SBML Model Report

Model name: “Brnnmark2013 - Insulin signalling in human adipocytes (diabetic condition)”

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 Elin Nyman[2] at April 19th 2013 at 2:43 p. m. and last time modified at April eighth 2016 at 5:27 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	27
events	0	constraints	0
reactions	34	function definitions	0
global parameters	68	unit definitions	0
rules	12	initial assignments	0

Model Notes

Brnnmark2013 - Insulin signalling in human adipocytes (diabetic condition)

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The paper describes insulin signalling in human adipocytes under normal and diabetic states using mathematical models based on experimental data. This model corresponds to insulin signalling under diabetic condtion

This model is described in the article:Insulin Signaling in Type 2 Diabetes: EXPERIMENTAL AND MODELING ANALYSES REVEAL MECHANISMS OF INSULIN RESISTANCE IN HUMAN ADIPOCYTES.Brnnmark C, Nyman E, Fagerholm S, Bergenholm L, Ekstrand EM, Cedersund G, Strlfors P.J Biol Chem. 2013 Apr 5;288(14):9867-80.

Abstract:

Type 2 diabetes originates in an expanding adipose tissue that for unknown reasons becomes insulin resistant. Insulin resistance reflects impairments in insulin signaling, but mechanisms involved are unclear because current research is fragmented. We report a systems level mechanistic understanding of insulin resistance, using systems wide and internally consistent data from human adipocytes. Based on quantitative steady-state and dynamic time course data on signaling intermediaries, normally and in diabetes, we developed a dynamic mathematical model of insulin signaling. The model structure and parameters are identical in the normal and diabetic states of the model, except for three parameters that change in diabetes: (i) reduced concentration of insulin receptor, (ii) reduced concentration of insulin-regulated glucose transporter GLUT4, and (iii) changed feedback from mammalian target of rapamycin in complex with raptor (mTORC1). Modeling reveals that at the core of insulin resistance in human adipocytes is attenuation of a positive feedback from mTORC1 to the insulin receptor substrate-1, which explains reduced sensitivity and signal strength throughout the signaling network. Model simulations with inhibition of mTORC1 are comparable with experimental data on inhibition of mTORC1 using rapamycin in human adipocytes. We demonstrate the potential of the model for identification of drug targets, e.g. increasing the feedback restores insulin signaling, both at the cellular level and, using a multilevel model, at the whole body level. Our findings suggest that insulin resistance in an expanded adipose tissue results from cell growth restriction to prevent cell necrosis.

This model is hosted on BioModels Database and identifiedby: MODEL1304160000 .

To cite BioModels Database, please use: BioModels Database: An enhanced, curated and annotated resourcefor 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
cellvolume	cellvolume	0000290	3	1	litre	☑	

3.1 Compartment cellvolume

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

Name cellvolume

SBO:0000290 physical compartment

4 Species

This model contains 27 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
IR	IR	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRp	IRp	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRins	IRins	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRip	IRip	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRi	IRi	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRS1	IRS1	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRS1p	IRS1p	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRS1p307	IRS1p307	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IRS1307	IRS1307	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
X	X	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Xp	Xp	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PKB	PKB	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PKB308p	PKB308p	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PKB473p	PKB473p	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
PKB308p473p	PKB308p473p	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
mTORC1	mTORC1	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
mTORC1a	mTORC1a	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
mTORC2	mTORC2	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
mTORC2a	mTORC2a	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AS160	AS160	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AS160p	AS160p	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
GLUT4m	GLUT4m	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
GLUT4	GLUT4	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S6K	S6K	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S6Kp	S6Kp	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S6	S6	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S6p	S6p	cellvolume	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 68 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
diabetes	diabetes		0.150		☑
k1a	k1a		0.633		☑
k1basal	k1basal		0.037		☑
k1c	k1c		0.877		☑
k1d	k1d		31.010		☑
k1f	k1f		1840.000		☑
k1g	k1g		1944.000		☑
k1r	k1r		0.547		☑
k2a	k2a		3.227		☑
k2c	k2c		5759.000		☑
k2basal	k2basal		0.042		☑
k2b	k2b		3424.000		☑
k2d	k2d		280.800		☑
k2f	k2f		2.913		☑
k2g	k2g		0.267		☑
k3a	k3a		0.001		☑
k3b	k3b		0.099		☑
k4a	k4a		5790.000		☑
k4b	k4b		34.800		☑
k4c	k4c		4.456		☑
k4e	k4e		42.840		☑
k4f	k4f		143.600		☑
k4h	k4h		0.536		☑
k5a1	k5a1		1.842		☑
k5a2	k5a2		0.055		☑
k5b	k5b		24.830		☑
k5d	k5d		1.060		☑
km5	km5		2.650		☑
k5c	k5c		0.086		☑
k6f1	k6f1		2.652		☑
k6f2	k6f2		36.930		☑
km6	km6		30.540		☑
n6	n6		2.137		☑
k6b	k6b		65.180		☑
k7f	k7f		50.980		☑
k7b	k7b		2286.000		☑
k8	k8		724.200		☑

