

SBML Model Report

Model name: “Mosca2012 - Central Carbon Metabolism Regulated by AKT”



May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following three authors: Vijayalakshmi Chelliah¹, Ettore Mosca² and Roberta Alfieri³ at September third 2012 at 3:27 p. m. and last time modified at October ninth 2014 at 5:31 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	34
events	0	constraints	0
reactions	29	function definitions	28
global parameters	86	unit definitions	3
rules	34	initial assignments	0

Model Notes

Mosca2012 - Central Carbon Metabolism Regulated by AKT

The role of the PI3K/Akt/PKB signalling pathway in oncogenesis has been extensively investigated and altered expression or mutations of many components of this pathway have been

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implicated in human cancers. Indeed, expression of constitutively active forms of Akt/PKB can prevent cell death upon growth factor withdrawal. PI3K/Akt/mTOR-mediated survival relies on a profound metabolic adaptation, including aerobic glycolysis. Here, the link between the PI3K/Akt/mTOR pathway, glycolysis, lactic acid production and nucleotide biosynthesis has been modelled, considering two states - high and low PI3K/Akt/mTOR activity. The high PI3K/Akt/mTOR activity represents cancer cell line where PI3K/Akt/mTOR promotes a high rate of glucose metabolism (condition H) and the low PI3K/Akt/mTOR activity is characterised by a lower glycolytic rate due to a reduced PI3K/Akt/mTOR signal (condition L). This model corresponds to the high PI3K/Akt/mTOR signal (condition H).

This model is described in the article: [Computational Modelling of the Metabolic States Regulated by the Kinase Akt](#). Mosca E, Alfieri R, Maj C, Bevilacqua A, Canti G, Milanesi L. *Frontiers in Systems Biology*. 2012 Oct 13

Abstract:

Signal transduction pathways and gene regulation determine a major reorganization of metabolic activities in order to support cell proliferation. Protein Kinase B (PKB), also known as Akt, participates in the PI3K/Akt/mTOR pathway, a master regulator of aerobic glycolysis and cellular biosynthesis, two activities shown by both normal and cancer proliferating cells. Not surprisingly considering its relevance for cellular metabolism, Akt/PKB is often found hyperactive in cancer cells. In the last decade, many efforts have been made to improve the understanding of the control of glucose metabolism and the identification of a therapeutic window between proliferating cancer cells and proliferating normal cells. In this context, we have modelled the link between the PI3K/Akt/mTOR pathway, glycolysis, lactic acid production and nucleotide biosynthesis. We used a computational model in order to compare two metabolic states generated by the specific variation of the metabolic fluxes regulated by the activity of the PI3K/Akt/mTOR pathway. One of the two states represented the metabolism of a growing cancer cell characterised by aerobic glycolysis and cellular biosynthesis, while the other state represented the same metabolic network with a reduced glycolytic rate and a higher mitochondrial pyruvate metabolism, as reported in literature in relation to the activity of the PI3K/Akt/mTOR. Some steps that link glycolysis and pentose phosphate pathway revealed their importance for controlling the dynamics of cancer glucose metabolism.

This model is hosted on [BioModels Database](#) and identified by: [MODEL1210150000](#).

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

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2 Unit Definitions

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

2.1 Unit volume

Name volume

Definition nl

2.2 Unit time

Name time

Definition 60 s

2.3 Unit substance

Name substance

Definition nmol

2.4 Unit area

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

Definition m²

2.5 Unit length

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

Definition m

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
compartment_1	compartment		3	1	litre	<input checked="" type="checkbox"/>	

3.1 Compartment compartment_1

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

Name compartment

4 Species

This model contains 34 species. The boundary condition of 13 of these species is set to true so that these species' amount cannot be changed by any reaction. Section 9 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condi- tion
species_1	GLC	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_2	G6P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_3	ADP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input checked="" type="checkbox"/>
species_4	ATP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_5	F6P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_6	F16P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_7	E4P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_8	PGN	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_9	GLC_e	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_10	NADP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input checked="" type="checkbox"/>
species_11	NADPH	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_12	BPG	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_13	RU5P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_14	X5P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_15	R5P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_16	GAP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_17	S7P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_18	NADH	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input checked="" type="checkbox"/>
species_19	NAD	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_20	AMP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_21	PRPP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Id	Name	Compartment	Derived Unit	Constant	Boundary Condi- tion
species_22	G1P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_23	Pi	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_24	GLY	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_25	CIT	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_26	F26P	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_27	DHAP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_28	PG3	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_29	PG2	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_30	PEP	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_31	PYR	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
species_32	LAC	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_33	CO2	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
species_34	O2	compartment_1	$\text{nmol} \cdot \text{nl}^{-1}$	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

5 Parameters

This model contains 86 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
parameter_1	Atot		0.011		<input checked="" type="checkbox"/>
parameter_2	NPtr		$1.932 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_3	Ntot		0.001		<input checked="" type="checkbox"/>
parameter_4	GPa_Vr		0.018		<input type="checkbox"/>
parameter_5	GPa_Keq		0.420		<input checked="" type="checkbox"/>
parameter_6	GPb_Keq		16.620		<input checked="" type="checkbox"/>
parameter_7	GPb_Vr		$6.03725213205671 \cdot 10^{-5}$		<input type="checkbox"/>
parameter_8	FBA_Vr		11.560		<input type="checkbox"/>
parameter_9	TPI_Vr		49.208		<input type="checkbox"/>
parameter_10	GAPDH_Vr		135.425		<input type="checkbox"/>
parameter_11	PGK_Vr		71.722		<input type="checkbox"/>
parameter_12	FBA_Keq		0.002		<input checked="" type="checkbox"/>
parameter_13	PGI_Vmr		17486.511		<input type="checkbox"/>
parameter_14	PGI_Keq		0.056		<input checked="" type="checkbox"/>
parameter_15	PGLM_Vmr		0.204		<input type="checkbox"/>
parameter_16	PGLM_Keq		17.200		<input checked="" type="checkbox"/>
parameter_17	scale1e3		1000.000		<input checked="" type="checkbox"/>
parameter_18	TPI_Keq		0.381		<input checked="" type="checkbox"/>
parameter_19	GAPDH_Keq		0.357		<input checked="" type="checkbox"/>
parameter_20	PGK_Keq		11.369		<input checked="" type="checkbox"/>
parameter_21	PGYM_Keq		1.649		<input checked="" type="checkbox"/>
parameter_22	PGYM_Vr		58.980		<input type="checkbox"/>
parameter_23	ENO_Keq		1.413		<input checked="" type="checkbox"/>
parameter_24	ENO_Vr		179.835		<input type="checkbox"/>
parameter_25	LDH_Keq		3452.500		<input checked="" type="checkbox"/>
parameter_26	LDH_Vr		54.047		<input type="checkbox"/>
parameter_27	AMP		0.003		<input type="checkbox"/>
parameter_28	AKT		1.000		<input checked="" type="checkbox"/>
parameter_29	AKT_MPM		1.000		<input checked="" type="checkbox"/>
parameter_30	GLUT_Vf		23.030		<input type="checkbox"/>
parameter_31	HK_Vf		86.850		<input type="checkbox"/>
parameter_32	PGI_Vmf		7778.000		<input type="checkbox"/>
parameter_33	G6PDH_Vf		1.008		<input type="checkbox"/>
parameter_34	PGDH_Vf		31.020		<input type="checkbox"/>
parameter_35	TKL_Vf		1056.000		<input type="checkbox"/>
parameter_36	TKL2_Vf		0.176		<input type="checkbox"/>
parameter_37	FBA_Vf		14.630		<input type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
parameter_38	TPI_Vf		5.976		<input type="checkbox"/>
parameter_39	GAPDH_Vf		109.100		<input type="checkbox"/>
parameter_40	PGK_Vf		73.410		<input type="checkbox"/>
parameter_41	GS_Vf		32040.000		<input type="checkbox"/>
parameter_42	PFK_Vf		107.600		<input type="checkbox"/>
parameter_43	ENO_Vf		160.900		<input type="checkbox"/>
parameter_44	PK_Vf		27.810		<input type="checkbox"/>
parameter_45	LDH_Vf		340.300		<input type="checkbox"/>
parameter_46	DHase_Vf		4982000.000		<input type="checkbox"/>
parameter_47	DPHase_Vf		127800.000		<input type="checkbox"/>
parameter_48	MPM_Vf		9801000.000		<input type="checkbox"/>
parameter_49	PGK_Kp		$1.3 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_50	PGK_Kq		$2.7 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_51	PGK_Ka		$7.9 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_52	PGK_Kb		$4 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_53	ENO_Kmp		$6 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_54	ENO_Kms		$3.8 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_55	PGLM_Vmaxf		7.364		<input checked="" type="checkbox"/>
parameter_56	PGLM_KG6P		$3 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_57	PGLM_KG1P		$6.3 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_58	GPa_Vmaxf		0.033		<input checked="" type="checkbox"/>
parameter_59	GPa_KiGLYb		$1.5 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_60	GPa_KiG1P		0.010		<input checked="" type="checkbox"/>
parameter_61	GPa_KiGLYf		0.002		<input checked="" type="checkbox"/>
parameter_62	GPa_KPi		0.004		<input checked="" type="checkbox"/>
parameter_63	GPb_Vmaxf		0.010		<input checked="" type="checkbox"/>
parameter_64	GPb_KiGLYb		0.004		<input checked="" type="checkbox"/>
parameter_65	GPb_KG1P		0.002		<input checked="" type="checkbox"/>
parameter_66	GPb_KiGLYf		0.015		<input checked="" type="checkbox"/>
parameter_67	GPb_KiPi		0.005		<input checked="" type="checkbox"/>
parameter_68	FBA_Kdhap		$8 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_69	FBA_Kg3p		$1.6 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_70	FBA_Kfbp		$9 \cdot 10^{-6}$		<input checked="" type="checkbox"/>
parameter_71	TPI_Kmp		0.002		<input checked="" type="checkbox"/>
parameter_72	TPI_Kms		$5.1 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_73	GAPDH_Kdpg		$2.2 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_74	GAPDH_Knadh		10^{-5}		<input checked="" type="checkbox"/>
parameter_75	GAPDH_Kg3p		$1.9 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_76	GAPDH_Knad		$9 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_77	GAPDH_Kp		0.029		<input checked="" type="checkbox"/>
parameter_78	PGYM_Vmf		154.000		<input checked="" type="checkbox"/>
parameter_79	PGYM_Kmp		$1.2 \cdot 10^{-4}$		<input checked="" type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
parameter_80	PGYM_Kms		$1.9 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_81	PGI_Kf6p		$5 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_82	PGI_Kg6p		$4 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
parameter_83	LDH_Kp		0.005		<input checked="" type="checkbox"/>
parameter_84	LDH_Kq		$7 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
parameter_85	LDH_Ka		$2 \cdot 10^{-6}$		<input checked="" type="checkbox"/>
parameter_86	LDH_Kb		$3 \cdot 10^{-4}$		<input checked="" type="checkbox"/>

6 Function definitions

This is an overview of 28 function definitions.

6.1 Function definition RUPE

Name RUPE

Arguments V_{\max} , RU5P, X5P, K_{eq_RUPE} , KRu5P, KX5P

Mathematical Expression

$$\frac{V_{\max} \cdot \left(RU5P - \frac{X5P}{K_{eq_RUPE}} \right)}{RU5P + KRu5P \cdot \left(1 + \frac{X5P}{KX5P} \right)} \quad (1)$$

6.2 Function definition PGDH

Name PGDH

Arguments V_{\max} , K6PG1, KNADP, PGN, NADP, RU5P, NADPH, Kapp, BPG, KPGA23, ATP, KATP, K6PG2, KNADPH

Mathematical Expression

$$\frac{\frac{V_{\max}}{K6PG1} \cdot \left(PGN \cdot NADP - \frac{RU5P \cdot NADPH}{Kapp} \right)}{\left(1 + \frac{NADP}{KNADP} \right) \cdot \left(1 + \frac{PGN}{K6PG1} + \frac{BPG}{KPGA23} \right) + \frac{ATP}{KATP} + \frac{NADPH \cdot \left(1 + \frac{PGN}{K6PG2} \right)}{KNADPH}} \quad (2)$$

6.3 Function definition G6PDH

Name G6PDH

Arguments V_{\max} , KG6P, KNADP, G6P, NADP, PGN, NADPH, Kapp, ATP, KATP, KNADPH, BPG, KPGA23

Mathematical Expression

$$\frac{\frac{V_{\max}}{K_{G6P}} \cdot \left(G6P \cdot NADP - \frac{PGN \cdot NADPH}{K_{app}} \right)}{1 + \frac{NADP \cdot \left(1 + \frac{G6P}{K_{G6P}} \right)}{K_{NADP}} + \frac{ATP}{K_{ATP}} + \frac{NADPH}{K_{NADPH}} + \frac{BPG}{K_{PGA23}}} \quad (3)$$

6.4 Function definition TKL

Name TKL

Arguments V_{\max} , R5P, X5P, GAP, S7P, K_{eq_TKL} , K1, K2, K6, K3, K5, K4, K7

Mathematical Expression

$$\frac{V_{\max} \cdot \left(R5P \cdot X5P - \frac{GAP \cdot S7P}{K_{eq_TKL}} \right)}{(K1 + R5P) \cdot X5P + (K2 + K6 \cdot S7P) \cdot R5P + (K3 + K5 \cdot S7P) \cdot GAP + K4 \cdot S7P + K7 \cdot X5P \cdot GAP} \quad (4)$$

6.5 Function definition PGI

Name PGI

Arguments V_{mf} , A, K_{g6p} , V_{mr} , P, K_{f6p} , E4P, K_{ery4p} , F16P, K_{fbp} , PGN, K_{pg}

Mathematical Expression

$$\frac{\frac{V_{mf} \cdot A}{K_{g6p}} - \frac{V_{mr} \cdot P}{K_{f6p}}}{1 + \frac{A}{K_{g6p}} + \frac{P}{K_{f6p}} + \frac{E4P}{K_{ery4p}} + \frac{F16P}{K_{fbp}} + \frac{PGN}{K_{pg}}} \quad (5)$$

6.6 Function definition TKL2

Name TKL2

Arguments V_{\max} , E4P, X5P, GAP, F6P, K_{eq_TKL2} , K1, K2, K6, K3, K5, K4, K7

Mathematical Expression

$$\frac{V_{\max} \cdot \left(E4P \cdot X5P - \frac{GAP \cdot F6P}{K_{eq_TKL2}} \right)}{(K1 + E4P) \cdot X5P + (K2 + K6 \cdot F6P) \cdot E4P + (K3 + K5 \cdot F6P) \cdot GAP + K4 \cdot F6P + K7 \cdot X5P \cdot GAP} \quad (6)$$

6.7 Function definition HK

Name HK

Arguments Vmf, Ka, Kb, A, B, P, Q, Kapp, Kp, Kq

Mathematical Expression

$$\frac{\frac{V_{mf}}{K_a \cdot K_b} \cdot \left(A \cdot B - \frac{P \cdot Q}{K_{app}} \right)}{1 + \frac{A}{K_a} + \frac{B}{K_b} + \frac{A \cdot B}{K_a \cdot K_b} + \frac{P}{K_p} + \frac{Q}{K_q} + \frac{P \cdot Q}{K_p \cdot K_q} + \frac{A \cdot Q}{K_a \cdot K_q} + \frac{P \cdot B}{K_p \cdot K_b}} \quad (7)$$

6.8 Function definition R5PI

Name R5PI

Arguments Vmax, RU5P, R5P, Keq_R5PI, KRu5P, KR5P

Mathematical Expression

$$\frac{V_{max} \cdot \left(RU5P - \frac{R5P}{K_{eq_R5PI}} \right)}{RU5P + KRu5P \cdot \left(1 + \frac{R5P}{KR5P} \right)} \quad (8)$$

6.9 Function definition GLUT

Name GLUT

Arguments Vmaxf, GLC_e, GLC, keq, KGlc_e, KGlc

Mathematical Expression

$$\frac{V_{maxf} \cdot \left(GLC_e - \frac{GLC}{k_{eq}} \right)}{KGlc_e \cdot \left(1 + \frac{GLC}{KGlc} \right) + GLC_e} \quad (9)$$

6.10 Function definition TAL

Name TAL

Arguments Vmax, S7P, GAP, E4P, F6P, Keq_TAL, K1, K2, K6, K3, K5, K4, K7

Mathematical Expression

$$\frac{V_{max} \cdot \left(S7P \cdot GAP - \frac{E4P \cdot F6P}{K_{eq_TAL}} \right)}{(K1 + GAP) \cdot S7P + (K2 + K6 \cdot F6P) \cdot GAP + (K3 + K5 \cdot F6P) \cdot E4P + K4 \cdot F6P + K7 \cdot S7P \cdot E4P} \quad (10)$$

6.11 Function definition PGLM

Name PGLM

Arguments Vmaxf, G1P, KG1P, Vmaxr, G6P, KG6P

Mathematical Expression

$$\frac{\frac{V_{\max f} \cdot G1P}{KG1P} - \frac{V_{\max r} \cdot G6P}{KG6P}}{1 + \frac{G1P}{KG1P} + \frac{G6P}{KG6P}} \quad (11)$$

