SBML Model Report

Model name: “Achcar2012 - Glycolysis in bloodstream form T. brucei”

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Lukas Endler[2] at November 20th 2012 at 6:36 p. m. and last time modified at September third 2014 at 4:23 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	3
species types	0	species	31
events	0	constraints	0
reactions	23	function definitions	5
global parameters	0	unit definitions	5
rules	0	initial assignments	0

Model Notes

Achcar2012 - Glycolysis in bloodstream form T. brucei

Kinetic models of metabolism require quantitative knowledge of detailed kinetic parameters. However, the knowledge about these parameters is often uncertain. An analysis of the effect of

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parameter uncertainties on a particularly well defined example of a quantitative metablic model, the model of glycolysis in bloodstream form Trypanosoma brucei , has been presented here.

This model is described in the article:Dynamic modelling under uncertainty: the case of Trypanosoma brucei energy metabolism.Achcar F, Kerkhoven EJ; SilicoTryp Consortium, Bakker BM, Barrett MP, Breitling R.PLoS Comput Biol. 2012 Jan; 8(1):e1002352.

Abstract:

Kinetic models of metabolism require detailed knowledge of kinetic parameters. However, due to measurement errors or lack of data this knowledge is often uncertain. The model of glycolysis in the parasitic protozoan Trypanosoma brucei is a particularly well analysed example of a quantitative metabolic model, but so far it has been studied with a fixed set of parameters only. Here we evaluate the effect of parameter uncertainty. In order to define probability distributions for each parameter, information about the experimental sources and confidence intervals for all parameters were collected. We created a wiki-based website dedicated to the detailed documentation of this information: the SilicoTryp wiki (http://silicotryp.ibls.gla.ac.uk/wiki/Glycolysis). Using information collected in the wiki, we then assigned probability distributions to all parameters of the model. This allowed us to sample sets of alternative models, accurately representing our degree of uncertainty. Some properties of the model, such as the repartition of the glycolytic flux between the glycerol and pyruvate producing branches, are robust to these uncertainties. However, our analysis also allowed us to identify fragilities of the model leading to the accumulation of 3-phosphoglycerate and/or pyruvate. The analysis of the control coefficients revealed the importance of taking into account the uncertainties about the parameters, as the ranking of the reactions can be greatly affected. This work will now form the basis for a comprehensive Bayesian analysis and extension of the model considering alternative topologies.

This model is hosted on BioModels Database and identified by: MODEL1209130000 .

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

2 Unit Definitions

This is an overview of five unit definitions.

2.1 Unit `volume`

Definition µl

2.2 Unit `length`

Definition m

2.3 Unit substance

Definition nmol

2.4 Unit time

Definition 60 s

2.5 Unit area

Definition m^2

3 Compartments

This model contains three compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
cytosol	cytosol		3	5.4549	µl	☑	
glycosome	glycosome		3	0.2451	µl	☑	
default	default		3	1	litre	☑	

3.1 Compartment cytosol

This is a three dimensional compartment with a constant size of 5.4549 µl.

Name cytosol

3.2 Compartment glycosome

This is a three dimensional compartment with a constant size of 0.2451 µl.

Name glycosome

3.3 Compartment default

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

Name default

4 Species

This model contains 31 species. The boundary condition of five of these species is set to `true` so that these species' amount cannot be changed by any reaction. Section 7 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
_2PGA_c	_2PGA_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
ATP_g	ATP_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
ATP_c	ATP_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Pyr_c	Pyr_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
DHAP_c	DHAP_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Pyr_e	Pyr_e	default	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☑	☑
Gly3P_c	Gly3P_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
DHAP_g	DHAP_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
NAD_g	NAD_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Glc6P_g	Glc6P_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Fru16BP_g	Fru16BP_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
ADP_c	ADP_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
_3PGA_c	_3PGA_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Gly_g	Gly_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Fru6P_g	Fru6P_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Gly_e	Gly_e	default	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☑	☑
_3PGA_g	_3PGA_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Gly_c	Gly_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
Pi_g	Pi_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☑	☑
AMP_c	AMP_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☐	☐
O2_c	O2_c	default	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☑	☑

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
GA3P_g	GA3P_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
Gly3P_g	Gly3P_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
ADP_g	ADP_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
PEP_c	PEP_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
AMP_g	AMP_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
_13BPGA_g	_13BPGA_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
Glc_c	Glc_c	cytosol	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
Glc_e	Glc_e	default	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	☑	☑
Glc_g	Glc_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟
NADH_g	NADH_g	glycosome	$\mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$	⊟	⊟

5 Function definitions

This is an overview of five function definitions.