Id	Name	SBO	Value	Unit	Constant
glut1	glut1		7042.000		☑
k9f1	k9f1		0.130		☑
k9b1	k9b1		0.044		☑
k9f2	k9f2		3.329		☑
k9b2	k9b2		31.000		☑
km9	km9		5873.000		☑
n9	n9		0.986		☑
scaleIR	scaleIR		5.202		☑
scaleIRS1	scaleIRS1		0.376		☑
scaleIRS1ds	scaleIRS1ds		14.890		☑
scaleIRS1307	scaleIRS1307		0.059		☑
scalePKB308	scalePKB308		0.044		☑
scalePKB473	scalePKB473		0.013		☑
scaleAS160	scaleAS160		0.027		☑
scaleGLUCOSE	scaleGLUCOSE		0.041		☑
scaleS6K	scaleS6K		0.747		☑
scaleS6	scaleS6		0.115		☑
gluc	gluc		0.050		☑
insulin	insulin		10.000		☑
measuredIRp	measuredIRp		0.000		⊟
measuredIRint	measuredIRint		0.000		⊟
measuredIRS1p	measuredIRS1p		0.000		⊟
measuredIRS1307	measuredIRS1307		0.000		⊟
measuredPKB308p	measuredPKB308p		0.000		⊟
measuredPKB473p	measuredPKB473p		0.000		⊟
measuredAS160p	measuredAS160p		0.000		⊟
measuredmTORC1a	measuredmTORC1a		0.000		⊟
measuredS6Kp	measuredS6Kp		0.000		⊟
measuredS6p	measuredS6p		0.000		⊟
measuredmTORC2a	measuredmTORC2a		0.000		⊟
glucoseuptake	glucoseuptake		0.000		⊟

6 Rules

This is an overview of twelve rules.

6.1 Rule measuredIRp

Rule measuredIRp is an assignment rule for parameter measuredIRp:

$$\text{measuredIRp} = \text{scaleIR} \cdot (\text{[IRp]} + \text{[IRip]}) \tag{1}$$

6.2 Rule measuredIRint

Rule measuredIRint is an assignment rule for parameter measuredIRint:

$$\text{measuredIRint} = [\text{IRi}] + [\text{IRip}] \tag{2}$$

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

6.3 Rule measuredIRS1p

Rule measuredIRS1p is an assignment rule for parameter measuredIRS1p:

$$\text{measuredIRS1p} = \text{scaleIRS1} \cdot ([\text{IRS1p}] + [\text{IRS1p307}]) \tag{3}$$

6.4 Rule measuredIRS1307

Rule measuredIRS1307 is an assignment rule for parameter measuredIRS1307:

$$\text{measuredIRS1307} = \text{scaleIRS1307} \cdot ([\text{IRS1p307}] + [\text{IRS1307}]) \tag{4}$$

6.5 Rule measuredPKB308p

Rule measuredPKB308p is an assignment rule for parameter measuredPKB308p:

$$\text{measuredPKB308p} = \text{scalePKB308} \cdot ([\text{PKB308p}] + [\text{PKB308p473p}]) \tag{5}$$

6.6 Rule measuredPKB473p

Rule measuredPKB473p is an assignment rule for parameter measuredPKB473p:

$$\text{measuredPKB473p} = \text{scalePKB473} \cdot ([\text{PKB473p}] + [\text{PKB308p473p}]) \tag{6}$$

6.7 Rule measuredAS160p

Rule measuredAS160p is an assignment rule for parameter measuredAS160p:

$$\text{measuredAS160p} = \text{scaleAS160} \cdot [\text{AS160p}] \tag{7}$$

6.8 Rule measuredmTORC1a

Rule measuredmTORC1a is an assignment rule for parameter measuredmTORC1a:

$$\text{measuredmTORC1a} = [\text{mTORC1a}] \tag{8}$$

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

6.9 Rule measuredS6Kp

Rule measuredS6Kp is an assignment rule for parameter measuredS6Kp:

$$\text{measuredS6Kp} = \text{scaleS6K} \cdot [\text{S6Kp}] \tag{9}$$

6.10 Rule measuredS6p

Rule measuredS6p is an assignment rule for parameter measuredS6p:

$$\text{measuredS6p} = \text{scaleS6} \cdot [\text{S6p}] \tag{10}$$

6.11 Rule measuredmTORC2a

Rule measuredmTORC2a is an assignment rule for parameter measuredmTORC2a:

$$\text{measuredmTORC2a} = [\text{mTORC2a}] \tag{11}$$

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

6.12 Rule glucoseuptake

Rule glucoseuptake is an assignment rule for parameter glucoseuptake:

$$\text{glucoseuptake} = \text{k8} \cdot [\text{GLUT4m}] \cdot \text{gluc} + \text{glut1} \cdot \text{gluc} \tag{12}$$