6.12 Function definition PRPPS

Name PRPPS

Arguments Vmax, R5P, ATP, PRPP, AMP, Kapp, KATP, KR5P

Mathematical Expression

$$\frac{V_{\max} \cdot \left(R5P \cdot ATP - \frac{PRPP \cdot AMP}{K_{app}} \right)}{(KATP + ATP) \cdot (KR5P + R5P)} \quad (12)$$

6.13 Function definition GPa

Name GPa

Arguments Vmaxf, GLY, Pi, KiGLYf, KPi, Vmaxr, G1P, KGLYb, KiG1P, KiPi, KiGLYb

Mathematical Expression

$$\frac{V_{\max f} \cdot \frac{GLY \cdot Pi}{KiGLYf \cdot KPi} - V_{\max r} \cdot \frac{GLY \cdot G1P}{KGLYb \cdot KiG1P}}{1 + \frac{GLY}{KiGLYf} + \frac{Pi}{KiPi} + \frac{GLY}{KiGLYb} + \frac{G1P}{KiG1P} + \frac{GLY \cdot Pi}{KiGLYf \cdot KPi} + \frac{GLY \cdot G1P}{KGLYb \cdot KiG1P}} \quad (13)$$

6.14 Function definition GPb

Name GPb

Arguments Vmaxf, GLY, Pi, KiGLYf, KPi, Vmaxr, G1P, KiGLYb, KG1P, KiPi, KiG1P, AMP, nH, Kamp

Mathematical Expression

$$\frac{\frac{V_{\max f} \cdot \frac{GLY \cdot Pi}{KiGLYf \cdot KPi} - V_{\max r} \cdot \frac{GLY \cdot G1P}{KGLYb \cdot KG1P}}{1 + \frac{GLY}{KiGLYf} + \frac{Pi}{KiPi} + \frac{GLY}{KiGLYb} + \frac{G1P}{KiG1P} + \frac{GLY \cdot Pi}{KiGLYf \cdot KPi} + \frac{GLY \cdot G1P}{KGLYb \cdot KG1P}} \cdot \frac{AMP^{nH}}{K_{amp}}}{1 + \frac{AMP^{nH}}{K_{amp}}} \quad (14)$$

6.15 Function definition FBA

Name FBA

Arguments Vmf, A, Kfbp, Vmr, P, Q, Kdhap, Kg3p

Mathematical Expression

$$\frac{\frac{Vmf \cdot A}{Kfbp} - \frac{Vmr \cdot P \cdot Q}{Kdhap \cdot Kg3p}}{1 + \frac{A}{Kfbp} + \frac{P}{Kdhap} + \frac{Q}{Kg3p} + \frac{P \cdot Q}{Kdhap \cdot Kg3p}} \quad (15)$$

6.16 Function definition TPI

Name TPI

Arguments Vf, GAP, Kms, Vr, DHAP, Kmp

Mathematical Expression

$$\frac{\frac{Vf \cdot GAP}{Kms} - \frac{Vr \cdot DHAP}{Kmp}}{1 + \frac{GAP}{Kms} + \frac{DHAP}{Kmp}} \quad (16)$$

6.17 Function definition GAPDH

Name GAPDH

Arguments Vmf, A, B, C, Knad, Kg3p, Kp, Vmr, P, Q, Kdpg, Knadh

Mathematical Expression

$$\frac{\frac{Vmf \cdot A \cdot B \cdot C}{Knad \cdot Kg3p \cdot Kp} - \frac{Vmr \cdot P \cdot Q}{Kdpg \cdot Knadh}}{1 + \frac{A}{Knad} + \frac{A \cdot B}{Knad \cdot Kg3p} + \frac{A \cdot B \cdot C}{Knad \cdot Kg3p \cdot Kp} + \frac{P \cdot Q}{Kdpg \cdot Knadh} + \frac{Q}{Knadh}} \quad (17)$$

6.18 Function definition PGK

Name PGK

Arguments Vmf, A, B, alfa, Ka, Kb, Vmr, P, Q, beta, Kp, Kq

Mathematical Expression

$$\frac{\frac{Vmf \cdot A \cdot B}{\alpha \cdot Ka \cdot Kb} - \frac{Vmr \cdot P \cdot Q}{\beta \cdot Kp \cdot Kq}}{1 + \frac{A}{Ka} + \frac{B}{Kb} + \frac{A \cdot B}{\alpha \cdot Ka \cdot Kb} + \frac{P \cdot Q}{\beta \cdot Kp \cdot Kq} + \frac{P}{Kp} + \frac{Q}{Kq}} \quad (18)$$

6.19 Function definition PFK

Name PFK

Arguments Vm, a, B, Katp, beta, F26P, alfa, Kf26bp, A, Kf6p, L, CIT, Kcit, Kiatp, Q, P, Kadp, Kfbp, Kapp

Mathematical Expression

$$\begin{aligned}
 & Vm \cdot \frac{\frac{a \cdot B}{Katp}}{1 + \frac{a \cdot B}{Katp}} \cdot \frac{1 + \frac{\beta \cdot a \cdot F26P}{\alpha \cdot Kf26bp}}{1 + \frac{a \cdot F26P}{\alpha \cdot Kf26bp}} \\
 & \cdot \left(\frac{\frac{a \cdot A \cdot \left(1 + \frac{a \cdot F26P}{\alpha \cdot Kf26bp}\right)}{Kf6p \cdot \left(1 + \frac{a \cdot F26P}{Kf26bp}\right)} \cdot \left(1 + \frac{a \cdot A \cdot \left(1 + \frac{a \cdot F26P}{\alpha \cdot Kf26bp}\right)}{Kf6p \cdot \left(1 + \frac{a \cdot F26P}{Kf26bp}\right)}\right)^3}{\frac{L \cdot \left(1 + \frac{a \cdot CIT}{Kcit}\right)^4 \cdot \left(1 + \frac{a \cdot B}{Kiatp}\right)^4}{\left(1 + \frac{a \cdot F26P}{Kf26bp}\right)^4} + \left(1 + \frac{a \cdot A \cdot \left(1 + \frac{a \cdot F26P}{\alpha \cdot Kf26bp}\right)}{Kf6p \cdot \left(1 + \frac{a \cdot F26P}{Kf26bp}\right)}\right)^4} \right. \\
 & \left. - \frac{\frac{a \cdot Q \cdot a \cdot P}{Kadp \cdot Kfbp \cdot Kapp}}{\frac{a \cdot Q}{Kadp} + \frac{a \cdot P}{Kfbp} + \frac{a \cdot Q \cdot a \cdot P}{Kadp \cdot Kfbp} + 1} \right)
 \end{aligned} \tag{19}$$

6.20 Function definition function_1

Name PGYM [1]

Arguments Vmf, PG3, Kms, Vmr, PG2, Kmp

Mathematical Expression

$$\frac{\frac{Vmf \cdot PG3}{Kms} - \frac{Vmr \cdot PG2}{Kmp}}{1 + \frac{PG3}{Kms} + \frac{PG2}{Kmp}} \tag{20}$$

6.21 Function definition GS

Name GS

Arguments Vmaxf, Kf, a, G1P, ATP, GLY, Pi, ADP, Keq, Kr

Mathematical Expression

$$\frac{\frac{Vmaxf}{Kf} \cdot a \cdot G1P \cdot a \cdot ATP \cdot a \cdot GLY \cdot \left(1 - \frac{(a \cdot Pi)^2 \cdot a \cdot ADP}{a \cdot G1P \cdot a \cdot ATP \cdot Keq}\right)}{1 + \frac{a \cdot G1P \cdot a \cdot ATP \cdot a \cdot GLY}{Kf} + \frac{a \cdot GLY \cdot (a \cdot Pi)^2 \cdot a \cdot ADP}{Kr}} \tag{21}$$

6.22 Function definition `function_2`

Name ENO [1]

Arguments Vmf, PG2, Kms, Vmr, PEP, Kmp

Mathematical Expression

$$\frac{\frac{Vmf \cdot PG2}{Kms} - \frac{Vmr \cdot PEP}{Kmp}}{1 + \frac{PG2}{Kms} + \frac{PEP}{Kmp}} \quad (22)$$

6.23 Function definition `function_3`

Name PK [1]

Arguments Vm, B, Kadp, A, Kpep, L, Q, Kiatp, F16P, Kfbp, P, Katp, Kpyr, Kapp, a

Mathematical Expression

$$Vm \cdot \left(\frac{\frac{a \cdot B}{Kadp}}{1 + \frac{a \cdot B}{Kadp}} \cdot \frac{\frac{a \cdot A}{Kpep} \cdot \left(1 + \frac{a \cdot A}{Kpep}\right)^3}{\frac{L \cdot \left(1 + \frac{a \cdot Q}{Kiatp}\right)^4}{\left(1 + \frac{a \cdot F16P}{Kfbp}\right)^4} + \left(1 + \frac{a \cdot A}{Kpep}\right)^4} - \frac{\frac{a \cdot Q \cdot a \cdot P}{Katp \cdot Kpyr \cdot Kapp}}{\frac{a \cdot Q}{Katp} + \frac{a \cdot P}{Kpyr} + \frac{a \cdot Q \cdot a \cdot P}{Katp \cdot Kpyr} + 1} \right) \quad (23)$$

6.24 Function definition `function_4`

Name LDH [1]

Arguments Vmf, A, B, alfa, Ka, Kb, Vmr, P, Q, beta, Kp, Kq

Mathematical Expression

$$\frac{\frac{Vmf \cdot A \cdot B}{alfa \cdot Ka \cdot Kb} - \frac{Vmr \cdot P \cdot Q}{beta \cdot Kp \cdot Kq}}{1 + \frac{A}{Ka} + \frac{B}{Kb} + \frac{A \cdot B}{alfa \cdot Ka \cdot Kb} + \frac{P \cdot Q}{beta \cdot Kp \cdot Kq} + \frac{P}{Kp} + \frac{Q}{Kq}} \quad (24)$$

6.25 Function definition `function_5`

Name AK [1]

Arguments Vf, ADP, ATP, AMP, Keq

Mathematical Expression

$$\frac{Vf \cdot ADP^2 \cdot \left(1 - \frac{ATP \cdot AMP}{Keq}\right)}{(1 + ADP)^2 + (1 + ATP) \cdot (1 + AMP) - 1} \quad (25)$$

6.26 Function definition `function_6`

Name DHase [1]

Arguments Vf, NADH, NAD, Keq

Mathematical Expression

$$\frac{Vf \cdot NADH \cdot \left(1 - \frac{NAD}{NADH \cdot Keq}\right)}{1 + NADH + 1 + NAD - 1} \quad (26)$$

6.27 Function definition `function_7`

Name DPHase [1]

Arguments Vf, NADPH, NADP, Keq

Mathematical Expression

$$\frac{Vf \cdot NADPH \cdot \left(1 - \frac{NADP}{NADPH \cdot Keq}\right)}{1 + NADPH + 1 + NADP - 1} \quad (27)$$

6.28 Function definition `function_8`

Name MPM [1]

Arguments Vmf, PYR, y, Pi, ADP, O2, ATP, CO2, Keq

Mathematical Expression

$$\frac{Vmf \cdot PYR^{\frac{1}{y}} \cdot Pi \cdot ADP \cdot O2^{\frac{5}{2y}} \cdot \left(1 - \frac{ATP \cdot CO2^{\frac{3}{y}}}{PYR^{\frac{1}{y}} \cdot O2^{\frac{5}{2y}} \cdot Pi \cdot ADP \cdot Keq}\right)}{(1 + PYR)^{\frac{1}{y}} \cdot (1 + O2)^{\frac{5}{2y}} \cdot (1 + Pi) \cdot (1 + ADP) + (1 + ATP) \cdot (1 + CO2)^{\frac{3}{y}} - 1} \quad (28)$$

7 Rules

This is an overview of 34 rules.

7.1 Rule `parameter_35`

Rule `parameter_35` is an assignment rule for parameter `parameter_35`:

$$parameter_35 = 1056 \cdot parameter_28 \quad (29)$$

7.2 Rule `parameter_36`

Rule `parameter_36` is an assignment rule for parameter `parameter_36`:

$$\text{parameter_36} = 0.1761 \cdot \text{parameter_28} \quad (30)$$

7.3 Rule `parameter_40`

Rule `parameter_40` is an assignment rule for parameter `parameter_40`:

$$\text{parameter_40} = 73.41 \cdot \text{parameter_28} \quad (31)$$

7.4 Rule `parameter_44`

Rule `parameter_44` is an assignment rule for parameter `parameter_44`:

$$\text{parameter_44} = 27.81 \cdot \text{parameter_28} \quad (32)$$

7.5 Rule `parameter_30`

Rule `parameter_30` is an assignment rule for parameter `parameter_30`:

$$\text{parameter_30} = 23.03 \cdot \text{parameter_28} \quad (33)$$

7.6 Rule `parameter_42`

Rule `parameter_42` is an assignment rule for parameter `parameter_42`:

$$\text{parameter_42} = 107.6 \cdot \text{parameter_28} \quad (34)$$

7.7 Rule `parameter_11`

Rule `parameter_11` is an assignment rule for parameter `parameter_11`:

$$\text{parameter_11} = \frac{\text{parameter_40} \cdot \text{parameter_49} \cdot \text{parameter_50}}{\text{parameter_51} \cdot \text{parameter_52} \cdot \text{parameter_20}} \quad (35)$$

7.8 Rule `parameter_48`

Rule `parameter_48` is an assignment rule for parameter `parameter_48`:

$$\text{parameter_48} = 9801000 \cdot \text{parameter_29} \quad (36)$$

7.9 Rule `parameter_34`

Rule `parameter_34` is an assignment rule for parameter `parameter_34`:

$$\text{parameter_34} = 31.02 \cdot \text{parameter_28} \quad (37)$$

7.10 Rule `parameter_43`

Rule `parameter_43` is an assignment rule for parameter `parameter_43`:

$$\text{parameter_43} = 160.9 \cdot \text{parameter_28} \quad (38)$$

7.11 Rule `parameter_24`

Rule `parameter_24` is an assignment rule for parameter `parameter_24`:

$$\text{parameter_24} = \frac{\text{parameter_43} \cdot \text{parameter_53}}{\text{parameter_54} \cdot \text{parameter_23}} \quad (39)$$

7.12 Rule `parameter_15`

Rule `parameter_15` is an assignment rule for parameter `parameter_15`:

$$\text{parameter_15} = \frac{\text{parameter_55} \cdot \text{parameter_56}}{\text{parameter_57} \cdot \text{parameter_16}} \quad (40)$$

7.13 Rule `parameter_47`

Rule `parameter_47` is an assignment rule for parameter `parameter_47`:

$$\text{parameter_47} = 127800 \cdot \text{parameter_28} \quad (41)$$

7.14 Rule `species_10`

Rule `species_10` is an assignment rule for species `species_10`:

$$\text{species_10} = \text{parameter_2} - [\text{species_11}] \quad (42)$$

7.15 Rule `species_3`

Rule `species_3` is an assignment rule for species `species_3`:

$$\text{species_3} = \text{parameter_1} - [\text{species_4}] \quad (43)$$

7.16 Rule `species_18`

Rule `species_18` is an assignment rule for species `species_18`:

$$\text{species_18} = \text{parameter_3} - [\text{species_19}] \quad (44)$$

7.17 Rule `parameter_4`

Rule `parameter_4` is an assignment rule for parameter `parameter_4`:

$$\text{parameter_4} = \frac{\text{parameter_58} \cdot \text{parameter_59} \cdot \text{parameter_60}}{\text{parameter_61} \cdot \text{parameter_62} \cdot \text{parameter_5}} \quad (45)$$

7.18 Rule `parameter_7`

Rule `parameter_7` is an assignment rule for parameter `parameter_7`:

$$\text{parameter_7} = \frac{\text{parameter_63} \cdot \text{parameter_64} \cdot \text{parameter_65}}{\text{parameter_66} \cdot \text{parameter_67} \cdot \text{parameter_6}} \quad (46)$$

7.19 Rule `parameter_37`

Rule `parameter_37` is an assignment rule for parameter `parameter_37`:

$$\text{parameter_37} = 14.63 \cdot \text{parameter_28} \quad (47)$$

7.20 Rule `parameter_8`

Rule `parameter_8` is an assignment rule for parameter `parameter_8`:

$$\text{parameter_8} = \frac{\text{parameter_37} \cdot \text{parameter_68} \cdot \text{parameter_69}}{\text{parameter_12} \cdot \text{parameter_70}} \quad (48)$$

7.21 Rule `parameter_38`

Rule `parameter_38` is an assignment rule for parameter `parameter_38`:

$$\text{parameter_38} = 5.976 \cdot \text{parameter_28} \quad (49)$$

7.22 Rule `parameter_9`

Rule `parameter_9` is an assignment rule for parameter `parameter_9`:

$$\text{parameter_9} = \frac{\text{parameter_38} \cdot \text{parameter_71}}{\text{parameter_72} \cdot \text{parameter_18}} \quad (50)$$

7.23 Rule `parameter_39`

Rule `parameter_39` is an assignment rule for parameter `parameter_39`:

$$\text{parameter_39} = 109.1 \cdot \text{parameter_28} \quad (51)$$

7.24 Rule `parameter_10`

Rule `parameter_10` is an assignment rule for parameter `parameter_10`:

$$\text{parameter_10} = \frac{\text{parameter_39} \cdot \text{parameter_73} \cdot \text{parameter_74}}{\text{parameter_75} \cdot \text{parameter_76} \cdot \text{parameter_77} \cdot \text{parameter_19}} \quad (52)$$