5.1 Function definition mass_action_rev

Name mass_action_rev

Arguments k1, S, k2, P

Mathematical Expression

$$\mathrm{k1} \cdot \mathrm{S} - \mathrm{k2} \cdot \mathrm{P} \tag{1}$$

5.2 Function definition vAK

Name vAK

Arguments ADP, AMP, ATP, k1, k2

Mathematical Expression

$$\mathrm{k1} \cdot \mathrm{ADP}^2 - \mathrm{AMP} \cdot \mathrm{ATP} \cdot \mathrm{k2} \tag{2}$$

5.3 Function definition v1sub1prod

Name v1sub1prod

Arguments Vfmax, Keq, S, Ks, P, Kp

Mathematical Expression

$$\frac{\mathrm{Vfmax} \cdot \mathrm{S} \cdot \left(1 - \frac{\mathrm{P}}{\mathrm{Keq} \cdot \mathrm{S}}\right)}{\mathrm{Ks} \cdot \left(1 + \frac{\mathrm{S}}{\mathrm{Ks}} + \frac{\mathrm{P}}{\mathrm{Kp}}\right)} \tag{3}$$

5.4 Function definition v1sub

Name v1sub

Arguments Vfmax, S, Ks

Mathematical Expression

$$\frac{\mathrm{Vfmax} \cdot \mathrm{S}}{\mathrm{Ks} \cdot \left(1 + \frac{\mathrm{S}}{\mathrm{Ks}}\right)} \tag{4}$$

5.5 Function definition v2sub2prod

Name v2sub2prod

Arguments Vfmax, Keq, S1, Ks1, S2, Ks2, P1, Kp1, P2, Kp2

Mathematical Expression

$$\frac{\mathrm{Vfmax} \cdot \mathrm{S1} \cdot \mathrm{S2} \cdot \left(1 - \frac{\mathrm{P1} \cdot \mathrm{P2}}{\mathrm{Keq} \cdot \mathrm{S1} \cdot \mathrm{S2}}\right)}{\mathrm{Ks1} \cdot \mathrm{Ks2} \cdot \left(1 + \frac{\mathrm{S2}}{\mathrm{Ks2}} + \frac{\mathrm{P2}}{\mathrm{Kp2}}\right) \cdot \left(1 + \frac{\mathrm{S1}}{\mathrm{Ks1}} + \frac{\mathrm{P1}}{\mathrm{Kp1}}\right)} \tag{5}$$

6 Reactions

This model contains 23 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 4: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	GlyT_g	GlyT_g	$\text{Gly\_g} \xrightleftharpoons{\text{Gly\_g, Gly\_c}} \text{Gly\_c}$	
2	PYK_c	PYK_c	$\text{PEP\_c} + \text{ADP\_c} \xrightleftharpoons{\text{ADP\_c, PEP\_c, ATP\_c}} \text{Pyr\_c} + \text{ATP\_c}$	
3	GlyT_c	GlyT_c	$\text{Gly\_c} \xrightleftharpoons{\text{Gly\_c, Gly\_e}} \text{Gly\_e}$	
4	GlcT_g	GlcT_g	$\text{Glc\_c} \xrightleftharpoons{\text{Glc\_c, Glc\_g}} \text{Glc\_g}$	
5	PyrT_c	PyrT_c	$\text{Pyr\_c} \xrightleftharpoons{\text{Pyr\_c}} \text{Pyr\_e}$	
6	GlcT_c	GlcT_c	$\text{Glc\_e} \xrightleftharpoons{\text{Glc\_e, Glc\_c}} \text{Glc\_c}$	
7	PFK_g	PFK_g	$\text{ATP\_g} + \text{Fru6P\_g} \xrightleftharpoons{\text{ATP\_g, Fru6P\_g, Fru16BP\_g}} \text{Fru16BP\_g} + \text{ADP\_g}$	
8	ENO_c	ENO_c	$\text{\_2PGA\_c} \xrightleftharpoons{\text{\_2PGA\_c, PEP\_c}} \text{PEP\_c}$	
9	HXK_g	HXK_g	$\text{ATP\_g} + \text{Glc\_g} \xrightleftharpoons{\text{ATP\_g, Glc\_g, Glc6P\_g, ADP\_g}} \text{Glc6P\_g} + \text{ADP\_g}$	
10	_3PGAT_g	_3PGAT_g	$\text{\_3PGA\_g} \xrightleftharpoons{\text{\_3PGA\_g, \_3PGA\_c}} \text{\_3PGA\_c}$	
11	PGK_g	PGK_g	$\text{\_13BPGA\_g} + \text{ADP\_g} \xrightleftharpoons{\text{\_13BPGA\_g, ADP\_g, \_3PGA\_g, ATP\_g}} \text{\_3PGA\_g} + \text{ATP\_g}$	
12	PGAM_c	PGAM_c	$\text{\_3PGA\_c} \xrightleftharpoons{\text{\_3PGA\_c, \_2PGA\_c}} \text{\_2PGA\_c}$	