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	v1a	v1a	$\mathrm{IR} \xrightarrow{\mathrm{IR}} \mathrm{IRins}$	
2	v1basal	v1basal	$\mathrm{IR} \xrightarrow{\mathrm{IR}} \mathrm{IRp}$	
3	v1c	v1c	$\mathrm{IRins} \xrightarrow{\mathrm{IRins}} \mathrm{IRp}$	
4	v1d	v1d	$\mathrm{IRp} \xrightarrow{\mathrm{IRp}} \mathrm{IRip}$	
5	v1e	v1e	$\mathrm{IRip} \xrightarrow{\mathrm{Xp,\ IRip,\ Xp}} \mathrm{IRi}$	
6	v1g	v1g	$\mathrm{IRp} \xrightarrow{\mathrm{IRp}} \mathrm{IR}$	
7	v1r	v1r	$\mathrm{IRi} \xrightarrow{\mathrm{IRi}} \mathrm{IR}$	
8	v2a	v2a	$\mathrm{IRS1} \xrightarrow{\mathrm{IRip,\ IRS1,\ IRip}} \mathrm{IRS1p}$	
9	v2b	v2b	$\mathrm{IRS1p} \xrightarrow{\mathrm{IRS1p}} \mathrm{IRS1}$	
10	v2c	v2c	$\mathrm{IRS1p} \xrightarrow{\mathrm{mTORC1a,\ IRS1p,\ mTORC1a}} \mathrm{IRS1p307}$	
11	v2d	v2d	$\mathrm{IRS1p307} \xrightarrow{\mathrm{IRS1p307}} \mathrm{IRS1p}$	
12	v2f	v2f	$\mathrm{IRS1p307} \xrightarrow{\mathrm{IRS1p307}} \mathrm{IRS1307}$	
13	v2basal	v2basal	$\mathrm{IRS1} \xrightarrow{\mathrm{IRS1}} \mathrm{IRS1307}$	
14	v2g	v2g	$\mathrm{IRS1307} \xrightarrow{\mathrm{IRS1307}} \mathrm{IRS1}$	
15	v3a	v3a	$\mathrm{X} \xrightarrow{\mathrm{IRS1p,\ X,\ IRS1p}} \mathrm{Xp}$	
16	v3b	v3b	$\mathrm{Xp} \xrightarrow{\mathrm{Xp}} \mathrm{X}$	

№	Id	Name	Reaction Equation	SBO
17	v5a	v5a	$\text{mTORC1} \xrightarrow{\text{PKB308p, PKB308p473p, mTORC1, PKB308p473p, PKB308p}} \text{mTORC1a}$	
18	v5b	v5b	$\text{mTORC1a} \xrightarrow{\text{mTORC1a}} \text{mTORC1}$	
19	v5c	v5c	$\text{mTORC2} \xrightarrow{\text{IRip, mTORC2, IRip}} \text{mTORC2a}$	
20	v5d	v5d	$\text{mTORC2a} \xrightarrow{\text{mTORC2a}} \text{mTORC2}$	
21	v4a	v4a	$\text{PKB} \xrightarrow{\text{IRS1p, PKB, IRS1p}} \text{PKB308p}$	
22	v4b	v4b	$\text{PKB308p} \xrightarrow{\text{PKB308p}} \text{PKB}$	
23	v4c	v4c	$\text{PKB308p} \xrightarrow{\text{mTORC2a, PKB308p, mTORC2a}} \text{PKB308p473p}$	
24	v4e	v4e	$\text{PKB473p} \xrightarrow{\text{IRS1p307, PKB473p, IRS1p307}} \text{PKB308p473p}$	
25	v4f	v4f	$\text{PKB308p473p} \xrightarrow{\text{PKB308p473p}} \text{PKB473p}$	
26	v4h	v4h	$\text{PKB473p} \xrightarrow{\text{PKB473p}} \text{PKB}$	
27	v6f1	v6f1	$\text{AS160} \xrightarrow{\text{PKB308p473p, PKB473p, AS160, PKB308p473p, PKB473p}} \text{AS160p}$	
28	v6b1	v6b1	$\text{AS160p} \xrightarrow{\text{AS160p}} \text{AS160}$	
29	v7f	v7f	$\text{GLUT4} \xrightarrow{\text{AS160p, GLUT4, AS160p}} \text{GLUT4m}$	
30	v7b	v7b	$\text{GLUT4m} \xrightarrow{\text{GLUT4m}} \text{GLUT4}$	
31	v9f1	v9f1	$\text{S6K} \xrightarrow{\text{mTORC1a, S6K, mTORC1a}} \text{S6Kp}$	
32	v9b1	v9b1	$\text{S6Kp} \xrightarrow{\text{S6Kp}} \text{S6K}$	
33	v9f2	v9f2	$\text{S6} \xrightarrow{\text{S6Kp, S6, S6Kp}} \text{S6p}$	
34	v9b2	v9b2	$\text{S6p} \xrightarrow{\text{S6p}} \text{S6}$	

7.1 Reaction `v1a`

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

Name v1a

Reaction equation

$$\mathrm{IR} \xrightarrow{\mathrm{IR}} \mathrm{IRins} \tag{13}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
`IR`	IR	

Modifier

Table 7: Properties of each modifier.

Id	Name	SBO
`IR`	IR	

Product

Table 8: Properties of each product.

Id	Name	SBO
`IRins`	IRins	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = [\mathrm{IR}] \cdot \mathrm{k1a} \cdot \mathrm{insulin} \tag{14}$$

7.2 Reaction `v1basal`

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

Name v1basal

Reaction equation

$$\mathrm{IR} \xrightarrow{\mathrm{IR}} \mathrm{IRp} \tag{15}$$

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
IR	IR	

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
IR	IR	

Product

Table 11: Properties of each product.

Id	Name	SBO
IRp	IRp	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{k1basal} \cdot [\mathrm{IR}] \tag{16}$$

7.3 Reaction v1c

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

Name v1c

Reaction equation

$$\mathrm{IRins} \xrightarrow{\mathrm{IRins}} \mathrm{IRp} \tag{17}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
IRins	IRins	

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
IRins	IRins	

Product

Table 14: Properties of each product.