7.25 Rule `parameter_41`

Rule `parameter_41` is an assignment rule for parameter `parameter_41`:

$$\text{parameter_41} = 32040 \cdot \text{parameter_28} \quad (53)$$

7.26 Rule parameter_46

Rule parameter_46 is an assignment rule for parameter parameter_46:

$$\text{parameter_46} = 4982000 \cdot \text{parameter_28} \quad (54)$$

7.27 Rule parameter_22

Rule parameter_22 is an assignment rule for parameter parameter_22:

$$\text{parameter_22} = \frac{\text{parameter_78} \cdot \text{parameter_79}}{\text{parameter_80} \cdot \text{parameter_21}} \quad (55)$$

7.28 Rule parameter_31

Rule parameter_31 is an assignment rule for parameter parameter_31:

$$\text{parameter_31} = 86.85 \cdot \text{parameter_28} \quad (56)$$

7.29 Rule parameter_33

Rule parameter_33 is an assignment rule for parameter parameter_33:

$$\text{parameter_33} = 1.008 \cdot \text{parameter_28} \quad (57)$$

7.30 Rule parameter_32

Rule parameter_32 is an assignment rule for parameter parameter_32:

$$\text{parameter_32} = 7778 \cdot \text{parameter_28} \quad (58)$$

7.31 Rule parameter_13

Rule parameter_13 is an assignment rule for parameter parameter_13:

$$\text{parameter_13} = \text{parameter_32} \cdot \frac{\text{parameter_81}}{\text{parameter_82} \cdot \text{parameter_14}} \quad (59)$$

7.32 Rule parameter_27

Rule parameter_27 is an assignment rule for parameter parameter_27:

$$\text{parameter_27} = [\text{species_20}] \quad (60)$$

Derived unit nmol · nl⁻¹

7.33 Rule parameter_45

Rule parameter_45 is an assignment rule for parameter parameter_45:

$$\text{parameter_45} = 340.3 \cdot \text{parameter_28} \quad (61)$$

7.34 Rule `parameter_26`

Rule `parameter_26` is an assignment rule for parameter `parameter_26`:

$$\text{parameter_26} = \frac{\text{parameter_45} \cdot \text{parameter_83} \cdot \text{parameter_84}}{\text{parameter_85} \cdot \text{parameter_86} \cdot \text{parameter_25}} \quad (62)$$

8 Reactions

This model contains 29 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

Nº	Id	Name	Reaction Equation	SBO
1	reaction_1	GLUT	$\text{species}_9 \xrightleftharpoons{\text{species}_9, \text{species}_1} \text{species}_1$	
2	reaction_2	HK	$\text{species}_1 + \text{species}_4 \xrightleftharpoons{\text{species}_1, \text{species}_4, \text{species}_2, \text{species}_3} \text{species}_2 + \text{species}_3$	
3	reaction_3	PGI	$\text{species}_2 \xrightleftharpoons{\text{species}_7, \text{species}_6, \text{species}_8, \text{species}_2, \text{species}_5, \text{species}_7, \text{species}_6, \text{species}_8} \text{species}_7$	
4	reaction_4	G6PDH	$\text{species}_2 + \text{species}_{10} \xrightleftharpoons{\text{species}_4, \text{species}_{12}, \text{species}_2, \text{species}_{10}, \text{species}_8, \text{species}_{11}} \text{species}_{11}$	
5	reaction_5	PGDH	$\text{species}_8 + \text{species}_{10} \xrightleftharpoons{\text{species}_{12}, \text{species}_4, \text{species}_8, \text{species}_{10}, \text{species}_{13}, \text{species}_{11}} \text{species}_{11}$	
6	reaction_6	RUPE	$\text{species}_{13} \xrightleftharpoons{\text{species}_{13}, \text{species}_{14}} \text{species}_{14}$	
7	reaction_7	R5PI	$\text{species}_{13} \xrightleftharpoons{\text{species}_{13}, \text{species}_{15}} \text{species}_{15}$	
8	reaction_8	TKL	$\text{species}_{15} + \text{species}_{14} \xrightleftharpoons{\text{species}_{15}, \text{species}_{14}, \text{species}_{16}, \text{species}_{17}} \text{species}_{16} + \text{species}_{17}$	
9	reaction_9	TKL2	$\text{species}_{14} + \text{species}_7 \xrightleftharpoons{\text{species}_7, \text{species}_{14}, \text{species}_{16}, \text{species}_5} \text{species}_{16} + \text{species}_5$	
10	reaction_10	TAL	$\text{species}_{17} + \text{species}_{16} \xrightleftharpoons{\text{species}_{17}, \text{species}_{16}, \text{species}_7, \text{species}_5} \text{species}_5 + \text{species}_7$	

Nº	Id	Name	Reaction Equation	SBO
11	reaction_11	PRPPS	$\text{species_15} + \text{species_4} \xrightleftharpoons[\text{species_21}]{\text{species_15, species_4, species_21, species_20}} \text{species_20} + \text{species_21}$	
12	reaction_12	PGLM	$\text{species_22} \xrightleftharpoons[\text{species_2}]{\text{species_22, species_2}} \text{species_2}$	
13	reaction_13	GPa	$\text{species_24} + \text{species_23} \xrightleftharpoons[\text{species_22}]{\text{species_24, species_23, species_22}} \text{species_24} + \text{species_22}$	
14	reaction_14	FBA	$\text{species_6} \xrightleftharpoons[\text{species_27}]{\text{species_6, species_27, species_16}} \text{species_16} + \text{species_27}$	
15	reaction_15	TPI	$\text{species_16} \xrightleftharpoons[\text{species_27}]{\text{species_16, species_27}} \text{species_27}$	
16	reaction_16	GAPDH	$\text{species_16} + \text{species_19} + \text{species_23} \xrightleftharpoons[\text{species_18}]{\text{species_19, species_16, species_23, species_12, species_18}} \text{species_12} + \text{species_18}$	
17	reaction_17	PGK	$\text{species_12} + \text{species_3} \xrightleftharpoons[\text{species_4}]{\text{species_12, species_3, species_28, species_4}} \text{species_28} + \text{species_4}$	
18	reaction_18	GPb	$\text{species_24} + \text{species_23} \xrightleftharpoons[\text{species_22}]{\text{species_24, species_23, species_22}} \text{species_24} + \text{species_22}$	
19	reaction_19	GS	$\text{species_22} + \text{species_4} \xrightleftharpoons[\text{species_3} + 2 \text{ species_23}]{\text{species_22, species_4, species_24, species_23, species_3}} \text{species_24} + \text{species_23}$	
20	reaction_20	PFK	$\text{species_5} + \text{species_4} \xrightleftharpoons[\text{species_3}]{\text{species_26, species_25, species_4, species_26, species_5, species_3}} \text{species_26} + \text{species_5}$	
21	reaction_21	PGYM	$\text{species_28} \xrightleftharpoons[\text{species_29}]{\text{species_28, species_29}} \text{species_29}$	
22	reaction_22	ENO	$\text{species_29} \xrightleftharpoons[\text{species_30}]{\text{species_29, species_30}} \text{species_30}$	

Nº	Id	Name	Reaction Equation	SBO
23	reaction_23	PK	$\text{species_30} + \text{species_3} \xrightleftharpoons[\text{species_4}]{\text{species_6, species_3, species_30, species_4, species_6, species_3}}$	
24	reaction_24	LDH	$\text{species_31} + \text{species_18} \xrightleftharpoons[\text{species_19}]{\text{species_18, species_31, species_32, species_19}} \text{species_32} + \text{species_19}$	
25	reaction_25	AK	$2 \text{ species_3} \xrightleftharpoons[\text{species_20}]{\text{species_3, species_4, species_20}} \text{species_4} + \text{species_20}$	
26	reaction_26	DHase	$\text{species_18} \xrightleftharpoons[\text{species_19}]{\text{species_18, species_19}} \text{species_19}$	
27	reaction_27	DPHase	$\text{species_11} \xrightleftharpoons[\text{species_10}]{\text{species_11, species_10}} \text{species_10}$	
28	reaction_28	MPM	$0 \cdot 08 \text{ species_31} + 0 \cdot 2 \text{ species_34} + \text{species_23} + \text{species_3} \xrightleftharpoons[\text{species_4}]{\text{species_31, species_23, species_3, species_34, species_4, species_33}} 0 \cdot 24 \text{ species_31} + 0 \cdot 2 \text{ species_34} + \text{species_23} + \text{species_4}$	
29	reaction_29	ATPase	$\text{species_4} \xrightarrow{\text{species_4}} \text{species_3} + \text{species_23}$	

8.1 Reaction `reaction_1`

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

Name GLUT

Reaction equation



Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
<code>species_9</code>	GLC_e	

Modifiers

Table 7: Properties of each modifier.

Id	Name	SBO
<code>species_9</code>	GLC_e	
<code>species_1</code>	GLC	

Product

Table 8: Properties of each product.

Id	Name	SBO
<code>species_1</code>	GLC	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{vol}(\text{compartment_1}) \cdot \text{GLUT}(\text{parameter_30}, [\text{species_9}], [\text{species_1}], \text{keq}, \text{KGlc_e}, \text{KGlc}) \quad (64)$$

$$\text{GLUT}(V_{\text{maxf}}, \text{GLC_e}, \text{GLC}, \text{keq}, \text{KGlc_e}, \text{KGlc}) = \frac{V_{\text{maxf}} \cdot \left(\text{GLC_e} - \frac{\text{GLC}}{\text{keq}} \right)}{\text{KGlc_e} \cdot \left(1 + \frac{\text{GLC}}{\text{KGlc}} \right) + \text{GLC_e}} \quad (65)$$

$$\text{GLUT}(V_{\max f}, \text{GLC_e}, \text{GLC}, k_{\text{eq}}, K_{\text{Glc_e}}, K_{\text{Glc}}) = \frac{V_{\max f} \cdot \left(\text{GLC_e} - \frac{\text{GLC}}{k_{\text{eq}}} \right)}{K_{\text{Glc_e}} \cdot \left(1 + \frac{\text{GLC}}{K_{\text{Glc}}} \right) + \text{GLC_e}} \quad (66)$$

Table 9: Properties of each parameter.

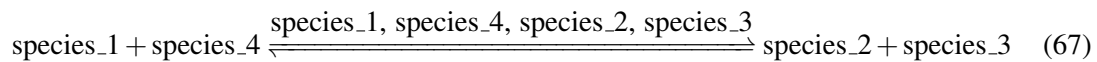
Id	Name	SBO	Value	Unit	Constant
keq	keq		1.000		<input checked="" type="checkbox"/>
KGlc_e	KGlc_e		0.010		<input checked="" type="checkbox"/>
KGlc	KGlc		0.009		<input checked="" type="checkbox"/>

8.2 Reaction `reaction_2`

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name HK

Reaction equation



Reactants

Table 10: Properties of each reactant.

Id	Name	SBO
species_1	GLC	
species_4	ATP	

Modifiers

Table 11: Properties of each modifier.

Id	Name	SBO
species_1	GLC	
species_4	ATP	
species_2	G6P	
species_3	ADP	

Products

Table 12: Properties of each product.

Id	Name	SBO
species_2	G6P	
species_3	ADP	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{vol}(\text{compartment}_1) \cdot \text{HK}(\text{parameter}_{31}, K_a, K_b, [\text{species}_1], [\text{species}_4], [\text{species}_2], [\text{species}_3], K_{app}, K_p, K_q) \quad (68)$$

$$\begin{aligned} & \text{HK}(V_{mf}, K_a, K_b, A, B, P, Q, K_{app}, K_p, K_q) \\ &= \frac{\frac{V_{mf}}{K_a \cdot K_b} \cdot \left(A \cdot B - \frac{P \cdot Q}{K_{app}} \right)}{1 + \frac{A}{K_a} + \frac{B}{K_b} + \frac{A \cdot B}{K_a \cdot K_b} + \frac{P}{K_p} + \frac{Q}{K_q} + \frac{P \cdot Q}{K_p \cdot K_q} + \frac{A \cdot Q}{K_a \cdot K_q} + \frac{P \cdot B}{K_p \cdot K_b}} \end{aligned} \quad (69)$$

$$\begin{aligned} & \text{HK}(V_{mf}, K_a, K_b, A, B, P, Q, K_{app}, K_p, K_q) \\ &= \frac{\frac{V_{mf}}{K_a \cdot K_b} \cdot \left(A \cdot B - \frac{P \cdot Q}{K_{app}} \right)}{1 + \frac{A}{K_a} + \frac{B}{K_b} + \frac{A \cdot B}{K_a \cdot K_b} + \frac{P}{K_p} + \frac{Q}{K_q} + \frac{P \cdot Q}{K_p \cdot K_q} + \frac{A \cdot Q}{K_a \cdot K_q} + \frac{P \cdot B}{K_p \cdot K_b}} \end{aligned} \quad (70)$$

Table 13: Properties of each parameter.

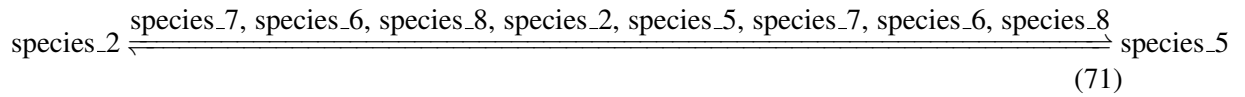
Id	Name	SBO	Value	Unit	Constant
Ka	Ka		10^{-4}		✓
Kb	Kb		0.001		✓
Kapp	Kapp		651.000		✓
Kp	Kp		$2 \cdot 10^{-5}$		✓
Kq	Kq		0.004		✓

8.3 Reaction `reaction_3`

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

Name PGI

Reaction equation



Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
species_2	G6P	

Modifiers

Table 15: Properties of each modifier.

Id	Name	SBO
species_7	E4P	
species_6	F16P	
species_8	PGN	
species_2	G6P	
species_5	F6P	
species_7	E4P	
species_6	F16P	
species_8	PGN	

Product

Table 16: Properties of each product.

Id	Name	SBO
species_5	F6P	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{vol}(\text{compartment_1}) \cdot \text{PGI}(\text{parameter_32}, [\text{species_2}], \text{parameter_82}, \text{parameter_13}, [\text{species_5}], \text{parameter_81}, [\text{species_7}], \text{Kery4p}, [\text{species_6}], \text{Kfbp}, [\text{species_8}], \text{Kpg}) \quad (72)$$

$$\begin{aligned} & \text{PGI}(\text{Vmf}, \text{A}, \text{Kg6p}, \text{Vmr}, \text{P}, \text{Kf6p}, \text{E4P}, \text{Kery4p}, \text{F16P}, \text{Kfbp}, \text{PGN}, \text{Kpg}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A}}{\text{Kg6p}} - \frac{\text{Vmr} \cdot \text{P}}{\text{Kf6p}}}{1 + \frac{\text{A}}{\text{Kg6p}} + \frac{\text{P}}{\text{Kf6p}} + \frac{\text{E4P}}{\text{Kery4p}} + \frac{\text{F16P}}{\text{Kfbp}} + \frac{\text{PGN}}{\text{Kpg}}} \end{aligned} \quad (73)$$

$$\begin{aligned} & \text{PGI}(\text{Vmf}, \text{A}, \text{Kg6p}, \text{Vmr}, \text{P}, \text{Kf6p}, \text{E4P}, \text{Kery4p}, \text{F16P}, \text{Kfbp}, \text{PGN}, \text{Kpg}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A}}{\text{Kg6p}} - \frac{\text{Vmr} \cdot \text{P}}{\text{Kf6p}}}{1 + \frac{\text{A}}{\text{Kg6p}} + \frac{\text{P}}{\text{Kf6p}} + \frac{\text{E4P}}{\text{Kery4p}} + \frac{\text{F16P}}{\text{Kfbp}} + \frac{\text{PGN}}{\text{Kpg}}} \end{aligned} \quad (74)$$

Table 17: Properties of each parameter.

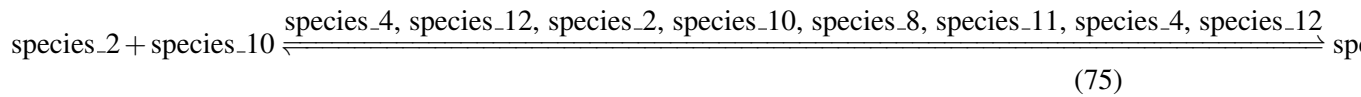
Id	Name	SBO	Value	Unit	Constant
Kery4p	Kery4p		10^{-6}		<input checked="" type="checkbox"/>
Kfbp	Kfbp		$6 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
Kpg	Kpg		$1.5 \cdot 10^{-5}$		<input checked="" type="checkbox"/>

8.4 Reaction [reaction_4](#)

This is a reversible reaction of two reactants forming two products influenced by eight modifiers.

Name G6PDH

Reaction equation



Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
species_2	G6P	
species_10	NADP	

Modifiers

Table 19: Properties of each modifier.

Id	Name	SBO
species_4	ATP	
species_12	BPG	
species_2	G6P	
species_10	NADP	
species_8	PGN	
species_11	NADPH	
species_4	ATP	
species_12	BPG	

Products

Table 20: Properties of each product.