№	Id	Name	Reaction Equation	SBO
13	G3PDH_g	G3PDH_g	$\mathrm{NADH\_g} + \mathrm{DHAP\_g} \overset{\mathrm{DHAP\_g,\ NADH\_g,\ Gly3P\_g,\ NAD\_g}}{\rightleftharpoons} \mathrm{Gly3P\_g} + \mathrm{NAD\_g}$	
14	ATPu_c	ATPu_c	$\mathrm{ATP\_c} \overset{\mathrm{ATP\_c,\ ADP\_c}}{\rightleftharpoons} \mathrm{ADP\_c}$	
15	GK_g	GK_g	$\mathrm{Gly3P\_g} + \mathrm{ADP\_g} \overset{\mathrm{Gly3P\_g,\ ADP\_g,\ Gly\_g,\ ATP\_g}}{\rightleftharpoons} \mathrm{Gly\_g} + \mathrm{ATP\_g}$	
16	ALD_g	ALD_g	$\mathrm{Fru16BP\_g} \overset{\mathrm{ATP\_g,\ ADP\_g,\ AMP\_g,\ Fru16BP\_g,\ GA3P\_g,\ DHAP\_g,\ ATP\_g,\ ADP\_g,\ A}}{\rightleftharpoons} \mathrm{DHAP\_g}$	
17	AK_c	AK_c	$2\,\mathrm{ADP\_c} \overset{\mathrm{ADP\_c,\ AMP\_c,\ ATP\_c}}{\rightleftharpoons} \mathrm{AMP\_c} + \mathrm{ATP\_c}$	
18	PGI_g	PGI_g	$\mathrm{Glc6P\_g} \overset{\mathrm{Glc6P\_g,\ Fru6P\_g}}{\rightleftharpoons} \mathrm{Fru6P\_g}$	
19	GAPDH_g	GAPDH_g	$\mathrm{GA3P\_g} + \mathrm{NAD\_g} + \mathrm{Pi\_g} \overset{\mathrm{GA3P\_g,\ NAD\_g,\ \_13BPGA\_g,\ NADH\_g}}{\rightleftharpoons} \mathrm{NADH\_g} + \mathrm{\_13BPGA\_g}$	
20	AK_g	AK_g	$2\,\mathrm{ADP\_g} \overset{\mathrm{ADP\_g,\ AMP\_g,\ ATP\_g}}{\rightleftharpoons} \mathrm{AMP\_g} + \mathrm{ATP\_g}$	
21	GDA_g	GDA_g	$\mathrm{Gly3P\_g} + \mathrm{DHAP\_c} \overset{\mathrm{Gly3P\_g,\ DHAP\_c,\ Gly3P\_c,\ DHAP\_g}}{\rightleftharpoons} \mathrm{Gly3P\_c} + \mathrm{DHAP\_g}$	
22	GPO_c	GPO_c	$\mathrm{Gly3P\_c} \overset{\mathrm{Gly3P\_c}}{\rightleftharpoons} \mathrm{DHAP\_c}$	
23	TPI_g	TPI_g	$\mathrm{DHAP\_g} \overset{\mathrm{DHAP\_g,\ GA3P\_g}}{\rightleftharpoons} \mathrm{GA3P\_g}$	

6.1 Reaction GlyT_g

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

Name GlyT_g

Reaction equation

$$\text{Gly\_g} \overset{\text{Gly\_g, Gly\_c}}{\rightleftharpoons} \text{Gly\_c} \tag{6}$$

Reactant

Table 5: Properties of each reactant.

Id	Name	SBO
Gly_g	Gly_g	

Modifiers

Table 6: Properties of each modifier.