Id	Name	SBO
IRp	IRp	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = [\text{IRins}] \cdot \text{k1c} \tag{18}$$

7.4 Reaction v1d

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

Name v1d

Reaction equation

$$\text{IRp} \xrightarrow{\text{IRp}} \text{IRip} \tag{19}$$

Reactant

Table 15: Properties of each reactant.

Id	Name	SBO
IRp	IRp	

Modifier

Table 16: Properties of each modifier.

Id	Name	SBO
IRp	IRp	

Product

Table 17: Properties of each product.

Id	Name	SBO
IRip	IRip	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = [\mathrm{IRp}] \cdot \mathrm{k1d} \tag{20}$$

7.5 Reaction v1e

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

Name v1e

Reaction equation

$$\mathrm{IRip} \xrightarrow{\mathrm{Xp,\ IRip,\ Xp}} \mathrm{IRi} \tag{21}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
IRip	IRip	

Modifiers

Table 19: Properties of each modifier.

Id	Name	SBO
Xp	Xp	
IRip	IRip	
Xp	Xp	

Product

Table 20: Properties of each product.

Id	Name	SBO
IRi	IRi	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = [\mathrm{IRip}] \cdot \mathrm{k1f} \cdot [\mathrm{Xp}] \tag{22}$$

7.6 Reaction v1g

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

Name v1g

Reaction equation

$$\mathrm{IRp} \xrightarrow{\mathrm{IRp}} \mathrm{IR} \tag{23}$$

Reactant

Table 21: Properties of each reactant.

Id	Name	SBO
IRp	IRp	

Modifier

Table 22: Properties of each modifier.

Id	Name	SBO
IRp	IRp	

Product

Table 23: Properties of each product.

Id	Name	SBO
IR	IR	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = [\mathrm{IRp}] \cdot \mathrm{k1g} \tag{24}$$

7.7 Reaction v1r

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

Name v1r

Reaction equation

$$\mathrm{IRi} \xrightarrow{\mathrm{IRi}} \mathrm{IR} \tag{25}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
IRi	IRi	

Modifier

Table 25: Properties of each modifier.

Id	Name	SBO
IRi	IRi	

Product

Table 26: Properties of each product.

Id	Name	SBO
IR	IR	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = [\mathrm{IRi}] \cdot \mathrm{k1r} \tag{26}$$

7.8 Reaction v2a

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

Name v2a

Reaction equation

$$\mathrm{IRS1} \xrightarrow{\mathrm{IRip,\ IRS1,\ IRip}} \mathrm{IRS1p} \tag{27}$$

Reactant

Table 27: Properties of each reactant.

Id	Name	SBO
IRS1	IRS1	

Modifiers

Table 28: Properties of each modifier.

Id	Name	SBO
IRip	IRip	
IRS1	IRS1	
IRip	IRip	

Product

Table 29: Properties of each product.

Id	Name	SBO
IRS1p	IRS1p	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = [\text{IRS1}] \cdot \text{k2a} \cdot [\text{IRip}] \tag{28}$$

7.9 Reaction v2b

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

Name v2b

Reaction equation

$$\text{IRS1p} \xrightarrow{\text{IRS1p}} \text{IRS1} \tag{29}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
IRS1p	IRS1p	

Modifier

Table 31: Properties of each modifier.

Id	Name	SBO
IRS1p	IRS1p	

Product

Table 32: Properties of each product.

Id	Name	SBO
IRS1	IRS1	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = [\text{IRS1p}] \cdot \text{k2b} \tag{30}$$

7.10 Reaction v2c

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

Name v2c

Reaction equation

$$\text{IRS1p} \xrightarrow{\text{mTORC1a, IRS1p, mTORC1a}} \text{IRS1p307} \tag{31}$$

Reactant

Table 33: Properties of each reactant.

Id	Name	SBO
IRS1p	IRS1p	

Modifiers

Table 34: Properties of each modifier.

Id	Name	SBO
mTORC1a	mTORC1a	
IRS1p	IRS1p	
mTORC1a	mTORC1a	

Product

Table 35: Properties of each product.

Id	Name	SBO
IRS1p307	IRS1p307	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = [\text{IRS1p}] \cdot \text{k2c} \cdot [\text{mTORC1a}] \cdot \text{diabetes} \tag{32}$$

7.11 Reaction v2d

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

Name v2d

Reaction equation

$$\text{IRS1p307} \xrightarrow{\text{IRS1p307}} \text{IRS1p} \tag{33}$$

Reactant

Table 36: Properties of each reactant.

Id	Name	SBO
IRS1p307	IRS1p307	

Modifier

Table 37: Properties of each modifier.

Id	Name	SBO
IRS1p307	IRS1p307	

Product

Table 38: Properties of each product.

Id	Name	SBO
IRS1p	IRS1p	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = [\text{IRS1p307}] \cdot \text{k2d} \tag{34}$$

7.12 Reaction v2f

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

Name v2f

Reaction equation

$$\text{IRS1p307} \xrightarrow{\text{IRS1p307}} \text{IRS1307} \tag{35}$$

Reactant

Table 39: Properties of each reactant.

Id	Name	SBO
IRS1p307	IRS1p307	

Modifier

Table 40: Properties of each modifier.

Id	Name	SBO
IRS1p307	IRS1p307	

Product

Table 41: Properties of each product.

Id	Name	SBO
IRS1307	IRS1307	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = [\text{IRS1p307}] \cdot \text{k2f} \tag{36}$$

7.13 Reaction v2basal

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

Name v2basal

Reaction equation

$$\text{IRS1} \xrightarrow{\text{IRS1}} \text{IRS1307} \tag{37}$$

Reactant

Table 42: Properties of each reactant.