Id	Name	SBO
species_8	PGN	
species_11	NADPH	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{vol}(\text{compartment}_1) \cdot \text{G6PDH}(\text{parameter}_{.33}, \text{KG6P}, \text{KNADP}, [\text{species}_2], [\text{species}_{10}], [\text{species}_8], [\text{species}_{11}], \text{Kapp}, [\text{species}_4], \text{KATP}, \text{KNADPH}, [\text{species}_{12}], \text{KPGA23}) \quad (76)$$

$$\text{G6PDH}(\text{Vmax}, \text{KG6P}, \text{KNADP}, \text{G6P}, \text{NADP}, \text{PGN}, \text{NADPH}, \text{Kapp}, \text{ATP}, \text{KATP}, \text{KNADPH}, \text{BPG}, \text{KPGA23}) = \frac{\frac{\text{Vmax}}{\text{KG6P}} \cdot \left(\text{G6P} \cdot \text{NADP} - \frac{\text{PGN} \cdot \text{NADPH}}{\text{Kapp}} \right)}{1 + \frac{\text{NADP} \cdot \left(1 + \frac{\text{G6P}}{\text{KG6P}} \right)}{\text{KNADP}} + \frac{\text{ATP}}{\text{KATP}} + \frac{\text{NADPH}}{\text{KNADPH}} + \frac{\text{BPG}}{\text{KPGA23}}} \quad (77)$$

$$\text{G6PDH}(\text{Vmax}, \text{KG6P}, \text{KNADP}, \text{G6P}, \text{NADP}, \text{PGN}, \text{NADPH}, \text{Kapp}, \text{ATP}, \text{KATP}, \text{KNADPH}, \text{BPG}, \text{KPGA23}) = \frac{\frac{\text{Vmax}}{\text{KG6P}} \cdot \left(\text{G6P} \cdot \text{NADP} - \frac{\text{PGN} \cdot \text{NADPH}}{\text{Kapp}} \right)}{1 + \frac{\text{NADP} \cdot \left(1 + \frac{\text{G6P}}{\text{KG6P}} \right)}{\text{KNADP}} + \frac{\text{ATP}}{\text{KATP}} + \frac{\text{NADPH}}{\text{KNADPH}} + \frac{\text{BPG}}{\text{KPGA23}}} \quad (78)$$

Table 21: Properties of each parameter.

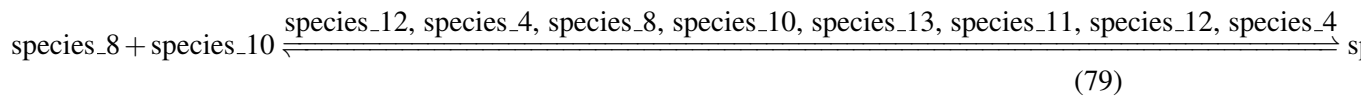
Id	Name	SBO	Value	Unit	Constant
KG6P	KG6P		$6.67 \cdot 10^{-8}$		✓
KNADP	KNADP		$3.67 \cdot 10^{-9}$		✓
Kapp	Kapp		2000.000		✓
KATP	KATP		$7.49 \cdot 10^{-7}$		✓
KNADPH	KNADPH		$3.12 \cdot 10^{-9}$		✓
KPGA23	KPGA23		$2.289 \cdot 10^{-6}$		✓

8.5 Reaction [reaction_5](#)

This is a reversible reaction of two reactants forming two products influenced by eight modifiers.

Name PGDH

Reaction equation



Reactants

Table 22: Properties of each reactant.

Id	Name	SBO
species_8	PGN	
species_10	NADP	

Modifiers

Table 23: Properties of each modifier.

Id	Name	SBO
species_12	BPG	
species_4	ATP	
species_8	PGN	
species_10	NADP	
species_13	RU5P	
species_11	NADPH	
species_12	BPG	
species_4	ATP	

Id	Name	SBO
----	------	-----

Products

Table 24: Properties of each product.

Id	Name	SBO
species_13	RU5P	
species_11	NADPH	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{vol}(\text{compartment_1}) \cdot \text{PGDH}(\text{parameter_34}, \text{K6PG1}, \text{KNADP}, [\text{species_8}], [\text{species_10}], [\text{species_13}], [\text{species_11}], \text{Kapp}, [\text{species_12}], \text{KPGA23}, [\text{species_4}], \text{KATP}, \text{K6PG2}, \text{KNADPH}) \quad (80)$$

$$\text{PGDH}(\text{Vmax}, \text{K6PG1}, \text{KNADP}, \text{PGN}, \text{NADP}, \text{RU5P}, \text{NADPH}, \text{Kapp}, \text{BPG}, \text{KPGA23}, \text{ATP}, \text{KATP}, \text{K6PG2}, \text{KNADPH}) = \frac{\frac{\text{Vmax}}{\text{K6PG1}} \cdot \left(\text{PGN} \cdot \text{NADP} - \frac{\text{RU5P} \cdot \text{NADPH}}{\text{Kapp}} \right)}{\left(1 + \frac{\text{NADP}}{\text{KNADP}} \right) \cdot \left(1 + \frac{\text{PGN}}{\text{K6PG1}} + \frac{\text{BPG}}{\text{KPGA23}} \right) + \frac{\text{ATP}}{\text{KATP}} + \frac{\text{NADPH} \cdot \left(1 + \frac{\text{PGN}}{\text{K6PG2}} \right)}{\text{KNADPH}}} \quad (81)$$

$$\text{PGDH}(\text{Vmax}, \text{K6PG1}, \text{KNADP}, \text{PGN}, \text{NADP}, \text{RU5P}, \text{NADPH}, \text{Kapp}, \text{BPG}, \text{KPGA23}, \text{ATP}, \text{KATP}, \text{K6PG2}, \text{KNADPH}) = \frac{\frac{\text{Vmax}}{\text{K6PG1}} \cdot \left(\text{PGN} \cdot \text{NADP} - \frac{\text{RU5P} \cdot \text{NADPH}}{\text{Kapp}} \right)}{\left(1 + \frac{\text{NADP}}{\text{KNADP}} \right) \cdot \left(1 + \frac{\text{PGN}}{\text{K6PG1}} + \frac{\text{BPG}}{\text{KPGA23}} \right) + \frac{\text{ATP}}{\text{KATP}} + \frac{\text{NADPH} \cdot \left(1 + \frac{\text{PGN}}{\text{K6PG2}} \right)}{\text{KNADPH}}} \quad (82)$$

Table 25: Properties of each parameter.

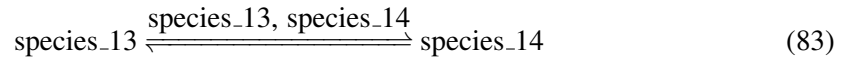
Id	Name	SBO	Value	Unit	Constant
K6PG1	K6PG1		10^{-8}		✓
KNADP	KNADP		$1.8 \cdot 10^{-8}$		✓
Kapp	Kapp		141.700		✓
KPGA23	KPGA23		$1.2 \cdot 10^{-7}$		✓
KATP	KATP		$1.54 \cdot 10^{-7}$		✓
K6PG2	K6PG2		$5.8 \cdot 10^{-8}$		✓
KNADPH	KNADPH		$4.5 \cdot 10^{-9}$		✓

8.6 Reaction `reaction_6`

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

Name RUPE

Reaction equation



Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
<code>species_13</code>	RU5P	

Modifiers

Table 27: Properties of each modifier.

Id	Name	SBO
<code>species_13</code>	RU5P	
<code>species_14</code>	X5P	

Product

Table 28: Properties of each product.

Id	Name	SBO
<code>species_14</code>	X5P	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \text{vol}(\text{compartment_1}) \cdot \text{RUPE}(\text{Vmax}, [\text{species_13}], [\text{species_14}], \text{Keq_RUPE}, \text{KRu5P}, \text{KX5P}) \quad (84)$$

$$\text{RUPE}(\text{Vmax}, \text{RU5P}, \text{X5P}, \text{Keq_RUPE}, \text{KRu5P}, \text{KX5P}) = \frac{\text{Vmax} \cdot \left(\text{RU5P} - \frac{\text{X5P}}{\text{Keq_RUPE}} \right)}{\text{RU5P} + \text{KRu5P} \cdot \left(1 + \frac{\text{X5P}}{\text{KX5P}} \right)} \quad (85)$$

$$\text{RUPE}(V_{\max}, \text{RU5P}, \text{X5P}, K_{\text{eq_RUPE}}, K_{\text{Ru5P}}, K_{\text{X5P}}) = \frac{V_{\max} \cdot \left(\text{RU5P} - \frac{\text{X5P}}{K_{\text{eq_RUPE}}} \right)}{\text{RU5P} + K_{\text{Ru5P}} \cdot \left(1 + \frac{\text{X5P}}{K_{\text{X5P}}} \right)} \quad (86)$$

Table 29: Properties of each parameter.

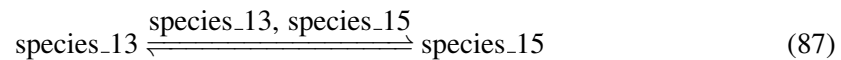
Id	Name	SBO	Value	Unit	Constant
Vmax	Vmax		1.471		<input checked="" type="checkbox"/>
Keq_RUPE	Keq_RUPE		2.700		<input checked="" type="checkbox"/>
KRu5P	KRu5P		$1.9 \cdot 10^{-7}$		<input checked="" type="checkbox"/>
KX5P	KX5P		$5 \cdot 10^{-7}$		<input checked="" type="checkbox"/>

8.7 Reaction `reaction_7`

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

Name R5PI

Reaction equation



Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
species_13	RU5P	

Modifiers

Table 31: Properties of each modifier.

Id	Name	SBO
species_13	RU5P	
species_15	R5P	

Product

Table 32: Properties of each product.

Id	Name	SBO
species_15	R5P	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \text{vol}(\text{compartment}_1) \cdot \text{R5PI}(\text{Vmax}, [\text{species}_13], [\text{species}_15], \text{Keq_R5PI}, \text{KRu5P}, \text{KR5P}) \quad (88)$$

$$\text{R5PI}(\text{Vmax}, \text{RU5P}, \text{R5P}, \text{Keq_R5PI}, \text{KRu5P}, \text{KR5P}) = \frac{\text{Vmax} \cdot \left(\text{RU5P} - \frac{\text{R5P}}{\text{Keq_R5PI}} \right)}{\text{RU5P} + \text{KRu5P} \cdot \left(1 + \frac{\text{R5P}}{\text{KR5P}} \right)} \quad (89)$$

$$\text{R5PI}(\text{Vmax}, \text{RU5P}, \text{R5P}, \text{Keq_R5PI}, \text{KRu5P}, \text{KR5P}) = \frac{\text{Vmax} \cdot \left(\text{RU5P} - \frac{\text{R5P}}{\text{Keq_R5PI}} \right)}{\text{RU5P} + \text{KRu5P} \cdot \left(1 + \frac{\text{R5P}}{\text{KR5P}} \right)} \quad (90)$$

Table 33: Properties of each parameter.

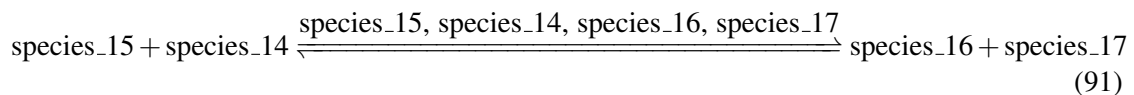
Id	Name	SBO	Value	Unit	Constant
Vmax	Vmax		0.765		✓
Keq_R5PI	Keq_R5PI		3.000		✓
KRu5P	KRu5P		$7.8 \cdot 10^{-7}$		✓
KR5P	KR5P		$2.2 \cdot 10^{-6}$		✓

8.8 Reaction `reaction_8`

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name TKL

Reaction equation



Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
species_15	R5P	
species_14	X5P	

Modifiers

Table 35: Properties of each modifier.

Id	Name	SBO
species_15	R5P	
species_14	X5P	
species_16	GAP	
species_17	S7P	

Products

Table 36: Properties of each product.

Id	Name	SBO
species_16	GAP	
species_17	S7P	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{vol}(\text{compartment}_1) \cdot \text{TKL}(\text{parameter}_{35}, [\text{species}_{15}], [\text{species}_{14}], [\text{species}_{16}], [\text{species}_{17}], \text{Keq_TKL}, K1, K2, K6, K3, K5, K4, K7) \quad (92)$$

$$\begin{aligned} & \text{TKL}(\text{Vmax}, \text{R5P}, \text{X5P}, \text{GAP}, \text{S7P}, \text{Keq_TKL}, K1, K2, K6, K3, K5, K4, K7) \quad (93) \\ &= \frac{\text{Vmax} \cdot \left(\text{R5P} \cdot \text{X5P} - \frac{\text{GAP} \cdot \text{S7P}}{\text{Keq_TKL}} \right)}{(\text{K1} + \text{R5P}) \cdot \text{X5P} + (\text{K2} + \text{K6} \cdot \text{S7P}) \cdot \text{R5P} + (\text{K3} + \text{K5} \cdot \text{S7P}) \cdot \text{GAP} + \text{K4} \cdot \text{S7P} + \text{K7} \cdot \text{X5P} \cdot \text{GAP}} \end{aligned}$$

$$\begin{aligned} & \text{TKL}(\text{Vmax}, \text{R5P}, \text{X5P}, \text{GAP}, \text{S7P}, \text{Keq_TKL}, K1, K2, K6, K3, K5, K4, K7) \quad (94) \\ &= \frac{\text{Vmax} \cdot \left(\text{R5P} \cdot \text{X5P} - \frac{\text{GAP} \cdot \text{S7P}}{\text{Keq_TKL}} \right)}{(\text{K1} + \text{R5P}) \cdot \text{X5P} + (\text{K2} + \text{K6} \cdot \text{S7P}) \cdot \text{R5P} + (\text{K3} + \text{K5} \cdot \text{S7P}) \cdot \text{GAP} + \text{K4} \cdot \text{S7P} + \text{K7} \cdot \text{X5P} \cdot \text{GAP}} \end{aligned}$$

Table 37: Properties of each parameter.

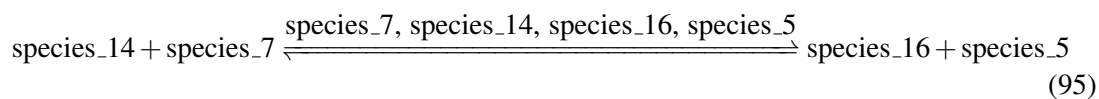
Id	Name	SBO	Value	Unit	Constant
Keq_TKL	Keq_TKL		2.080		<input checked="" type="checkbox"/>
K1	K1		$4.177 \cdot 10^{-7}$		<input checked="" type="checkbox"/>
K2	K2		$3.055 \cdot 10^{-7}$		<input checked="" type="checkbox"/>
K6	K6		0.008		<input checked="" type="checkbox"/>
K3	K3		$1.2432 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
K5	K5		0.411		<input checked="" type="checkbox"/>
K4	K4		$4.96 \cdot 10^{-9}$		<input checked="" type="checkbox"/>
K7	K7		48.800		<input checked="" type="checkbox"/>

8.9 Reaction `reaction_9`

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name TKL2

Reaction equation



Reactants

Table 38: Properties of each reactant.

Id	Name	SBO
species_14	X5P	
species_7	E4P	

Modifiers

Table 39: Properties of each modifier.

Id	Name	SBO
species_7	E4P	
species_14	X5P	
species_16	GAP	
species_5	F6P	

Products

Table 40: Properties of each product.

Id	Name	SBO
species_16	GAP	
species_5	F6P	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{vol}(\text{compartment}_1) \cdot \text{TKL2}(\text{parameter}_{36}, [\text{species}_7], [\text{species}_{14}], [\text{species}_{16}], [\text{species}_5], \text{Keq_TKL2}, K1, K2, K6, K3, K5, K4, K7) \quad (96)$$

$$\begin{aligned} & \text{TKL2}(\text{Vmax}, \text{E4P}, \text{X5P}, \text{GAP}, \text{F6P}, \text{Keq_TKL2}, K1, K2, K6, K3, K5, K4, K7) \quad (97) \\ &= \frac{\text{Vmax} \cdot \left(\text{E4P} \cdot \text{X5P} - \frac{\text{GAP} \cdot \text{F6P}}{\text{Keq_TKL2}} \right)}{(\text{K1} + \text{E4P}) \cdot \text{X5P} + (\text{K2} + \text{K6} \cdot \text{F6P}) \cdot \text{E4P} + (\text{K3} + \text{K5} \cdot \text{F6P}) \cdot \text{GAP} + \text{K4} \cdot \text{F6P} + \text{K7} \cdot \text{X5P} \cdot \text{GAP}} \end{aligned}$$

$$\begin{aligned} & \text{TKL2}(\text{Vmax}, \text{E4P}, \text{X5P}, \text{GAP}, \text{F6P}, \text{Keq_TKL2}, K1, K2, K6, K3, K5, K4, K7) \quad (98) \\ &= \frac{\text{Vmax} \cdot \left(\text{E4P} \cdot \text{X5P} - \frac{\text{GAP} \cdot \text{F6P}}{\text{Keq_TKL2}} \right)}{(\text{K1} + \text{E4P}) \cdot \text{X5P} + (\text{K2} + \text{K6} \cdot \text{F6P}) \cdot \text{E4P} + (\text{K3} + \text{K5} \cdot \text{F6P}) \cdot \text{GAP} + \text{K4} \cdot \text{F6P} + \text{K7} \cdot \text{X5P} \cdot \text{GAP}} \end{aligned}$$

Table 41: Properties of each parameter.