Id	Name	SBO
Gly_g	Gly_g	
Gly_c	Gly_c	

Product

Table 7: Properties of each product.

Id	Name	SBO
Gly_c	Gly_c	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{mass\_action\_rev}\left(\text{GlyT\_g\_k}, [\text{Gly\_g}], \text{GlyT\_g\_k}, [\text{Gly\_c}]\right) \tag{7}$$

$$\text{mass\_action\_rev}\left(\text{k1}, \text{S}, \text{k2}, \text{P}\right) = \text{k1} \cdot \text{S} - \text{k2} \cdot \text{P} \tag{8}$$

Table 8: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GlyT_g_k	GlyT_g_k		9000.0		☑

6.2 Reaction PYK_c

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

Name PYK_c

Reaction equation

$$\mathrm{PEP\_c} + \mathrm{ADP\_c} \xrightleftharpoons{\mathrm{ADP\_c,\ PEP\_c,\ ATP\_c}} \mathrm{Pyr\_c} + \mathrm{ATP\_c} \tag{9}$$

Reactants

Table 9: Properties of each reactant.

Id	Name	SBO
PEP_c	PEP_c	
ADP_c	ADP_c	

Modifiers

Table 10: Properties of each modifier.

Id	Name	SBO
ADP_c	ADP_c	
PEP_c	PEP_c	
ATP_c	ATP_c	

Products

Table 11: Properties of each product.

Id	Name	SBO
Pyr_c	Pyr_c	
ATP_c	ATP_c	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \frac{[\text{ADP\_c}] \cdot \text{PYK\_c\_Vmax} \cdot \left(\frac{[\text{PEP\_c}]}{\text{PYK\_c\_KmPEP} \cdot \left(1 + \frac{[\text{ADP\_c}]}{\text{PYK\_c\_KiADP}} + \frac{[\text{ATP\_c}]}{\text{PYK\_c\_KiATP}}\right)} \right)^{\text{PYK\_c\_n}}}{\text{PYK\_c\_KmADP} \cdot \left(1 + \frac{[\text{ADP\_c}]}{\text{PYK\_c\_KmADP}}\right) \cdot \left(1 + \left(\frac{[\text{PEP\_c}]}{\text{PYK\_c\_KmPEP} \cdot \left(1 + \frac{[\text{ADP\_c}]}{\text{PYK\_c\_KiADP}} + \frac{[\text{ATP\_c}]}{\text{PYK\_c\_KiATP}}\right)} \right)^{\text{PYK\_c\_n}}\right)} \tag{10}$$

Table 12: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
PYK_c_Vmax	PYK_c_Vmax		1020.000		☑
PYK_c_KmPEP	PYK_c_KmPEP		0.340		☑
PYK_c_KiATP	PYK_c_KiATP		0.570		☑
PYK_c_KiADP	PYK_c_KiADP		0.640		☑
PYK_c_n	PYK_c_n		2.500		☑
PYK_c_KmADP	PYK_c_KmADP		0.114		☑

6.3 Reaction GlyT_c

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

Name GlyT_c

Reaction equation

$$\text{Gly\_c} \underset{\text{Gly\_c, Gly\_e}}{\rightleftharpoons} \text{Gly\_e} \tag{11}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
Gly_c	Gly_c	

Modifiers

Table 14: Properties of each modifier.

Id	Name	SBO
Gly_c	Gly_c	
Gly_e	Gly_e	

Product

Table 15: Properties of each product.

Id	Name	SBO
Gly_e	Gly_e	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{GlyT\_c\_k} \cdot ([\mathrm{Gly\_c}] - [\mathrm{Gly\_e}]) + \frac{\mathrm{GlyT\_c\_Vmax} \cdot ([\mathrm{Gly\_c}] - [\mathrm{Gly\_e}])}{\mathrm{GlyT\_c\_KmGly} \cdot \left(1 + \frac{[\mathrm{Gly\_c}]}{\mathrm{GlyT\_c\_KmGly}}\right) \cdot \left(1 + \frac{[\mathrm{Gly\_e}]}{\mathrm{GlyT\_c\_KmGly}}\right)} \tag{12}$$

Table 16: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GlyT_c_Vmax	GlyT_c_Vmax		85.00		☑
GlyT_c_KmGly	GlyT_c_KmGly		0.17		☑
GlyT_c_k	GlyT_c_k		9.00		☑

6.4 Reaction GlcT_g

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

Name GlcT_g

Reaction equation

$$\mathrm{Glc\_c} \overset{\mathrm{Glc\_c,\ Glc\_g}}{\rightleftharpoons} \mathrm{Glc\_g} \tag{13}$$

Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
Glc_c	Glc_c	

Modifiers

Table 18: Properties of each modifier.