Id	Name	SBO
IRS1	IRS1	

Modifier

Table 43: Properties of each modifier.

Id	Name	SBO
IRS1	IRS1	

Product

Table 44: Properties of each product.

Id	Name	SBO
IRS1307	IRS1307	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = [\text{IRS1}] \cdot \text{k2basal} \tag{38}$$

7.14 Reaction v2g

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

Name v2g

Reaction equation

$$\text{IRS1307} \xrightarrow{\text{IRS1307}} \text{IRS1} \tag{39}$$

Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
IRS1307	IRS1307	

Modifier

Table 46: Properties of each modifier.

Id	Name	SBO
IRS1307	IRS1307	

Product

Table 47: Properties of each product.

Id	Name	SBO
IRS1	IRS1	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = [\text{IRS1307}] \cdot \text{k2g} \tag{40}$$

7.15 Reaction v3a

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

Name v3a

Reaction equation

$$\text{X} \xrightarrow{\text{IRS1p, X, IRS1p}} \text{Xp} \tag{41}$$

Reactant

Table 48: Properties of each reactant.

Id	Name	SBO
X	X	

Modifiers

Table 49: Properties of each modifier.

Id	Name	SBO
IRS1p	IRS1p	
X	X	
IRS1p	IRS1p	

Product

Table 50: Properties of each product.

Id	Name	SBO
Xp	Xp	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = [\mathrm{X}] \cdot \mathrm{k3a} \cdot [\mathrm{IRS1p}] \tag{42}$$

7.16 Reaction v3b

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

Name v3b

Reaction equation

$$\mathrm{Xp} \xrightarrow{\mathrm{Xp}} \mathrm{X} \tag{43}$$

Reactant

Table 51: Properties of each reactant.

Id	Name	SBO
Xp	Xp	

Modifier

Table 52: Properties of each modifier.

Id	Name	SBO
Xp	Xp	

Product

Table 53: Properties of each product.

Id	Name	SBO
X	X	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = [\mathrm{Xp}] \cdot \mathrm{k3b} \tag{44}$$

7.17 Reaction v5a

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

Name v5a

Reaction equation

$$\mathrm{mTORC1} \xrightarrow{\text{PKB308p, PKB308p473p, mTORC1, PKB308p473p, PKB308p}} \mathrm{mTORC1a} \tag{45}$$

Reactant

Table 54: Properties of each reactant.

Id	Name	SBO
mTORC1	mTORC1	

Modifiers

Table 55: Properties of each modifier.

Id	Name	SBO
PKB308p	PKB308p	

Id	Name	SBO
PKB308p473p	PKB308p473p	
mTORC1	mTORC1	
PKB308p473p	PKB308p473p	
PKB308p	PKB308p	

Product

Table 56: Properties of each product.

Id	Name	SBO
mTORC1a	mTORC1a	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = [\text{mTORC1}] \cdot (\text{k5a1} \cdot [\text{PKB308p473p}] + \text{k5a2} \cdot [\text{PKB308p}]) \tag{46}$$

7.18 Reaction v5b

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

Name v5b

Reaction equation

$$\text{mTORC1a} \xrightarrow{\text{mTORC1a}} \text{mTORC1} \tag{47}$$

Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
mTORC1a	mTORC1a	

Modifier

Table 58: Properties of each modifier.

Id	Name	SBO
mTORC1a	mTORC1a	

Product

Table 59: Properties of each product.

Id	Name	SBO
mTORC1	mTORC1	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = [\text{mTORC1a}] \cdot \text{k5b} \tag{48}$$

7.19 Reaction v5c

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

Name v5c

Reaction equation

$$\text{mTORC2} \xrightarrow{\text{IRip, mTORC2, IRip}} \text{mTORC2a} \tag{49}$$

Reactant

Table 60: Properties of each reactant.

Id	Name	SBO
mTORC2	mTORC2	

Modifiers

Table 61: Properties of each modifier.

Id	Name	SBO
IRip	IRip	

Id	Name	SBO
mTORC2	mTORC2	
IRip	IRip	

Product

Table 62: Properties of each product.

Id	Name	SBO
mTORC2a	mTORC2a	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = [\text{mTORC2}] \cdot \text{k5c} \cdot [\text{IRip}] \tag{50}$$

7.20 Reaction v5d

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

Name v5d

Reaction equation

$$\text{mTORC2a} \xrightarrow{\text{mTORC2a}} \text{mTORC2} \tag{51}$$

Reactant

Table 63: Properties of each reactant.

Id	Name	SBO
mTORC2a	mTORC2a	

Modifier

Table 64: Properties of each modifier.

Id	Name	SBO
mTORC2a	mTORC2a	

Product

Table 65: Properties of each product.

Id	Name	SBO
mTORC2	mTORC2	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{k5d} \cdot [\text{mTORC2a}] \tag{52}$$

7.21 Reaction v4a

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

Name v4a

Reaction equation

$$\text{PKB} \xrightarrow{\text{IRS1p, PKB, IRS1p}} \text{PKB308p} \tag{53}$$

Reactant

Table 66: Properties of each reactant.

Id	Name	SBO
PKB	PKB	

Modifiers

Table 67: Properties of each modifier.

Id	Name	SBO
IRS1p	IRS1p	
PKB	PKB	
IRS1p	IRS1p	

Product

Table 68: Properties of each product.