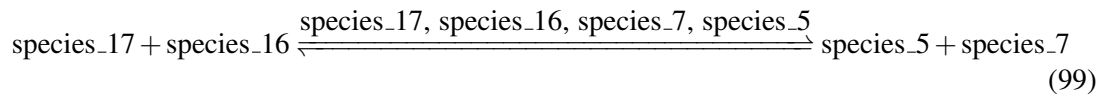
Id	Name	SBO	Value	Unit	Constant
Keq_TKL2	Keq_TKL2		29.700		✓
K1	K1		$1.84 \cdot 10^{-9}$		✓
K2	K2		$3.055 \cdot 10^{-7}$		✓
K6	K6		0.122		✓
K3	K3		$5.48 \cdot 10^{-8}$		✓
K5	K5		0.029		✓
K4	K4		$3 \cdot 10^{-10}$		✓
K7	K7		0.215		✓

8.10 Reaction `reaction_10`

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name TAL

Reaction equation



Reactants

Table 42: Properties of each reactant.

Id	Name	SBO
species_17	S7P	
species_16	GAP	

Modifiers

Table 43: Properties of each modifier.

Id	Name	SBO
species_17	S7P	
species_16	GAP	
species_7	E4P	
species_5	F6P	

Products

Table 44: Properties of each product.

Id	Name	SBO
species_5	F6P	
species_7	E4P	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{vol}(\text{compartment_1}) \cdot \text{TAL}(\text{Vmax}, [\text{species_17}], [\text{species_16}], [\text{species_7}], [\text{species_5}], \text{Keq_TAL}, \text{K1}, \text{K2}, \text{K6}, \text{K3}, \text{K5}, \text{K4}, \text{K7}) \quad (100)$$

$$\text{TAL}(\text{Vmax}, \text{S7P}, \text{GAP}, \text{E4P}, \text{F6P}, \text{Keq_TAL}, \text{K1}, \text{K2}, \text{K6}, \text{K3}, \text{K5}, \text{K4}, \text{K7}) \quad (101)$$

$$= \frac{\text{Vmax} \cdot \left(\text{S7P} \cdot \text{GAP} - \frac{\text{E4P} \cdot \text{F6P}}{\text{Keq_TAL}} \right)}{(\text{K1} + \text{GAP}) \cdot \text{S7P} + (\text{K2} + \text{K6} \cdot \text{F6P}) \cdot \text{GAP} + (\text{K3} + \text{K5} \cdot \text{F6P}) \cdot \text{E4P} + \text{K4} \cdot \text{F6P} + \text{K7} \cdot \text{S7P} \cdot \text{E4P}}$$

$$\text{TAL}(\text{Vmax}, \text{S7P}, \text{GAP}, \text{E4P}, \text{F6P}, \text{Keq_TAL}, \text{K1}, \text{K2}, \text{K6}, \text{K3}, \text{K5}, \text{K4}, \text{K7}) \quad (102)$$

$$= \frac{\text{Vmax} \cdot \left(\text{S7P} \cdot \text{GAP} - \frac{\text{E4P} \cdot \text{F6P}}{\text{Keq_TAL}} \right)}{(\text{K1} + \text{GAP}) \cdot \text{S7P} + (\text{K2} + \text{K6} \cdot \text{F6P}) \cdot \text{GAP} + (\text{K3} + \text{K5} \cdot \text{F6P}) \cdot \text{E4P} + \text{K4} \cdot \text{F6P} + \text{K7} \cdot \text{S7P} \cdot \text{E4P}}$$

Table 45: Properties of each parameter.

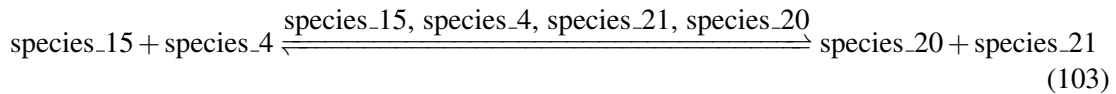
Id	Name	SBO	Value	Unit	Constant
Vmax	Vmax		58.270		✓
Keq_TAL	Keq_TAL		2.703		✓
K1	K1		$8.23 \cdot 10^{-9}$		✓
K2	K2		$4.765 \cdot 10^{-8}$		✓
K6	K6		0.465		✓
K3	K3		$1.733 \cdot 10^{-7}$		✓
K5	K5		0.868		✓
K4	K4		$6.095 \cdot 10^{-9}$		✓
K7	K7		2.524		✓

8.11 Reaction [reaction_11](#)

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name PRPPS

Reaction equation



Reactants

Table 46: Properties of each reactant.

Id	Name	SBO
species_15	R5P	
species_4	ATP	

Modifiers

Table 47: Properties of each modifier.

Id	Name	SBO
species_15	R5P	
species_4	ATP	
species_21	PRPP	
species_20	AMP	

Products

Table 48: Properties of each product.

Id	Name	SBO
species_20	AMP	
species_21	PRPP	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{vol}(\text{compartment}_1) \cdot \text{PRPPS}(\text{Vmax}, [\text{species}_15], [\text{species}_4], [\text{species}_21], [\text{species}_20], \text{Kapp}, \text{KATP}, \text{KR5P}) \quad (104)$$

$$\begin{aligned} & \text{PRPPS}(\text{Vmax}, \text{R5P}, \text{ATP}, \text{PRPP}, \text{AMP}, \text{Kapp}, \text{KATP}, \text{KR5P}) \\ &= \frac{\text{Vmax} \cdot \left(\text{R5P} \cdot \text{ATP} - \frac{\text{PRPP} \cdot \text{AMP}}{\text{Kapp}} \right)}{(\text{KATP} + \text{ATP}) \cdot (\text{KR5P} + \text{R5P})} \end{aligned} \quad (105)$$

$$\begin{aligned} & \text{PRPPS}(\text{Vmax}, \text{R5P}, \text{ATP}, \text{PRPP}, \text{AMP}, \text{Kapp}, \text{KATP}, \text{KR5P}) \\ &= \frac{\text{Vmax} \cdot \left(\text{R5P} \cdot \text{ATP} - \frac{\text{PRPP} \cdot \text{AMP}}{\text{Kapp}} \right)}{(\text{KATP} + \text{ATP}) \cdot (\text{KR5P} + \text{R5P})} \end{aligned} \quad (106)$$

Table 49: Properties of each parameter.

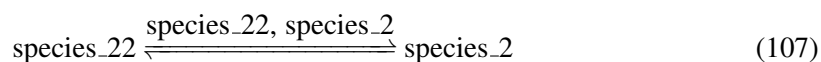
Id	Name	SBO	Value	Unit	Constant
Vmax	Vmax		0.510		✓
Kapp	Kapp		100000.000		✓
KATP	KATP		$3 \cdot 10^{-8}$		✓
KR5P	KR5P		$5.7 \cdot 10^{-7}$		✓

8.12 Reaction `reaction_12`

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

Name PGLM

Reaction equation



Reactant

Table 50: Properties of each reactant.

Id	Name	SBO
species_22	G1P	

Modifiers

Table 51: Properties of each modifier.

Id	Name	SBO
species_22	G1P	
species_2	G6P	

Product

Table 52: Properties of each product.

Id	Name	SBO
species_2	G6P	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{vol}(\text{compartment_1}) \cdot \text{PGLM}(\text{parameter_55}, [\text{species_22}], \text{parameter_57}, \text{parameter_15}, [\text{species_2}], \text{parameter_56}) \quad (108)$$

$$\text{PGLM}(\text{Vmaxf}, \text{G1P}, \text{KG1P}, \text{Vmaxr}, \text{G6P}, \text{KG6P}) = \frac{\frac{\text{Vmaxf} \cdot \text{G1P}}{\text{KG1P}} - \frac{\text{Vmaxr} \cdot \text{G6P}}{\text{KG6P}}}{1 + \frac{\text{G1P}}{\text{KG1P}} + \frac{\text{G6P}}{\text{KG6P}}} \quad (109)$$

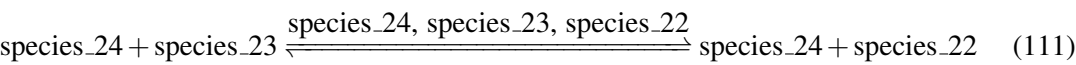
$$\text{PGLM}(\text{Vmaxf}, \text{G1P}, \text{KG1P}, \text{Vmaxr}, \text{G6P}, \text{KG6P}) = \frac{\frac{\text{Vmaxf} \cdot \text{G1P}}{\text{KG1P}} - \frac{\text{Vmaxr} \cdot \text{G6P}}{\text{KG6P}}}{1 + \frac{\text{G1P}}{\text{KG1P}} + \frac{\text{G6P}}{\text{KG6P}}} \quad (110)$$

8.13 Reaction `reaction_13`

This is a reversible reaction of two reactants forming two products influenced by three modifiers.

Name `GPa`

Reaction equation



Reactants

Table 53: Properties of each reactant.

Id	Name	SBO
<code>species_24</code>	GLY	
<code>species_23</code>	Pi	

Modifiers

Table 54: Properties of each modifier.

Id	Name	SBO
<code>species_24</code>	GLY	
<code>species_23</code>	Pi	
<code>species_22</code>	G1P	

Products

Table 55: Properties of each product.

Id	Name	SBO
<code>species_24</code>	GLY	
<code>species_22</code>	G1P	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{vol}(\text{compartment}_1) \cdot \text{GPa}(\text{parameter}_{58}, [\text{species}_{24}], [\text{species}_{23}], \text{parameter}_{61}, \text{parameter}_{62}, \text{parameter}_4, [\text{species}_{22}], \text{KGLYb}, \text{parameter}_{60}, \text{KiPi}, \text{parameter}_{59}) \quad (112)$$

$$\begin{aligned} & \text{GPa}(\text{Vmaxf}, \text{GLY}, \text{Pi}, \text{KiGLYf}, \text{KPi}, \text{Vmaxr}, \text{G1P}, \text{KGLYb}, \text{KiG1P}, \text{KiPi}, \text{KiGLYb}) \\ &= \frac{\text{Vmaxf} \cdot \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} - \text{Vmaxr} \cdot \frac{\text{GLY} \cdot \text{G1P}}{\text{KGLYb} \cdot \text{KiG1P}}}{1 + \frac{\text{GLY}}{\text{KiGLYf}} + \frac{\text{Pi}}{\text{KiPi}} + \frac{\text{GLY}}{\text{KiGLYb}} + \frac{\text{G1P}}{\text{KiG1P}} + \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} + \frac{\text{GLY} \cdot \text{G1P}}{\text{KiGLYb} \cdot \text{KiG1P}}} \end{aligned} \quad (113)$$

$$\begin{aligned} & \text{GPa}(\text{Vmaxf}, \text{GLY}, \text{Pi}, \text{KiGLYf}, \text{KPi}, \text{Vmaxr}, \text{G1P}, \text{KGLYb}, \text{KiG1P}, \text{KiPi}, \text{KiGLYb}) \\ &= \frac{\text{Vmaxf} \cdot \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} - \text{Vmaxr} \cdot \frac{\text{GLY} \cdot \text{G1P}}{\text{KGLYb} \cdot \text{KiG1P}}}{1 + \frac{\text{GLY}}{\text{KiGLYf}} + \frac{\text{Pi}}{\text{KiPi}} + \frac{\text{GLY}}{\text{KiGLYb}} + \frac{\text{G1P}}{\text{KiG1P}} + \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} + \frac{\text{GLY} \cdot \text{G1P}}{\text{KiGLYb} \cdot \text{KiG1P}}} \end{aligned} \quad (114)$$

Table 56: Properties of each parameter.

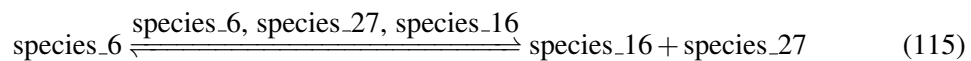
Id	Name	SBO	Value	Unit	Constant
KGLYb	KGLYb		$1.5 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
KiPi	KiPi		0.005		<input checked="" type="checkbox"/>

8.14 Reaction [reaction_14](#)

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

Name FBA

Reaction equation



Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
<code>species_6</code>	F16P	

Modifiers

Table 58: Properties of each modifier.

Id	Name	SBO
species_6	F16P	
species_27	DHAP	
species_16	GAP	

Products

Table 59: Properties of each product.

Id	Name	SBO
species_16	GAP	
species_27	DHAP	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{vol}(\text{compartment_1}) \cdot \text{FBA}(\text{parameter_37}, [\text{species_6}], \text{parameter_70}, \text{parameter_8}, [\text{species_27}], [\text{species_16}], \text{parameter_68}, \text{parameter_69}) \quad (116)$$

$$\text{FBA}(V_{mf}, A, K_{fbp}, V_{mr}, P, Q, K_{dhap}, K_{g3p}) = \frac{\frac{V_{mf} \cdot A}{K_{fbp}} - \frac{V_{mr} \cdot P \cdot Q}{K_{dhap} \cdot K_{g3p}}}{1 + \frac{A}{K_{fbp}} + \frac{P}{K_{dhap}} + \frac{Q}{K_{g3p}} + \frac{P \cdot Q}{K_{dhap} \cdot K_{g3p}}} \quad (117)$$

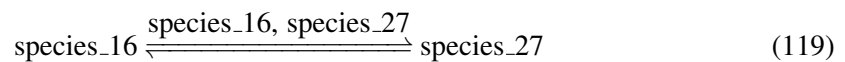
$$\text{FBA}(V_{mf}, A, K_{fbp}, V_{mr}, P, Q, K_{dhap}, K_{g3p}) = \frac{\frac{V_{mf} \cdot A}{K_{fbp}} - \frac{V_{mr} \cdot P \cdot Q}{K_{dhap} \cdot K_{g3p}}}{1 + \frac{A}{K_{fbp}} + \frac{P}{K_{dhap}} + \frac{Q}{K_{g3p}} + \frac{P \cdot Q}{K_{dhap} \cdot K_{g3p}}} \quad (118)$$

8.15 Reaction reaction_15

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

Name TPI

Reaction equation



Reactant

Table 60: Properties of each reactant.

Id	Name	SBO
species_16	GAP	

Modifiers

Table 61: Properties of each modifier.

Id	Name	SBO
species_16	GAP	
species_27	DHAP	

Product

Table 62: Properties of each product.

Id	Name	SBO
species_27	DHAP	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{vol}(\text{compartment_1}) \cdot \text{TPI}(\text{parameter_38}, [\text{species_16}], \text{parameter_72}, \text{parameter_9}, [\text{species_27}], \text{parameter_71}) \quad (120)$$

$$\text{TPI}(V_f, \text{GAP}, K_{ms}, V_r, \text{DHAP}, K_{mp}) = \frac{\frac{V_f \cdot \text{GAP}}{K_{ms}} - \frac{V_r \cdot \text{DHAP}}{K_{mp}}}{1 + \frac{\text{GAP}}{K_{ms}} + \frac{\text{DHAP}}{K_{mp}}} \quad (121)$$

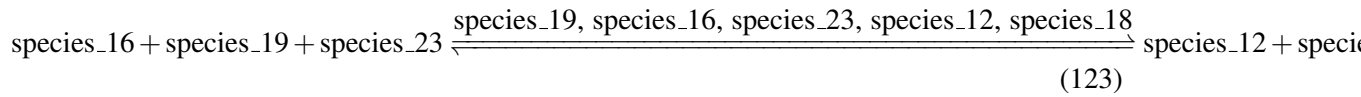
$$\text{TPI}(V_f, \text{GAP}, K_{ms}, V_r, \text{DHAP}, K_{mp}) = \frac{\frac{V_f \cdot \text{GAP}}{K_{ms}} - \frac{V_r \cdot \text{DHAP}}{K_{mp}}}{1 + \frac{\text{GAP}}{K_{ms}} + \frac{\text{DHAP}}{K_{mp}}} \quad (122)$$

8.16 Reaction [reaction_16](#)

This is a reversible reaction of three reactants forming two products influenced by five modifiers.

Name GAPDH

Reaction equation



Reactants

Table 63: Properties of each reactant.

Id	Name	SBO
species_16	GAP	
species_19	NAD	
species_23	Pi	

Modifiers

Table 64: Properties of each modifier.

Id	Name	SBO
species_19	NAD	
species_16	GAP	
species_23	Pi	
species_12	BPG	
species_18	NADH	

Products

Table 65: Properties of each product.