Id	Name	SBO
Glc_c	Glc_c	
Glc_g	Glc_g	

Product

Table 19: Properties of each product.

Id	Name	SBO
Glc_g	Glc_g	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{mass\_action\_rev}\left(\text{GlcT\_g\_k}, [\text{Glc\_c}], \text{GlcT\_g\_k}, [\text{Glc\_g}]\right) \tag{14}$$

$$\text{mass\_action\_rev}\left(\text{k1}, \text{S}, \text{k2}, \text{P}\right) = \text{k1} \cdot \text{S} - \text{k2} \cdot \text{P} \tag{15}$$

Table 20: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GlcT_g_k	GlcT_g_k		250000.0		☑

6.5 Reaction PyrT_c

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

Name PyrT_c

Reaction equation

$$\text{Pyr\_c} \overset{\text{Pyr\_c}}{\rightleftharpoons} \text{Pyr\_e} \tag{16}$$

Reactant

Table 21: Properties of each reactant.

Id	Name	SBO
Pyr_c	Pyr_c	

Modifier

Table 22: Properties of each modifier.

Id	Name	SBO
Pyr_c	Pyr_c	

Product

Table 23: Properties of each product.

Id	Name	SBO
Pyr_e	Pyr_e	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{v1sub}\left(\text{PyrT\_c\_Vmax}, [\text{Pyr\_c}], \text{PyrT\_c\_KmPyr}\right) \tag{17}$$

$$\text{v1sub}\left(\text{Vfmax}, \text{S}, \text{Ks}\right) = \frac{\text{Vfmax} \cdot \text{S}}{\text{Ks} \cdot \left(1 + \frac{\text{S}}{\text{Ks}}\right)} \tag{18}$$

Table 24: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
PyrT_c_Vmax	PyrT_c_Vmax		200.00		☑
PyrT_c_KmPyr	PyrT_c_KmPyr		1.96		☑

6.6 Reaction GlcT_c

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

Name GlcT_c

Reaction equation

$$\mathrm{Glc\_e} \xrightleftharpoons{\mathrm{Glc\_e},\ \mathrm{Glc\_c}} \mathrm{Glc\_c} \tag{19}$$

Reactant

Table 25: Properties of each reactant.

Id	Name	SBO
Glc_e	Glc_e	

Modifiers

Table 26: Properties of each modifier.

Id	Name	SBO
Glc_e	Glc_e	
Glc_c	Glc_c	

Product

Table 27: Properties of each product.

Id	Name	SBO
Glc_c	Glc_c	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \frac{\mathrm{GlcT\_c\_Vmax} \cdot (\mathrm{[Glc\_e]} - \mathrm{[Glc\_c]})}{\mathrm{[Glc\_e]} + \mathrm{[Glc\_c]} + \mathrm{GlcT\_c\_KmGlc} + \frac{\mathrm{[Glc\_e]} \cdot \mathrm{[Glc\_c]} \cdot \mathrm{GlcT\_c\_alpha}}{\mathrm{GlcT\_c\_KmGlc}}} \tag{20}$$

Table 28: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GlcT_c_Vmax	GlcT_c_Vmax		108.90		☑
GlcT_c_KmGlc	GlcT_c_KmGlc		1.00		☑
GlcT_c_alpha	GlcT_c_alpha		0.75		☑

6.7 Reaction PFK_g

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

Name PFK_g

Reaction equation

$$\mathrm{ATP\_g} + \mathrm{Fru6P\_g} \xrightleftharpoons{\mathrm{ATP\_g,\ Fru6P\_g,\ Fru16BP\_g}} \mathrm{Fru16BP\_g} + \mathrm{ADP\_g} \tag{21}$$

Reactants

Table 29: Properties of each reactant.

Id	Name	SBO
ATP_g	ATP_g	
Fru6P_g	Fru6P_g	

Modifiers

Table 30: Properties of each modifier.

Id	Name	SBO
ATP_g	ATP_g	
Fru6P_g	Fru6P_g	
Fru16BP_g	Fru16BP_g	

Products

Table 31: Properties of each product.