Id	Name	SBO
PKB308p	PKB308p	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{k4a} \cdot [\text{PKB}] \cdot [\text{IRS1p}] \tag{54}$$

7.22 Reaction v4b

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

Name v4b

Reaction equation

$$\text{PKB308p} \xrightarrow{\text{PKB308p}} \text{PKB} \tag{55}$$

Reactant

Table 69: Properties of each reactant.

Id	Name	SBO
PKB308p	PKB308p	

Modifier

Table 70: Properties of each modifier.

Id	Name	SBO
PKB308p	PKB308p	

Product

Table 71: Properties of each product.

Id	Name	SBO
PKB	PKB	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{k4b} \cdot [\text{PKB308p}] \tag{56}$$

7.23 Reaction v4c

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

Name v4c

Reaction equation

$$\text{PKB308p} \xrightarrow{\text{mTORC2a, PKB308p, mTORC2a}} \text{PKB308p473p} \tag{57}$$

Reactant

Table 72: Properties of each reactant.

Id	Name	SBO
PKB308p	PKB308p	

Modifiers

Table 73: Properties of each modifier.

Id	Name	SBO
mTORC2a	mTORC2a	
PKB308p	PKB308p	
mTORC2a	mTORC2a	

Product

Table 74: Properties of each product.

Id	Name	SBO
PKB308p473p	PKB308p473p	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{k4c} \cdot [\text{PKB308p}] \cdot [\text{mTORC2a}] \tag{58}$$

7.24 Reaction v4e

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

Name v4e

Reaction equation

$$\text{PKB473p} \xrightarrow{\text{IRS1p307, PKB473p, IRS1p307}} \text{PKB308p473p} \tag{59}$$

Reactant

Table 75: Properties of each reactant.

Id	Name	SBO
PKB473p	PKB473p	

Modifiers

Table 76: Properties of each modifier.

Id	Name	SBO
IRS1p307	IRS1p307	
PKB473p	PKB473p	
IRS1p307	IRS1p307	

Product

Table 77: Properties of each product.

Id	Name	SBO
PKB308p473p	PKB308p473p	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{k4e} \cdot [\text{PKB473p}] \cdot [\text{IRS1p307}] \tag{60}$$

7.25 Reaction v4f

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

Name v4f

Reaction equation

$$\text{PKB308p473p} \xrightarrow{\text{PKB308p473p}} \text{PKB473p} \tag{61}$$

Reactant

Table 78: Properties of each reactant.

Id	Name	SBO
PKB308p473p	PKB308p473p	

Modifier

Table 79: Properties of each modifier.

Id	Name	SBO
PKB308p473p	PKB308p473p	

Product

Table 80: Properties of each product.

Id	Name	SBO
PKB473p	PKB473p	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{k4f} \cdot [\text{PKB308p473p}] \tag{62}$$

7.26 Reaction v4h

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

Name v4h

Reaction equation

$$\text{PKB473p} \xrightarrow{\text{PKB473p}} \text{PKB} \tag{63}$$

Reactant

Table 81: Properties of each reactant.

Id	Name	SBO
PKB473p	PKB473p	

Modifier

Table 82: Properties of each modifier.

Id	Name	SBO
PKB473p	PKB473p	

Product

Table 83: Properties of each product.

Id	Name	SBO
PKB	PKB	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{k4h} \cdot [\text{PKB473p}] \tag{64}$$

7.27 Reaction v6f1

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

Name v6f1

Reaction equation

$$\text{AS160} \xrightarrow{\text{PKB308p473p, PKB473p, AS160, PKB308p473p, PKB473p}} \text{AS160p} \tag{65}$$

Reactant

Table 84: Properties of each reactant.

Id	Name	SBO
AS160	AS160	

Modifiers

Table 85: Properties of each modifier.

Id	Name	SBO
PKB308p473p	PKB308p473p	
PKB473p	PKB473p	
AS160	AS160	
PKB308p473p	PKB308p473p	
PKB473p	PKB473p	

Product

Table 86: Properties of each product.

Id	Name	SBO
AS160p	AS160p	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = [\mathrm{AS160}] \cdot \left(\mathrm{k6f1} \cdot [\mathrm{PKB308p473p}] + \frac{\mathrm{k6f2} \cdot [\mathrm{PKB473p}]^{\mathrm{n6}}}{\mathrm{km6}^{\mathrm{n6}} + [\mathrm{PKB473p}]^{\mathrm{n6}}} \right) \tag{66}$$

7.28 Reaction v6b1

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

Name v6b1

Reaction equation

$$\mathrm{AS160p} \xrightarrow{\mathrm{AS160p}} \mathrm{AS160} \tag{67}$$

Reactant

Table 87: Properties of each reactant.

Id	Name	SBO
AS160p	AS160p	

Modifier

Table 88: Properties of each modifier.

Id	Name	SBO
AS160p	AS160p	

Product

Table 89: Properties of each product.

Id	Name	SBO
AS160	AS160	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = [\text{AS160p}] \cdot \text{k6b} \tag{68}$$

7.29 Reaction v7f

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

Name v7f

Reaction equation

$$\text{GLUT4} \xrightarrow{\text{AS160p, GLUT4, AS160p}} \text{GLUT4m} \tag{69}$$

Reactant

Table 90: Properties of each reactant.

