbc.org/content/274/42/30169.long] Per = 0 [without Inhibitor Pertuzumab] Per = 300000 [with Inhibitor Pertuzumab] - Stuart Moodie

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

This species takes part in one reaction (as a reactant in R35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Per} = -v_{49} \tag{169}$$

8.49 Species ShGS

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

This species takes part in three reactions (as a reactant in R9 and as a product in R8 and as a modifier in R11).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ShGS} = v_{8} - v_{9} \tag{170}$$

8.50 Species E2Per

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

This species takes part in one reaction (as a product in R36).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E2Per} = v_{50} \tag{171}$$

8.51 Species ERKPP

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

This species takes part in two reactions (as a reactant in R22 and as a product in R21).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ERKPP} = v_{25} - v_{26} \tag{172}$$

8.52 Species Rafa

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

This species takes part in four reactions (as a reactant in R14 and as a product in R13 and as a modifier in R15, R17_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Rafa} = v_{13} - v_{14} \tag{173}$$

8.53 Species RasGTP

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

This species takes part in three reactions (as a reactant in R12 and as a product in R11 and as a modifier in R13).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RasGTP} = v_{11} - v_{12} \tag{174}$$

8.54 Species ShcP

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

This species takes part in two reactions (as a reactant in R10 and as a product in R9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ShcP} = v_{9} - v_{10} \tag{175}$$

8.55 Species HRG

Initial concentration $3000\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in one reaction (as a reactant in R1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{HRG} = -\,v_1 \tag{176}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000410 implicit compartment: A compartment whose existence is inferred due to the presence of known material entities which must be bounded, allowing the creation of material entity pools

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