Id	Name	SBO
species_12	BPG	
species_18	NADH	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{vol}(\text{compartment_1}) \cdot \text{GAPDH}(\text{parameter_39}, [\text{species_19}], [\text{species_16}], [\text{species_23}], \text{parameter_76}, \text{parameter_75}, \text{parameter_77}, \text{parameter_10}, [\text{species_12}], [\text{species_18}], \text{parameter_73}, \text{parameter_74})$$

(124)

$$\begin{aligned} & \text{GAPDH}(\text{Vmf}, \text{A}, \text{B}, \text{C}, \text{Knad}, \text{Kg3p}, \text{Kp}, \text{Vmr}, \text{P}, \text{Q}, \text{Kdpg}, \text{Knadh}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A} \cdot \text{B} \cdot \text{C}}{\text{Knad} \cdot \text{Kg3p} \cdot \text{Kp}} - \frac{\text{Vmr} \cdot \text{P} \cdot \text{Q}}{\text{Kdpg} \cdot \text{Knadh}}}{1 + \frac{\text{A}}{\text{Knad}} + \frac{\text{A} \cdot \text{B}}{\text{Knad} \cdot \text{Kg3p}} + \frac{\text{A} \cdot \text{B} \cdot \text{C}}{\text{Knad} \cdot \text{Kg3p} \cdot \text{Kp}} + \frac{\text{P} \cdot \text{Q}}{\text{Kdpg} \cdot \text{Knadh}} + \frac{\text{Q}}{\text{Knadh}}} \end{aligned} \quad (125)$$

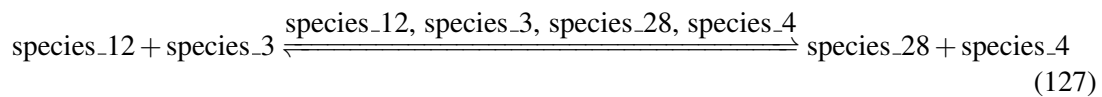
$$\begin{aligned} & \text{GAPDH}(\text{Vmf}, \text{A}, \text{B}, \text{C}, \text{Knad}, \text{Kg3p}, \text{Kp}, \text{Vmr}, \text{P}, \text{Q}, \text{Kdpg}, \text{Knadh}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A} \cdot \text{B} \cdot \text{C}}{\text{Knad} \cdot \text{Kg3p} \cdot \text{Kp}} - \frac{\text{Vmr} \cdot \text{P} \cdot \text{Q}}{\text{Kdpg} \cdot \text{Knadh}}}{1 + \frac{\text{A}}{\text{Knad}} + \frac{\text{A} \cdot \text{B}}{\text{Knad} \cdot \text{Kg3p}} + \frac{\text{A} \cdot \text{B} \cdot \text{C}}{\text{Knad} \cdot \text{Kg3p} \cdot \text{Kp}} + \frac{\text{P} \cdot \text{Q}}{\text{Kdpg} \cdot \text{Knadh}} + \frac{\text{Q}}{\text{Knadh}}} \end{aligned} \quad (126)$$

8.17 Reaction [reaction_17](#)

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name PGK

Reaction equation



Reactants

Table 66: Properties of each reactant.

Id	Name	SBO
species_12	BPG	
species_3	ADP	

Modifiers

Table 67: Properties of each modifier.

Id	Name	SBO
species_12	BPG	
species_3	ADP	
species_28	PG3	
species_4	ATP	

Products

Table 68: Properties of each product.

Id	Name	SBO
species_28	PG3	
species_4	ATP	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \text{vol}(\text{compartment}_1) \cdot \text{PGK}(\text{parameter}_{40}, [\text{species}_{12}], [\text{species}_3], \text{alfa}, \text{parameter}_{51}, \text{parameter}_{52}, \text{parameter}_{11}, [\text{species}_{28}], [\text{species}_4], \text{beta}, \text{parameter}_{49}, \text{parameter}_{50}) \quad (128)$$

$$\begin{aligned} & \text{PGK}(\text{Vmf}, \text{A}, \text{B}, \text{alfa}, \text{Ka}, \text{Kb}, \text{Vmr}, \text{P}, \text{Q}, \text{beta}, \text{Kp}, \text{Kq}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} - \frac{\text{Vmr} \cdot \text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}}}{1 + \frac{\text{A}}{\text{Ka}} + \frac{\text{B}}{\text{Kb}} + \frac{\text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} + \frac{\text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}} + \frac{\text{P}}{\text{Kp}} + \frac{\text{Q}}{\text{Kq}}} \end{aligned} \quad (129)$$

$$\begin{aligned} & \text{PGK}(\text{Vmf}, \text{A}, \text{B}, \text{alfa}, \text{Ka}, \text{Kb}, \text{Vmr}, \text{P}, \text{Q}, \text{beta}, \text{Kp}, \text{Kq}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} - \frac{\text{Vmr} \cdot \text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}}}{1 + \frac{\text{A}}{\text{Ka}} + \frac{\text{B}}{\text{Kb}} + \frac{\text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} + \frac{\text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}} + \frac{\text{P}}{\text{Kp}} + \frac{\text{Q}}{\text{Kq}}} \end{aligned} \quad (130)$$

Table 69: Properties of each parameter.

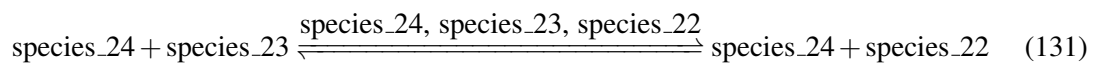
Id	Name	SBO	Value	Unit	Constant
alfa	alfa		1.0		<input checked="" type="checkbox"/>
beta	beta		1.0		<input checked="" type="checkbox"/>

8.18 Reaction [reaction_18](#)

This is a reversible reaction of two reactants forming two products influenced by three modifiers.

Name GPb

Reaction equation



Reactants

Table 70: Properties of each reactant.

Id	Name	SBO
species_24	GLY	
species_23	Pi	

Modifiers

Table 71: Properties of each modifier.

Id	Name	SBO
species_24	GLY	
species_23	Pi	
species_22	G1P	

Products

Table 72: Properties of each product.

Id	Name	SBO
species_24	GLY	
species_22	G1P	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{vol}(\text{compartment}_1) \cdot \text{GPb}(\text{parameter}_{63}, [\text{species}_{24}], [\text{species}_{23}], \text{parameter}_{66}, \text{KPi}, \text{parameter}_7, [\text{species}_{22}], \text{parameter}_{64}, \text{parameter}_{65}, \text{parameter}_{67}, \text{KiG1P}, \text{parameter}_{27}, \text{nH}, \text{Kamp}) \quad (132)$$

$$\text{GPb}(\text{Vmaxf}, \text{GLY}, \text{Pi}, \text{KiGLYf}, \text{KPi}, \text{Vmaxr}, \text{G1P}, \text{KiGLYb}, \text{KG1P}, \text{KiPi}, \text{KiG1P}, \text{AMP}, \text{nH}, \text{Kamp}) = \frac{\text{Vmaxf} \cdot \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} - \text{Vmaxr} \cdot \frac{\text{GLY} \cdot \text{G1P}}{\text{KiGLYb} \cdot \text{KG1P}}}{1 + \frac{\text{GLY}}{\text{KiGLYf}} + \frac{\text{Pi}}{\text{KiPi}} + \frac{\text{GLY}}{\text{KiGLYb}} + \frac{\text{G1P}}{\text{KiG1P}} + \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} + \frac{\text{GLY} \cdot \text{G1P}}{\text{KiGLYb} \cdot \text{KG1P}}} \cdot \frac{\text{AMP}^{\text{nH}}}{\text{Kamp}} \quad (133)$$

$$1 + \frac{\text{AMP}^{\text{nH}}}{\text{Kamp}}$$

$$\begin{aligned}
& \text{GPb}(\text{Vmaxf}, \text{GLY}, \text{Pi}, \text{KiGLYf}, \text{KPi}, \text{Vmaxr}, \text{G1P}, \text{KiGLYb}, \text{KG1P}, \text{KiPi}, \text{KiG1P}, \\
& \text{AMP}, \text{nH}, \text{Kamp}) = \frac{\frac{\text{Vmaxf} \cdot \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} - \text{Vmaxr} \cdot \frac{\text{GLY} \cdot \text{G1P}}{\text{KiGLYb} \cdot \text{KG1P}}}{1 + \frac{\text{GLY}}{\text{KiGLYf}} + \frac{\text{Pi}}{\text{KPi}} + \frac{\text{GLY}}{\text{KiGLYb}} + \frac{\text{G1P}}{\text{KG1P}} + \frac{\text{GLY} \cdot \text{Pi}}{\text{KiGLYf} \cdot \text{KPi}} + \frac{\text{GLY} \cdot \text{G1P}}{\text{KiGLYb} \cdot \text{KG1P}}} \cdot \frac{\text{AMP}^{\text{nH}}}{\text{Kamp}}} {1 + \frac{\text{AMP}^{\text{nH}}}{\text{Kamp}}} \quad (134)
\end{aligned}$$

Table 73: Properties of each parameter.

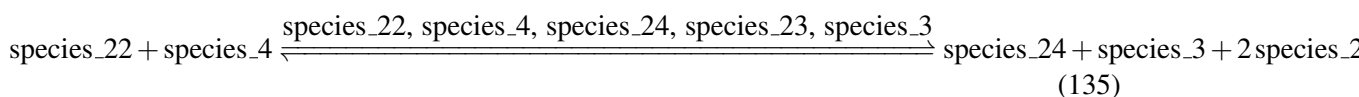
Id	Name	SBO	Value	Unit	Constant
KPi	KPi		$2 \cdot 10^{-4}$		✓
KiG1P	KiG1P		0.007		✓
nH	nH		1.750		✓
Kamp	Kamp		$1.9 \cdot 10^{-12}$		✓

8.19 Reaction [reaction_19](#)

This is a reversible reaction of two reactants forming three products influenced by five modifiers.

Name GS

Reaction equation



Reactants

Table 74: Properties of each reactant.

Id	Name	SBO
species_22	G1P	
species_4	ATP	

Modifiers

Table 75: Properties of each modifier.

Id	Name	SBO
species_22	G1P	
species_4	ATP	
species_24	GLY	

Id	Name	SBO
species_23	Pi	
species_3	ADP	

Products

Table 76: Properties of each product.

Id	Name	SBO
species_24	GLY	
species_3	ADP	
species_23	Pi	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{vol}(\text{compartment}_1) \cdot \text{GS}(\text{parameter}_{41}, \text{Kf}, \text{parameter}_{17}, [\text{species}_{22}], [\text{species}_4], [\text{species}_{24}], [\text{species}_{23}], [\text{species}_3], \text{Keq}, \text{Kr}) \quad (136)$$

$$\begin{aligned} & \text{GS}(\text{Vmaxf}, \text{Kf}, a, \text{G1P}, \text{ATP}, \text{GLY}, \text{Pi}, \text{ADP}, \text{Keq}, \text{Kr}) \\ &= \frac{\frac{\text{Vmaxf}}{\text{Kf}} \cdot a \cdot \text{G1P} \cdot a \cdot \text{ATP} \cdot a \cdot \text{GLY} \cdot \left(1 - \frac{(a \cdot \text{Pi})^2 \cdot a \cdot \text{ADP}}{a \cdot \text{G1P} \cdot a \cdot \text{ATP} \cdot \text{Keq}}\right)}{1 + \frac{a \cdot \text{G1P} \cdot a \cdot \text{ATP} \cdot a \cdot \text{GLY}}{\text{Kf}} + \frac{a \cdot \text{GLY} \cdot (a \cdot \text{Pi})^2 \cdot a \cdot \text{ADP}}{\text{Kr}}} \end{aligned} \quad (137)$$

$$\begin{aligned} & \text{GS}(\text{Vmaxf}, \text{Kf}, a, \text{G1P}, \text{ATP}, \text{GLY}, \text{Pi}, \text{ADP}, \text{Keq}, \text{Kr}) \\ &= \frac{\frac{\text{Vmaxf}}{\text{Kf}} \cdot a \cdot \text{G1P} \cdot a \cdot \text{ATP} \cdot a \cdot \text{GLY} \cdot \left(1 - \frac{(a \cdot \text{Pi})^2 \cdot a \cdot \text{ADP}}{a \cdot \text{G1P} \cdot a \cdot \text{ATP} \cdot \text{Keq}}\right)}{1 + \frac{a \cdot \text{G1P} \cdot a \cdot \text{ATP} \cdot a \cdot \text{GLY}}{\text{Kf}} + \frac{a \cdot \text{GLY} \cdot (a \cdot \text{Pi})^2 \cdot a \cdot \text{ADP}}{\text{Kr}}} \end{aligned} \quad (138)$$

Table 77: Properties of each parameter.

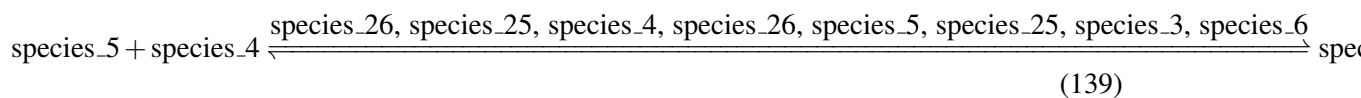
Id	Name	SBO	Value	Unit	Constant
Kf	Kf		17400.0		✓
Keq	Keq		267100.0		✓
Kr	Kr		158.0		✓

8.20 Reaction `reaction_20`

This is a reversible reaction of two reactants forming two products influenced by eight modifiers.

Name PFK

Reaction equation



Reactants

Table 78: Properties of each reactant.

Id	Name	SBO
species_5	F6P	
species_4	ATP	

Modifiers

Table 79: Properties of each modifier.

Id	Name	SBO
species_26	F26P	
species_25	CIT	
species_4	ATP	
species_26	F26P	
species_5	F6P	
species_25	CIT	
species_3	ADP	
species_6	F16P	

Products

Table 80: Properties of each product.

Id	Name	SBO
species_6	F16P	
species_3	ADP	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{vol}(\text{compartment_1}) \cdot \text{PFK}(\text{parameter_42}, \text{parameter_17}, [\text{species_4}], \text{Katp}, \text{beta}, [\text{species_26}], \text{alfa}, \text{Kf26bp}, [\text{species_5}], \text{Kf6p}, \text{L}, [\text{species_25}], \text{Kcit}, \text{Kiatp}, [\text{species_3}], [\text{species_6}], \text{Kadp}, \text{Kfbp}, \text{Kapp}) \quad (140)$$

$$\begin{aligned} &\text{PFK}(\text{Vm}, \text{a}, \text{B}, \text{Katp}, \text{beta}, \text{F26P}, \text{alfa}, \text{Kf26bp}, \text{A}, \text{Kf6p}, \text{L}, \text{CIT}, \text{Kcit}, \\ &\text{Kiatp}, \text{Q}, \text{P}, \text{Kadp}, \text{Kfbp}, \text{Kapp}) = \text{Vm} \cdot \frac{\frac{\text{a} \cdot \text{B}}{\text{Katp}}}{1 + \frac{\text{a} \cdot \text{B}}{\text{Katp}}} \cdot \frac{1 + \frac{\text{beta} \cdot \text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}}{1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}} \\ &\cdot \left(\frac{\frac{\text{a} \cdot \text{A} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}\right)}{\text{Kf6p} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)} \cdot \left(1 + \frac{\text{a} \cdot \text{A} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}\right)}{\text{Kf6p} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)}\right)^3}{\frac{\text{L} \cdot \left(1 + \frac{\text{a} \cdot \text{CIT}}{\text{Kcit}}\right)^4 \cdot \left(1 + \frac{\text{a} \cdot \text{B}}{\text{Kiatp}}\right)^4}{\left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)^4} + \left(1 + \frac{\text{a} \cdot \text{A} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}\right)}{\text{Kf6p} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)}\right)^4} - \frac{\frac{\text{a} \cdot \text{Q} \cdot \text{a} \cdot \text{P}}{\text{Kadp} \cdot \text{Kfbp} \cdot \text{Kapp}}}{\frac{\text{a} \cdot \text{Q}}{\text{Kadp}} + \frac{\text{a} \cdot \text{P}}{\text{Kfbp}} + \frac{\text{a} \cdot \text{Q} \cdot \text{a} \cdot \text{P}}{\text{Kadp} \cdot \text{Kfbp}} + 1} + 1 \right) \end{aligned} \quad (141)$$

$$\begin{aligned} &\text{PFK}(\text{Vm}, \text{a}, \text{B}, \text{Katp}, \text{beta}, \text{F26P}, \text{alfa}, \text{Kf26bp}, \text{A}, \text{Kf6p}, \text{L}, \text{CIT}, \text{Kcit}, \\ &\text{Kiatp}, \text{Q}, \text{P}, \text{Kadp}, \text{Kfbp}, \text{Kapp}) = \text{Vm} \cdot \frac{\frac{\text{a} \cdot \text{B}}{\text{Katp}}}{1 + \frac{\text{a} \cdot \text{B}}{\text{Katp}}} \cdot \frac{1 + \frac{\text{beta} \cdot \text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}}{1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}} \\ &\cdot \left(\frac{\frac{\text{a} \cdot \text{A} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}\right)}{\text{Kf6p} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)} \cdot \left(1 + \frac{\text{a} \cdot \text{A} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}\right)}{\text{Kf6p} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)}\right)^3}{\frac{\text{L} \cdot \left(1 + \frac{\text{a} \cdot \text{CIT}}{\text{Kcit}}\right)^4 \cdot \left(1 + \frac{\text{a} \cdot \text{B}}{\text{Kiatp}}\right)^4}{\left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)^4} + \left(1 + \frac{\text{a} \cdot \text{A} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{alfa} \cdot \text{Kf26bp}}\right)}{\text{Kf6p} \cdot \left(1 + \frac{\text{a} \cdot \text{F26P}}{\text{Kf26bp}}\right)}\right)^4} - \frac{\frac{\text{a} \cdot \text{Q} \cdot \text{a} \cdot \text{P}}{\text{Kadp} \cdot \text{Kfbp} \cdot \text{Kapp}}}{\frac{\text{a} \cdot \text{Q}}{\text{Kadp}} + \frac{\text{a} \cdot \text{P}}{\text{Kfbp}} + \frac{\text{a} \cdot \text{Q} \cdot \text{a} \cdot \text{P}}{\text{Kadp} \cdot \text{Kfbp}} + 1} + 1 \right) \end{aligned} \quad (142)$$

Table 81: Properties of each parameter.