Id	Name	SBO
GLUT4	GLUT4	

Modifiers

Table 91: Properties of each modifier.

Id	Name	SBO
AS160p	AS160p	
GLUT4	GLUT4	
AS160p	AS160p	

Product

Table 92: Properties of each product.

Id	Name	SBO
GLUT4m	GLUT4m	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = [\text{GLUT4}] \cdot \text{k7f} \cdot [\text{AS160p}] \tag{70}$$

7.30 Reaction v7b

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

Name v7b

Reaction equation

$$\text{GLUT4m} \xrightarrow{\text{GLUT4m}} \text{GLUT4} \tag{71}$$

Reactant

Table 93: Properties of each reactant.

Id	Name	SBO
GLUT4m	GLUT4m	

Modifier

Table 94: Properties of each modifier.

Id	Name	SBO
GLUT4m	GLUT4m	

Product

Table 95: Properties of each product.

Id	Name	SBO
GLUT4	GLUT4	

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = [\text{GLUT4m}] \cdot \text{k7b} \tag{72}$$

7.31 Reaction v9f1

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

Name v9f1

Reaction equation

$$\text{S6K} \xrightarrow{\text{mTORC1a, S6K, mTORC1a}} \text{S6Kp} \tag{73}$$

Reactant

Table 96: Properties of each reactant.

Id	Name	SBO
S6K	S6K	

Modifiers

Table 97: Properties of each modifier.

Id	Name	SBO
mTORC1a	mTORC1a	

Id	Name	SBO
S6K	S6K	
mTORC1a	mTORC1a	

Product

Table 98: Properties of each product.

Id	Name	SBO
S6Kp	S6Kp	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \frac{[\text{S6K}] \cdot \text{k9f1} \cdot [\text{mTORC1a}]^{\text{n9}}}{\text{km9}^{\text{n9}} + [\text{mTORC1a}]^{\text{n9}}} \tag{74}$$

7.32 Reaction v9b1

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

Name v9b1

Reaction equation

$$\text{S6Kp} \xrightarrow{\text{S6Kp}} \text{S6K} \tag{75}$$

Reactant

Table 99: Properties of each reactant.

Id	Name	SBO
S6Kp	S6Kp	

Modifier

Table 100: Properties of each modifier.

Id	Name	SBO
S6Kp	S6Kp	

Id	Name	SBO

Product

Table 101: Properties of each product.

Id	Name	SBO
S6K	S6K	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = [\text{S6Kp}] \cdot \text{k9b1} \tag{76}$$

7.33 Reaction v9f2

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

Name v9f2

Reaction equation

$$\text{S6} \xrightarrow{\text{S6Kp, S6, S6Kp}} \text{S6p} \tag{77}$$

Reactant

Table 102: Properties of each reactant.

Id	Name	SBO
S6	S6	

Modifiers

Table 103: Properties of each modifier.

Id	Name	SBO
S6Kp	S6Kp	
S6	S6	
S6Kp	S6Kp	

Product

Table 104: Properties of each product.

Id	Name	SBO
S6p	S6p	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = [\text{S6}] \cdot \text{k9f2} \cdot [\text{S6Kp}] \tag{78}$$

7.34 Reaction v9b2

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

Name v9b2

Reaction equation

$$\text{S6p} \xrightarrow{\text{S6p}} \text{S6} \tag{79}$$

Reactant

Table 105: Properties of each reactant.

Id	Name	SBO
S6p	S6p	

Modifier

Table 106: Properties of each modifier.

Id	Name	SBO
S6p	S6p	

Product

Table 107: Properties of each product.

Id	Name	SBO
S6	S6	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = [\text{S6p}] \cdot \text{k9b2} \tag{80}$$

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 IR

Name IR

Initial concentration $49.9344643421136\ \text{mol} \cdot \text{l}^{-1}$

This species takes part in six reactions (as a reactant in `v1a`, `v1basal` and as a product in `v1g`, `v1r` and as a modifier in `v1a`, `v1basal`).

$$\frac{\text{d}}{\text{d}t}\text{IR} = v_6 + v_7 - v_1 - v_2 \tag{81}$$

8.2 Species IRp

Name IRp

Initial concentration $9.31221500588088 \cdot 10^{-4}\ \text{mol} \cdot \text{l}^{-1}$

This species takes part in six reactions (as a reactant in `v1d`, `v1g` and as a product in `v1basal`, `v1c` and as a modifier in `v1d`, `v1g`).

$$\frac{\text{d}}{\text{d}t}\text{IRp} = v_2 + v_3 - v_4 - v_6 \tag{82}$$

8.3 Species IRins

Name IRins

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

This species takes part in three reactions (as a reactant in v1c and as a product in v1a and as a modifier in v1c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRins} = v_1 - v_3 \tag{83}$$

8.4 Species IRip

Name IRip

Initial concentration $0.011815001204792\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in seven reactions (as a reactant in v1e and as a product in v1d and as a modifier in v1e, v2a, v2a, v5c, v5c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRip} = v_4 - v_5 \tag{84}$$

8.5 Species IRi

Name IRi

Initial concentration $0.0527894351383809\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v1r and as a product in v1e and as a modifier in v1r).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRi} = v_5 - v_7 \tag{85}$$

8.6 Species IRS1

Name IRS1

Initial concentration $86.2418960059256\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in v2a, v2basal and as a product in v2b, v2g and as a modifier in v2a, v2basal).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRS1} = v_9 + v_{14} - v_8 - v_{13} \tag{86}$$