Id	Name	SBO
Fru16BP_g	Fru16BP_g	
ADP_g	ADP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \frac{[\text{ATP\_g}] \cdot [\text{Fru6P\_g}] \cdot \text{PFK\_g\_Vmax} \cdot \text{PFK\_g\_Ki1}}{\text{PFK\_g\_KmFru6P} \cdot \text{PFK\_g\_KmATP} \cdot \left(1 + \frac{[\text{ATP\_g}]}{\text{PFK\_g\_KmATP}}\right) \cdot ([\text{Fru16BP\_g}] + \text{PFK\_g\_Ki1}) \cdot \left(1 + \frac{[\text{Fru6P\_g}]}{\text{PFK\_g\_KmFru6P}} + \frac{[\text{Fr}}{\text{PF}}\right.} \tag{22}$$

Table 32: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
PFK_g_Vmax	PFK_g_Vmax		1708.000		☑
PFK_g_Ki1	PFK_g_Ki1		15.800		☑
PFK_g_KmFru6P	PFK_g_KmFru6P		0.820		☑
PFK_g_KmATP	PFK_g_KmATP		0.026		☑
PFK_g_Ki2	PFK_g_Ki2		10.700		☑

6.8 Reaction ENO_c

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

Name ENO_c

Reaction equation

$$\text{\_2PGA\_c} \underset{\text{\_2PGA\_c, PEP\_c}}{\rightleftharpoons} \text{PEP\_c} \tag{23}$$

Reactant

Table 33: Properties of each reactant.

Id	Name	SBO
_2PGA_c	_2PGA_c	

Modifiers

Table 34: Properties of each modifier.

Id	Name	SBO
_2PGA_c	_2PGA_c	

Id	Name	SBO
PEP_c	PEP_c	

Product

Table 35: Properties of each product.

Id	Name	SBO
PEP_c	PEP_c	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{v1sub1prod}\left(\text{ENO\_c\_Vmax}, \text{ENO\_c\_Keq}, [\text{\_2PGA\_c}], \text{ENO\_c\_Km2PGA}, [\text{PEP\_c}], \text{ENO\_c\_KmPEP}\right) \quad (24)$$

$$\text{v1sub1prod}\left(\text{Vfmax}, \text{Keq}, \text{S}, \text{Ks}, \text{P}, \text{Kp}\right) = \frac{\text{Vfmax} \cdot \text{S} \cdot \left(1 - \frac{\text{P}}{\text{Keq} \cdot \text{S}}\right)}{\text{Ks} \cdot \left(1 + \frac{\text{S}}{\text{Ks}} + \frac{\text{P}}{\text{Kp}}\right)} \quad (25)$$

Table 36: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
ENO_c_Vmax	ENO_c_Vmax		598.000		☑
ENO_c_Keq	ENO_c_Keq		6.700		☑
ENO_c_Km2PGA	ENO_c_Km2PGA		0.054		☑
ENO_c_KmPEP	ENO_c_KmPEP		0.240		☑

6.9 Reaction HXK_g

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

Name HXK_g

Reaction equation

$$\text{ATP\_g} + \text{Glc\_g} \xrightleftharpoons{\text{ATP\_g, Glc\_g, Glc6P\_g, ADP\_g}} \text{Glc6P\_g} + \text{ADP\_g} \quad (26)$$

Reactants

Table 37: Properties of each reactant.

Id	Name	SBO
ATP_g	ATP_g	
Glc_g	Glc_g	

Modifiers

Table 38: Properties of each modifier.

Id	Name	SBO
ATP_g	ATP_g	
Glc_g	Glc_g	
Glc6P_g	Glc6P_g	
ADP_g	ADP_g	

Products

Table 39: Properties of each product.