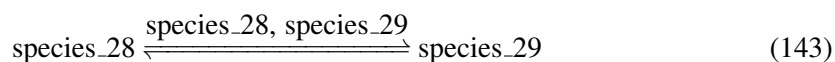
Id	Name	SBO	Value	Unit	Constant
Katp	Katp		$2.1 \cdot 10^{-5}$		✓
beta	beta		0.980		✓
alfa	alfa		0.320		✓
Kf26bp	Kf26bp		$8.4 \cdot 10^{-7}$		✓
Kf6p	Kf6p		1.000		✓
L	L		4.100		✓
Kcit	Kcit		6.800		✓
Kiatp	Kiatp		20.000		✓
Kadp	Kadp		5.000		✓
Kfbp	Kfbp		5.000		✓
Kapp	Kapp		247.000		✓

8.21 Reaction reaction_21

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

Name PGYM

Reaction equation



Reactant

Table 82: Properties of each reactant.

Id	Name	SBO
species_28	PG3	

Modifiers

Table 83: Properties of each modifier.

Id	Name	SBO
species_28	PG3	
species_29	PG2	

Product

Table 84: Properties of each product.

Id	Name	SBO
species_29	PG2	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{vol}(\text{compartment_1}) \cdot \text{function_1}(\text{parameter_78}, [\text{species_28}], \text{parameter_80}, \text{parameter_22}, [\text{species_29}], \text{parameter_79}) \quad (144)$$

$$\text{function_1}(V_{mf}, PG3, K_{ms}, V_{mr}, PG2, K_{mp}) = \frac{\frac{V_{mf} \cdot PG3}{K_{ms}} - \frac{V_{mr} \cdot PG2}{K_{mp}}}{1 + \frac{PG3}{K_{ms}} + \frac{PG2}{K_{mp}}} \quad (145)$$

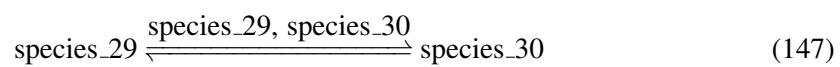
$$\text{function_1}(\text{Vmf}, \text{PG3}, \text{Kms}, \text{Vmr}, \text{PG2}, \text{Kmp}) = \frac{\frac{\text{Vmf} \cdot \text{PG3}}{\text{Kms}} - \frac{\text{Vmr} \cdot \text{PG2}}{\text{Kmp}}}{1 + \frac{\text{PG3}}{\text{Kms}} + \frac{\text{PG2}}{\text{Kmp}}} \quad (146)$$

8.22 Reaction `reaction_22`

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

Name ENO

Reaction equation



Reactant

Table 85: Properties of each reactant.

Id	Name	SBO
species_29	PG2	

Modifiers

Table 86: Properties of each modifier.

Id	Name	SBO
species_29	PG2	
species_30	PEP	

Product

Table 87: Properties of each product.

Id	Name	SBO
species_30	PEP	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{vol}(\text{compartment_1}) \cdot \text{function_2}(\text{parameter_43}, [\text{species_29}], \text{parameter_54}, \text{parameter_24}, [\text{species_30}], \text{parameter_53}) \quad (148)$$

$$\text{function_2}(\text{Vmf}, \text{PG2}, \text{Kms}, \text{Vmr}, \text{PEP}, \text{Kmp}) = \frac{\frac{\text{Vmf} \cdot \text{PG2}}{\text{Kms}} - \frac{\text{Vmr} \cdot \text{PEP}}{\text{Kmp}}}{1 + \frac{\text{PG2}}{\text{Kms}} + \frac{\text{PEP}}{\text{Kmp}}} \quad (149)$$

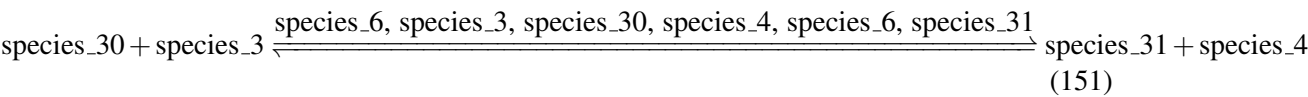
$$\text{function_2}(\text{Vmf}, \text{PG2}, \text{Kms}, \text{Vmr}, \text{PEP}, \text{Kmp}) = \frac{\frac{\text{Vmf} \cdot \text{PG2}}{\text{Kms}} - \frac{\text{Vmr} \cdot \text{PEP}}{\text{Kmp}}}{1 + \frac{\text{PG2}}{\text{Kms}} + \frac{\text{PEP}}{\text{Kmp}}} \quad (150)$$

8.23 Reaction `reaction_23`

This is a reversible reaction of two reactants forming two products influenced by six modifiers.

Name PK

Reaction equation



Reactants

Table 88: Properties of each reactant.

Id	Name	SBO
species_30	PEP	
species_3	ADP	

Modifiers

Table 89: Properties of each modifier.

Id	Name	SBO
species_6	F16P	
species_3	ADP	
species_30	PEP	
species_4	ATP	
species_6	F16P	
species_31	PYR	

Products

Table 90: Properties of each product.

Id	Name	SBO
species_31	PYR	
species_4	ATP	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{vol}(\text{compartment}_1) \cdot \text{function_3}(\text{parameter_44}, [\text{species}_3], \text{Kadp}, [\text{species}_{30}], \text{Kpep}, L, [\text{species}_4], \text{Kiatp}, [\text{species}_6], \text{Kfbp}, [\text{species}_{31}], \text{Katp}, \text{Kpyr}, \text{Kapp}, \text{parameter_17}) \quad (152)$$

$$\begin{aligned} & \text{function_3}(\text{Vm}, B, \text{Kadp}, A, \text{Kpep}, L, Q, \text{Kiatp}, \text{F16P}, \text{Kfbp}, P, \text{Katp}, \text{Kpyr}, \text{Kapp}, a) \\ &= \text{Vm} \cdot \left(\frac{\frac{a \cdot B}{\text{Kadp}}}{1 + \frac{a \cdot B}{\text{Kadp}}} \cdot \frac{\frac{a \cdot A}{\text{Kpep}} \cdot \left(1 + \frac{a \cdot A}{\text{Kpep}}\right)^3}{\frac{L \cdot \left(1 + \frac{a \cdot Q}{\text{Kiatp}}\right)^4}{\left(1 + \frac{a \cdot \text{F16P}}{\text{Kfbp}}\right)^4} + \left(1 + \frac{a \cdot A}{\text{Kpep}}\right)^4} - \frac{\frac{a \cdot Q \cdot a \cdot P}{\text{Katp} \cdot \text{Kpyr} \cdot \text{Kapp}}}{\frac{a \cdot Q}{\text{Katp}} + \frac{a \cdot P}{\text{Kpyr}} + \frac{a \cdot Q \cdot a \cdot P}{\text{Katp} \cdot \text{Kpyr}} + 1} \right) \quad (153) \end{aligned}$$

$$\begin{aligned} & \text{function_3}(\text{Vm}, B, \text{Kadp}, A, \text{Kpep}, L, Q, \text{Kiatp}, \text{F16P}, \text{Kfbp}, P, \text{Katp}, \text{Kpyr}, \text{Kapp}, a) \\ &= \text{Vm} \cdot \left(\frac{\frac{a \cdot B}{\text{Kadp}}}{1 + \frac{a \cdot B}{\text{Kadp}}} \cdot \frac{\frac{a \cdot A}{\text{Kpep}} \cdot \left(1 + \frac{a \cdot A}{\text{Kpep}}\right)^3}{\frac{L \cdot \left(1 + \frac{a \cdot Q}{\text{Kiatp}}\right)^4}{\left(1 + \frac{a \cdot \text{F16P}}{\text{Kfbp}}\right)^4} + \left(1 + \frac{a \cdot A}{\text{Kpep}}\right)^4} - \frac{\frac{a \cdot Q \cdot a \cdot P}{\text{Katp} \cdot \text{Kpyr} \cdot \text{Kapp}}}{\frac{a \cdot Q}{\text{Katp}} + \frac{a \cdot P}{\text{Kpyr}} + \frac{a \cdot Q \cdot a \cdot P}{\text{Katp} \cdot \text{Kpyr}} + 1} \right) \quad (154) \end{aligned}$$

Table 91: Properties of each parameter.

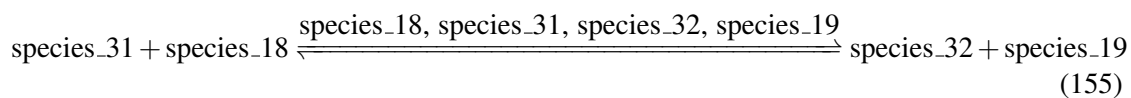
Id	Name	SBO	Value	Unit	Constant
Kadp	Kadp		0.400		✓
Kpep	Kpep		0.014		✓
L	L		1.000		✓
Kiatp	Kiatp		2.500		✓
Kfbp	Kfbp		$4 \cdot 10^{-4}$		✓
Katp	Katp		0.860		✓
Kpyr	Kpyr		10.000		✓
Kapp	Kapp		195172.000		✓

8.24 Reaction `reaction_24`

This is a reversible reaction of two reactants forming two products influenced by four modifiers.

Name LDH

Reaction equation



Reactants

Table 92: Properties of each reactant.

Id	Name	SBO
species_31	PYR	
species_18	NADH	

Modifiers

Table 93: Properties of each modifier.

Id	Name	SBO
species_18	NADH	
species_31	PYR	
species_32	LAC	
species_19	NAD	

Products

Table 94: Properties of each product.

Id	Name	SBO
species_32	LAC	
species_19	NAD	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{vol}(\text{compartment}_1) \cdot \text{function_4}(\text{parameter_45}, [\text{species_18}], [\text{species_31}], \text{alfa}, \text{parameter_85}, \text{parameter_86}, \text{parameter_26}, [\text{species_32}], [\text{species_19}], \text{beta}, \text{parameter_83}, \text{parameter_84}) \quad (156)$$

$$\begin{aligned} & \text{function_4}(\text{Vmf}, \text{A}, \text{B}, \text{alfa}, \text{Ka}, \text{Kb}, \text{Vmr}, \text{P}, \text{Q}, \text{beta}, \text{Kp}, \text{Kq}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} - \frac{\text{Vmr} \cdot \text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}}}{1 + \frac{\text{A}}{\text{Ka}} + \frac{\text{B}}{\text{Kb}} + \frac{\text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} + \frac{\text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}} + \frac{\text{P}}{\text{Kp}} + \frac{\text{Q}}{\text{Kq}}} \end{aligned} \quad (157)$$

$$\begin{aligned} & \text{function_4}(\text{Vmf}, \text{A}, \text{B}, \text{alfa}, \text{Ka}, \text{Kb}, \text{Vmr}, \text{P}, \text{Q}, \text{beta}, \text{Kp}, \text{Kq}) \\ &= \frac{\frac{\text{Vmf} \cdot \text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} - \frac{\text{Vmr} \cdot \text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}}}{1 + \frac{\text{A}}{\text{Ka}} + \frac{\text{B}}{\text{Kb}} + \frac{\text{A} \cdot \text{B}}{\text{alfa} \cdot \text{Ka} \cdot \text{Kb}} + \frac{\text{P} \cdot \text{Q}}{\text{beta} \cdot \text{Kp} \cdot \text{Kq}} + \frac{\text{P}}{\text{Kp}} + \frac{\text{Q}}{\text{Kq}}} \end{aligned} \quad (158)$$

Table 95: Properties of each parameter.

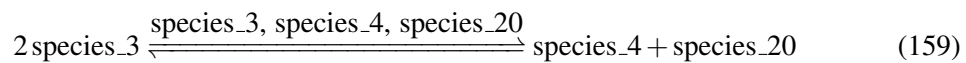
Id	Name	SBO	Value	Unit	Constant
alfa	alfa		1.0		<input checked="" type="checkbox"/>
beta	beta		1.0		<input checked="" type="checkbox"/>

8.25 Reaction [reaction_25](#)

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

Name AK

Reaction equation



Reactant

Table 96: Properties of each reactant.

Id	Name	SBO
species_3	ADP	

Modifiers

Table 97: Properties of each modifier.

Id	Name	SBO
species_3	ADP	
species_4	ATP	
species_20	AMP	

Products

Table 98: Properties of each product.

Id	Name	SBO
species_4	ATP	
species_20	AMP	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{vol}(\text{compartment_1}) \cdot \text{function_5}(\text{Vf}, [\text{species_3}], [\text{species_4}], [\text{species_20}], \text{Keq}) \quad (160)$$

$$\text{function_5}(\text{Vf}, \text{ADP}, \text{ATP}, \text{AMP}, \text{Keq}) = \frac{\text{Vf} \cdot \text{ADP}^2 \cdot \left(1 - \frac{\text{ATP} \cdot \text{AMP}}{\text{Keq}}\right)}{(1 + \text{ADP})^2 + (1 + \text{ATP}) \cdot (1 + \text{AMP}) - 1} \quad (161)$$

$$\text{function_5}(\text{Vf}, \text{ADP}, \text{ATP}, \text{AMP}, \text{Keq}) = \frac{\text{Vf} \cdot \text{ADP}^2 \cdot \left(1 - \frac{\text{ATP} \cdot \text{AMP}}{\text{Keq}}\right)}{(1 + \text{ADP})^2 + (1 + \text{ATP}) \cdot (1 + \text{AMP}) - 1} \quad (162)$$

Table 99: Properties of each parameter.

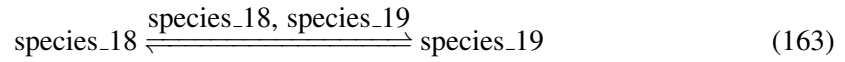
Id	Name	SBO	Value	Unit	Constant
Vf	Vf		141.20		<input checked="" type="checkbox"/>
Keq	Keq		2.26		<input checked="" type="checkbox"/>

8.26 Reaction [reaction_26](#)

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

Name DHase

Reaction equation



Reactant

Table 100: Properties of each reactant.

Id	Name	SBO
species_18	NADH	

Modifiers

Table 101: Properties of each modifier.

Id	Name	SBO
species_18	NADH	
species_19	NAD	

Product

Table 102: Properties of each product.

Id	Name	SBO
species_19	NAD	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{vol}(\text{compartment_1}) \cdot \text{function_6}(\text{parameter_46}, [\text{species_18}], [\text{species_19}], \text{Keq}) \quad (164)$$

$$\text{function_6}(Vf, \text{NADH}, \text{NAD}, \text{Keq}) = \frac{Vf \cdot \text{NADH} \cdot \left(1 - \frac{\text{NAD}}{\text{NADH} \cdot \text{Keq}}\right)}{1 + \text{NADH} + 1 + \text{NAD} - 1} \quad (165)$$

$$\text{function_6}(Vf, \text{NADH}, \text{NAD}, \text{Keq}) = \frac{Vf \cdot \text{NADH} \cdot \left(1 - \frac{\text{NAD}}{\text{NADH} \cdot \text{Keq}}\right)}{1 + \text{NADH} + 1 + \text{NAD} - 1} \quad (166)$$

Table 103: Properties of each parameter.

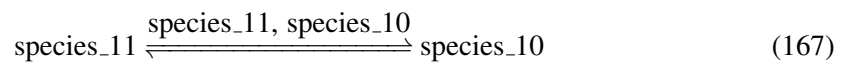
Id	Name	SBO	Value	Unit	Constant
Keq	Keq		300.0		<input checked="" type="checkbox"/>

8.27 Reaction [reaction_27](#)

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

Name DPHase

Reaction equation



Reactant

Table 104: Properties of each reactant.

Id	Name	SBO
species_11	NADPH	

Modifiers

Table 105: Properties of each modifier.

Id	Name	SBO
species_11	NADPH	
species_10	NADP	

Product

Table 106: Properties of each product.

Id	Name	SBO
species_10	NADP	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \text{vol}(\text{compartment_1}) \cdot \text{function_7}(\text{parameter_47}, [\text{species_11}], [\text{species_10}], \text{Keq}) \quad (168)$$

$$\text{function_7}(\text{Vf}, \text{NADPH}, \text{NADP}, \text{Keq}) = \frac{\text{Vf} \cdot \text{NADPH} \cdot \left(1 - \frac{\text{NADP}}{\text{NADPH} \cdot \text{Keq}}\right)}{1 + \text{NADPH} + 1 + \text{NADP} - 1} \quad (169)$$

$$\text{function_7}(\text{Vf}, \text{NADPH}, \text{NADP}, \text{Keq}) = \frac{\text{Vf} \cdot \text{NADPH} \cdot \left(1 - \frac{\text{NADP}}{\text{NADPH} \cdot \text{Keq}}\right)}{1 + \text{NADPH} + 1 + \text{NADP} - 1} \quad (170)$$

Table 107: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Keq	Keq		0.2		<input checked="" type="checkbox"/>

8.28 Reaction [reaction_28](#)

This is a reversible reaction of four reactants forming two products influenced by six modifiers.

Name MPM

Reaction equation

$$0.08 \text{species_31} + 0.2 \text{species_34} + \text{species_23} + \text{species_3} \xrightleftharpoons{\text{species_31}, \text{species_23}, \text{species_3}, \text{species_34}, \text{species_4},} \quad (171)$$

Reactants

Table 108: Properties of each reactant.