8.7 Species IRS1p

Name IRS1p

Initial concentration $9.5272377217019 \cdot 10^{-4}\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in ten reactions (as a reactant in v2b, v2c and as a product in v2a, v2d and as a modifier in v2b, v2c, v3a, v3a, v4a, v4a).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRS1p} = v_8 + v_{11} - v_9 - v_{10} \tag{87}$$

8.8 Species IRS1p307

Name IRS1p307

Initial concentration $0.00891531075576947\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in seven reactions (as a reactant in v2d, v2f and as a product in v2c and as a modifier in v2d, v2f, v4e, v4e).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRS1p307} = v_{10} - v_{11} - v_{12} \tag{88}$$

8.9 Species IRS1307

Name IRS1307

Initial concentration $13.7482359094757\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v2g and as a product in v2f, v2basal and as a modifier in v2g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IRS1307} = v_{12} + v_{13} - v_{14} \tag{89}$$

8.10 Species X

Name X

Initial concentration $99.9986712896423\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v3a and as a product in v3b and as a modifier in v3a).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{X} = v_{16} - v_{15} \tag{90}$$

8.11 Species Xp

Name Xp

Initial concentration $0.00132871035763352\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in v3b and as a product in v3a and as a modifier in v1e, v1e, v3b).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Xp} = v_{15} - v_{16} \tag{91}$$

8.12 Species PKB

Name PKB

Initial concentration $78.0219322115859\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v4a and as a product in v4b, v4h and as a modifier in v4a).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PKB} = v_{22} + v_{26} - v_{21} \tag{92}$$

8.13 Species PKB308p

Name PKB308p

Initial concentration $12.2197372437326\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in seven reactions (as a reactant in v4b, v4c and as a product in v4a and as a modifier in v5a, v5a, v4b, v4c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PKB308p} = v_{21} - v_{22} - v_{23} \tag{93}$$

8.14 Species PKB473p

Name PKB473p

Initial concentration $9.6963389945784\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in seven reactions (as a reactant in v4e, v4h and as a product in v4f and as a modifier in v4e, v4h, v6f1, v6f1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PKB473p} = v_{25} - v_{24} - v_{26} \tag{94}$$

8.15 Species PKB308p473p

Name PKB308p473p

Initial concentration $0.061992532897245\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in v4f and as a product in v4c, v4e and as a modifier in v5a, v5a, v4f, v6f1, v6f1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PKB308p473p} = v_{23} + v_{24} - v_{25} \tag{95}$$

8.16 Species mTORC1

Name mTORC1

Initial concentration $96.927052256569\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v5a and as a product in v5b and as a modifier in v5a).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{mTORC1} = v_{18} - v_{17} \tag{96}$$

8.17 Species mTORC1a

Name mTORC1a

Initial concentration $3.07294774343092\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in seven reactions (as a reactant in v5b and as a product in v5a and as a modifier in v2c, v2c, v5b, v9f1, v9f1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{mTORC1a} = v_{17} - v_{18} \tag{97}$$

8.18 Species mTORC2

Name mTORC2

Initial concentration $99.9045223943705\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v5c and as a product in v5d and as a modifier in v5c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{mTORC2} = v_{20} - v_{19} \tag{98}$$

8.19 Species mTORC2a

Name mTORC2a

Initial concentration $0.0954776056294795\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in v5d and as a product in v5c and as a modifier in v5d, v4c, v4c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{mTORC2a} = v_{19} - v_{20} \tag{99}$$

8.20 Species AS160

Name AS160

Initial concentration $95.4699007486273\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v6f1 and as a product in v6b1 and as a modifier in v6f1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AS160} = v_{28} - v_{27} \tag{100}$$

8.21 Species AS160p

Name AS160p

Initial concentration $4.53009925137289\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in v6b1 and as a product in v6f1 and as a modifier in v6b1, v7f, v7f).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AS160p} = v_{27} - v_{28} \tag{101}$$

8.22 Species GLUT4m

Name GLUT4m

Initial concentration $4.5880858350243\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v7b and as a product in v7f and as a modifier in v7b).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GLUT4m} = v_{29} - v_{30} \tag{102}$$

8.23 Species GLUT4

Name GLUT4

Initial concentration 45.4119141649757 $\mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v7f and as a product in v7b and as a modifier in v7f).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GLUT4} = v_{30} - v_{29} \tag{103}$$

8.24 Species S6K

Name S6K

Initial concentration 99.8296860066098 $\mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v9f1 and as a product in v9b1 and as a modifier in v9f1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S6K} = v_{32} - v_{31} \tag{104}$$

8.25 Species S6Kp

Name S6Kp

Initial concentration 0.170313993390069 $\mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in v9b1 and as a product in v9f1 and as a modifier in v9b1, v9f2, v9f2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S6Kp} = v_{31} - v_{32} \tag{105}$$

8.26 Species S6

Name S6

Initial concentration 98.2037625421647 $\mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v9f2 and as a product in v9b2 and as a modifier in v9f2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S6} = v_{34} - v_{33} \tag{106}$$

8.27 Species S6p

Name S6p

Initial concentration $1.79623745783512\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v9b2 and as a product in v9f2 and as a modifier in v9b2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S6p} = v_{33} - v_{34} \tag{107}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000290 physical compartment: Specific location of space, that can be bounded or not. A physical compartment can have 1, 2 or 3 dimensions

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