Id	Name	SBO
species_31	PYR	
species_34	O2	
species_23	Pi	
species_3	ADP	

Modifiers

Table 109: Properties of each modifier.

Id	Name	SBO
species_31	PYR	
species_23	Pi	
species_3	ADP	
species_34	O2	
species_4	ATP	
species_33	CO2	

Products

Table 110: Properties of each product.

Id	Name	SBO
species_33	CO2	
species_4	ATP	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \text{vol}(\text{compartment_1}) \cdot \text{function_8}(\text{parameter_48}, [\text{species_31}], y, [\text{species_23}], [\text{species_3}], [\text{species_34}], [\text{species_4}], [\text{species_33}], \text{Keq}) \quad (172)$$

$$\begin{aligned} & \text{function_8}(\text{Vmf}, \text{PYR}, y, \text{Pi}, \text{ADP}, \text{O2}, \text{ATP}, \text{CO2}, \text{Keq}) \\ &= \frac{\text{Vmf} \cdot \text{PYR}^{\frac{1}{y}} \cdot \text{Pi} \cdot \text{ADP} \cdot \text{O2}^{\frac{5}{2y}} \cdot \left(1 - \frac{\text{ATP} \cdot \text{CO2}^{\frac{3}{y}}}{\text{PYR}^{\frac{1}{y}} \cdot \text{O2}^{\frac{5}{2y}} \cdot \text{Pi} \cdot \text{ADP} \cdot \text{Keq}}\right)}{(1 + \text{PYR})^{\frac{1}{y}} \cdot (1 + \text{O2})^{\frac{5}{2y}} \cdot (1 + \text{Pi}) \cdot (1 + \text{ADP}) + (1 + \text{ATP}) \cdot (1 + \text{CO2})^{\frac{3}{y}} - 1} \end{aligned} \quad (173)$$

$$\begin{aligned} & \text{function_8}(\text{Vmf}, \text{PYR}, y, \text{Pi}, \text{ADP}, \text{O2}, \text{ATP}, \text{CO2}, \text{Keq}) \\ &= \frac{\text{Vmf} \cdot \text{PYR}^{\frac{1}{y}} \cdot \text{Pi} \cdot \text{ADP} \cdot \text{O2}^{\frac{5}{2y}} \cdot \left(1 - \frac{\text{ATP} \cdot \text{CO2}^{\frac{3}{y}}}{\text{PYR}^{\frac{1}{y}} \cdot \text{O2}^{\frac{5}{2y}} \cdot \text{Pi} \cdot \text{ADP} \cdot \text{Keq}}\right)}{(1 + \text{PYR})^{\frac{1}{y}} \cdot (1 + \text{O2})^{\frac{5}{2y}} \cdot (1 + \text{Pi}) \cdot (1 + \text{ADP}) + (1 + \text{ATP}) \cdot (1 + \text{CO2})^{\frac{3}{y}} - 1} \end{aligned} \quad (174)$$

Table 111: Properties of each parameter.

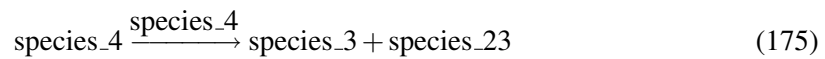
Id	Name	SBO	Value	Unit	Constant
y	y		12.5		<input checked="" type="checkbox"/>
Keq	Keq		1000000.0		<input checked="" type="checkbox"/>

8.29 Reaction [reaction_29](#)

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

Name ATPase

Reaction equation



Reactant

Table 112: Properties of each reactant.

Id	Name	SBO
species_4	ATP	

Modifier

Table 113: Properties of each modifier.

Id	Name	SBO
species_4	ATP	

Products

Table 114: Properties of each product.

Id	Name	SBO
species_3	ADP	
species_23	Pi	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{vol}(\text{compartment}_1) \cdot k1 \cdot [\text{species}_4] \quad (176)$$

Table 115: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		6210.0		<input checked="" type="checkbox"/>

9 Derived Rate Equations

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

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

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

9.1 Species `species_1`

Name GLC

SBO:0000247 simple chemical

Initial concentration $8.97 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a reactant in [reaction_2](#) and as a product in [reaction_1](#) and as a modifier in [reaction_1](#), [reaction_2](#)).

$$\frac{d}{dt} \text{species}_1 = v_1 - v_2 \quad (177)$$

9.2 Species `species_2`

Name G6P

SBO:0000247 simple chemical

Initial concentration $0.00109 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in eight reactions (as a reactant in [reaction_3](#), [reaction_4](#) and as a product in [reaction_2](#), [reaction_12](#) and as a modifier in [reaction_2](#), [reaction_3](#), [reaction_4](#), [reaction_12](#)).

$$\frac{d}{dt} \text{species}_2 = v_2 + v_{12} - v_3 - v_4 \quad (178)$$

9.3 Species `species_3`

Name ADP

SBO:0000247 simple chemical

Initial concentration 0.0027 nmol · nl⁻¹

Involved in rule `species_3`

This species takes part in 15 reactions (as a reactant in `reaction_17`, `reaction_23`, `reaction_25`, `reaction_28` and as a product in `reaction_2`, `reaction_19`, `reaction_20`, `reaction_29` and as a modifier in `reaction_2`, `reaction_17`, `reaction_19`, `reaction_20`, `reaction_23`, `reaction_25`, `reaction_28`). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.4 Species `species_4`

Name ATP

SBO:0000247 simple chemical

Initial concentration 0.0087 nmol · nl⁻¹

This species takes part in 22 reactions (as a reactant in `reaction_2`, `reaction_11`, `reaction_19`, `reaction_20`, `reaction_29` and as a product in `reaction_17`, `reaction_23`, `reaction_25`, `reaction_28` and as a modifier in `reaction_2`, `reaction_4`, `reaction_4`, `reaction_5`, `reaction_5`, `reaction_11`, `reaction_17`, `reaction_19`, `reaction_20`, `reaction_23`, `reaction_25`, `reaction_28`, `reaction_29`).

$$\frac{d}{dt}\text{species_4} = v_{17} + v_{23} + v_{25} + v_{28} - v_2 - v_{11} - v_{19} - v_{20} - v_{29} \quad (179)$$

9.5 Species `species_5`

Name F6P

SBO:0000247 simple chemical

Initial concentration 3.62 · 10⁻⁵ nmol · nl⁻¹

This species takes part in eight reactions (as a reactant in `reaction_20` and as a product in `reaction_3`, `reaction_9`, `reaction_10` and as a modifier in `reaction_3`, `reaction_9`, `reaction_10`, `reaction_20`).

$$\frac{d}{dt}\text{species_5} = v_3 + v_9 + v_{10} - v_{20} \quad (180)$$

9.6 Species `species_6`

Name F16P

SBO:0000247 simple chemical

Initial concentration $3.67 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in eight reactions (as a reactant in [reaction_14](#) and as a product in [reaction_20](#) and as a modifier in [reaction_3](#), [reaction_3](#), [reaction_14](#), [reaction_20](#), [reaction_23](#), [reaction_23](#)).

$$\frac{d}{dt}\text{species_6} = v_{20} - v_{14} \quad (181)$$

9.7 Species `species_7`

Name E4P

SBO:0000247 simple chemical

Initial concentration $9.3 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in [reaction_9](#) and as a product in [reaction_10](#) and as a modifier in [reaction_3](#), [reaction_3](#), [reaction_9](#), [reaction_10](#)).

$$\frac{d}{dt}\text{species_7} = v_{10} - v_9 \quad (182)$$

9.8 Species `species_8`

Name PGN

SBO:0000247 simple chemical

Initial concentration $10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in [reaction_5](#) and as a product in [reaction_4](#) and as a modifier in [reaction_3](#), [reaction_3](#), [reaction_4](#), [reaction_5](#)).

$$\frac{d}{dt}\text{species_8} = v_4 - v_5 \quad (183)$$

9.9 Species [species_9](#)

Name GLC_e

SBO:0000247 simple chemical

Initial concentration $0.01 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in two reactions (as a reactant in [reaction_1](#) and as a modifier in [reaction_1](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_9} = 0 \quad (184)$$

9.10 Species [species_10](#)

Name NADP

SBO:0000247 simple chemical

Initial concentration $6.118 \cdot 10^{-7} \text{ nmol} \cdot \text{nl}^{-1}$

Involved in rule [species_10](#)

This species takes part in six reactions (as a reactant in [reaction_4](#), [reaction_5](#) and as a product in [reaction_27](#) and as a modifier in [reaction_4](#), [reaction_5](#), [reaction_27](#)). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.11 Species [species_11](#)

Name NADPH

SBO:0000247 simple chemical

Initial concentration $1.87082 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in [reaction_27](#) and as a product in [reaction_4](#), [reaction_5](#) and as a modifier in [reaction_4](#), [reaction_5](#), [reaction_27](#)).

$$\frac{d}{dt}\text{species_11} = v_4 + v_5 - v_{27} \quad (185)$$

9.12 Species `species_12`

Name BPG

SBO:0000247 simple chemical

Initial concentration $6.29 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in eight reactions (as a reactant in `reaction_17` and as a product in `reaction_16` and as a modifier in `reaction_4`, `reaction_4`, `reaction_5`, `reaction_5`, `reaction_16`, `reaction_17`).

$$\frac{d}{dt}\text{species_12} = v_{16} - v_{17} \quad (186)$$

9.13 Species `species_13`

Name RU5P

SBO:0000247 simple chemical

Initial concentration $1.43 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in `reaction_6`, `reaction_7` and as a product in `reaction_5` and as a modifier in `reaction_5`, `reaction_6`, `reaction_7`).

$$\frac{d}{dt}\text{species_13} = v_5 - v_6 - v_7 \quad (187)$$

9.14 Species `species_14`

Name X5P

SBO:0000247 simple chemical

Initial concentration $2.42 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in `reaction_8`, `reaction_9` and as a product in `reaction_6` and as a modifier in `reaction_6`, `reaction_8`, `reaction_9`).

$$\frac{d}{dt}\text{species_14} = v_6 - v_8 - v_9 \quad (188)$$

9.15 Species [species_15](#)

Name R5P

SBO:0000247 simple chemical

Initial concentration $2.74 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in [reaction_8](#), [reaction_11](#) and as a product in [reaction_7](#) and as a modifier in [reaction_7](#), [reaction_8](#), [reaction_11](#)).

$$\frac{d}{dt}\text{species_15} = v_7 - v_8 - v_{11} \quad (189)$$

9.16 Species [species_16](#)

Name GAP

SBO:0000247 simple chemical

Initial concentration $1.53 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in twelve reactions (as a reactant in [reaction_10](#), [reaction_15](#), [reaction_16](#) and as a product in [reaction_8](#), [reaction_9](#), [reaction_14](#) and as a modifier in [reaction_8](#), [reaction_9](#), [reaction_10](#), [reaction_14](#), [reaction_15](#), [reaction_16](#)).

$$\frac{d}{dt}\text{species_16} = v_8 + v_9 + v_{14} - v_{10} - v_{15} - v_{16} \quad (190)$$

9.17 Species [species_17](#)

Name S7P

SBO:0000247 simple chemical

Initial concentration $8.58 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a reactant in [reaction_10](#) and as a product in [reaction_8](#) and as a modifier in [reaction_8](#), [reaction_10](#)).

$$\frac{d}{dt}\text{species_17} = v_8 - v_{10} \quad (191)$$

9.18 Species [species_18](#)

Name NADH

SBO:0000247 simple chemical

Initial concentration $5.000000000000001 \cdot 10^{-6} \text{ nmol} \cdot \text{nl}^{-1}$

Involved in rule [species_18](#)

This species takes part in six reactions (as a reactant in [reaction_24](#), [reaction_26](#) and as a product in [reaction_16](#) and as a modifier in [reaction_16](#), [reaction_24](#), [reaction_26](#)). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.19 Species [species_19](#)

Name NAD

SBO:0000247 simple chemical

Initial concentration $0.00134 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in [reaction_16](#) and as a product in [reaction_24](#), [reaction_26](#) and as a modifier in [reaction_16](#), [reaction_24](#), [reaction_26](#)).

$$\frac{d}{dt}\text{species_19} = v_{24} + v_{26} - v_{16} \quad (192)$$

9.20 Species [species_20](#)

Name AMP

SBO:0000247 simple chemical

Initial concentration $0.00311 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a product in [reaction_11](#), [reaction_25](#) and as a modifier in [reaction_11](#), [reaction_25](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_20} = 0 \quad (193)$$

9.21 Species `species_21`

Name PRPP

SBO:0000247 simple chemical

Initial concentration $0.0010 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in two reactions (as a product in [reaction_11](#) and as a modifier in [reaction_11](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_21} = 0 \quad (194)$$

9.22 Species `species_22`

Name G1P

SBO:0000247 simple chemical

Initial concentration $3.41 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in eight reactions (as a reactant in [reaction_12](#), [reaction_19](#) and as a product in [reaction_13](#), [reaction_18](#) and as a modifier in [reaction_12](#), [reaction_13](#), [reaction_18](#), [reaction_19](#)).

$$\frac{d}{dt}\text{species_22} = v_{13} + v_{18} - v_{12} - v_{19} \quad (195)$$

9.23 Species `species_23`

Name Pi

SBO:0000247 simple chemical

Initial concentration $0.02 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in eleven reactions (as a reactant in [reaction_13](#), [reaction_16](#), [reaction_18](#), [reaction_28](#) and as a product in [reaction_19](#), [reaction_29](#) and as a modifier in [reaction_13](#), [reaction_16](#), [reaction_18](#), [reaction_19](#), [reaction_28](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_23} = 0 \quad (196)$$

9.24 Species `species_24`

Name GLY

SBO:0000247 simple chemical

Initial concentration 0.208403745497308 nmol · nl⁻¹

This species takes part in eight reactions (as a reactant in [reaction_13](#), [reaction_18](#) and as a product in [reaction_13](#), [reaction_18](#), [reaction_19](#) and as a modifier in [reaction_13](#), [reaction_18](#), [reaction_19](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_24} = 0 \quad (197)$$

9.25 Species `species_25`

Name CIT

SBO:0000247 simple chemical

Initial concentration 0.00108 nmol · nl⁻¹

This species takes part in two reactions (as a modifier in [reaction_20](#), [reaction_20](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_25} = 0 \quad (198)$$

9.26 Species `species_26`

Name F26P

SBO:0000247 simple chemical

Initial concentration 3.67 · 10⁻⁶ nmol · nl⁻¹

This species takes part in two reactions (as a modifier in [reaction_20](#), [reaction_20](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_26} = 0 \quad (199)$$

9.27 Species `species_27`

Name DHAP

SBO:0000247 simple chemical

Initial concentration $5.53 \cdot 10^{-4} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a product in [reaction_14](#), [reaction_15](#) and as a modifier in [reaction_14](#), [reaction_15](#)).

$$\frac{d}{dt}\text{species.27} = v_{14} + v_{15} \quad (200)$$

9.28 Species `species_28`

Name PG3

SBO:0000247 simple chemical

Initial concentration $3.07 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a reactant in [reaction_21](#) and as a product in [reaction_17](#) and as a modifier in [reaction_17](#), [reaction_21](#)).

$$\frac{d}{dt}\text{species.28} = v_{17} - v_{21} \quad (201)$$

9.29 Species `species_29`

Name PG2

SBO:0000247 simple chemical

Initial concentration $4.98 \cdot 10^{-6} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a reactant in [reaction_22](#) and as a product in [reaction_21](#) and as a modifier in [reaction_21](#), [reaction_22](#)).

$$\frac{d}{dt}\text{species.29} = v_{21} - v_{22} \quad (202)$$

9.30 Species `species_30`

Name PEP

SBO:0000247 simple chemical

Initial concentration $5.79 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in four reactions (as a reactant in [reaction_23](#) and as a product in [reaction_22](#) and as a modifier in [reaction_22](#), [reaction_23](#)).

$$\frac{d}{dt}\text{species.30} = v_{22} - v_{23} \quad (203)$$

9.31 Species `species_31`

Name PYR

SBO:0000247 simple chemical

Initial concentration $0.00183 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in six reactions (as a reactant in [reaction_24](#), [reaction_28](#) and as a product in [reaction_23](#) and as a modifier in [reaction_23](#), [reaction_24](#), [reaction_28](#)).

$$\frac{d}{dt} \text{species_31} = v_{23} - v_{24} - 0.08 v_{28} \quad (204)$$

9.32 Species `species_32`

Name LAC

SBO:0000247 simple chemical

Initial concentration $0.0155 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in two reactions (as a product in [reaction_24](#) and as a modifier in [reaction_24](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt} \text{species_32} = 0 \quad (205)$$

9.33 Species `species_33`

Name CO2

SBO:0000247 simple chemical

Initial concentration $0.0214 \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in two reactions (as a product in [reaction_28](#) and as a modifier in [reaction_28](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt} \text{species_33} = 0 \quad (206)$$

9.34 Species `species_34`

Name O2

SBO:0000247 simple chemical

Initial concentration $6.5 \cdot 10^{-5} \text{ nmol} \cdot \text{nl}^{-1}$

This species takes part in two reactions (as a reactant in [reaction_28](#) and as a modifier in [reaction_28](#)), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{d}{dt}\text{species_34} = 0 \quad (207)$$

A Glossary of Systems Biology Ontology Terms

SBO:0000247 simple chemical: Simple, non-repetitive chemical entity

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