Id	Name	SBO
Glc6P_g	Glc6P_g	
ADP_g	ADP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \frac{[\text{ATP\_g}] \cdot [\text{Glc\_g}] \cdot \text{HXK\_g\_Vmax}}{\text{HXK\_g\_KmGlc} \cdot \text{HXK\_g\_KmATP} \cdot \left(1 + \frac{[\text{Glc\_g}]}{\text{HXK\_g\_KmGlc}} + \frac{[\text{Glc6P\_g}]}{\text{HXK\_g\_KmGlc6P}}\right) \cdot \left(1 + \frac{[\text{ATP\_g}]}{\text{HXK\_g\_KmATP}} + \frac{[\text{ADP\_g}]}{\text{HXK\_g\_KmADP}}\right)} \tag{27}$$

Table 40: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
HXK_g_Vmax	HXK_g_Vmax		1929.000		☑
HXK_g_KmGlc	HXK_g_KmGlc		0.100		☑
HXK_g_KmATP	HXK_g_KmATP		0.116		☑

Id	Name	SBO	Value	Unit	Constant
HXK_g_KmADP	HXK_g_KmADP		0.126		☑
HXK_g_KmGlc6P	HXK_g_KmGlc6P		12.000		☑

6.10 Reaction _3PGAT_g

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

Name _3PGAT_g

Reaction equation

$$\text{\_3PGA\_g} \xrightleftharpoons{\text{\_3PGA\_g, \_3PGA\_c}} \text{\_3PGA\_c} \tag{28}$$

Reactant

Table 41: Properties of each reactant.

Id	Name	SBO
_3PGA_g	_3PGA_g	

Modifiers

Table 42: Properties of each modifier.

Id	Name	SBO
_3PGA_g	_3PGA_g	
_3PGA_c	_3PGA_c	

Product

Table 43: Properties of each product.

Id	Name	SBO
_3PGA_c	_3PGA_c	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{mass\_action\_rev}\left(\text{\_3PGAT\_g\_k}, [\text{\_3PGA\_g}], \text{\_3PGAT\_g\_k}, [\text{\_3PGA\_c}]\right) \tag{29}$$

$$\text{mass\_action\_rev}\left(\text{k1}, \text{S}, \text{k2}, \text{P}\right) = \text{k1} \cdot \text{S} - \text{k2} \cdot \text{P} \tag{30}$$

Table 44: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
_3PGAT_g_k	_3PGAT_g_k		250.0		☑

6.11 Reaction PGK_g

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

Name PGK_g

Reaction equation

$$\text{\_13BPGA\_g} + \text{ADP\_g} \xrightleftharpoons{\text{\_13BPGA\_g, ADP\_g, \_3PGA\_g, ATP\_g}} \text{\_3PGA\_g} + \text{ATP\_g} \tag{31}$$

Reactants

Table 45: Properties of each reactant.

Id	Name	SBO
_13BPGA_g	_13BPGA_g	
ADP_g	ADP_g	

Modifiers

Table 46: Properties of each modifier.

Id	Name	SBO
_13BPGA_g	_13BPGA_g	
ADP_g	ADP_g	
_3PGA_g	_3PGA_g	
ATP_g	ATP_g	

Products

Table 47: Properties of each product.

Id	Name	SBO
_3PGA_g	_3PGA_g	
ATP_g	ATP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{v2sub2prod}\,(\text{PGK\_g\_Vmax}, \text{PGK\_g\_Keq}, [\text{\_13BPGA\_g}], \text{PGK\_g\_Km13BPGA}, [\text{ADP\_g}], \text{PGK\_g\_KmADP}, [\text{\_3PGA\_g}], \text{PGK\_g\_Km3PGA}, [\text{ATP\_g}], \text{PGK\_g\_KmATP}) \tag{32}$$

$$\begin{aligned} &\text{v2sub2prod}\,(\text{Vfmax}, \text{Keq}, \text{S1}, \text{Ks1}, \text{S2}, \text{Ks2}, \text{P1}, \text{Kp1}, \text{P2}, \text{Kp2}) \\ &= \frac{\text{Vfmax} \cdot \text{S1} \cdot \text{S2} \cdot \left(1 - \frac{\text{P1} \cdot \text{P2}}{\text{Keq} \cdot \text{S1} \cdot \text{S2}}\right)}{\text{Ks1} \cdot \text{Ks2} \cdot \left(1 + \frac{\text{S2}}{\text{Ks2}} + \frac{\text{P2}}{\text{Kp2}}\right) \cdot \left(1 + \frac{\text{S1}}{\text{Ks1}} + \frac{\text{P1}}{\text{Kp1}}\right)} \end{aligned} \tag{33}$$

Table 48: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
PGK_g_Vmax	PGK_g_Vmax		2862.000		☑
PGK_g_Keq	PGK_g_Keq		3332.000		☑
PGK_g_Km13BPGA	PGK_g_Km13BPGA		0.003		☑
PGK_g_KmADP	PGK_g_KmADP		0.100		☑
PGK_g_Km3PGA	PGK_g_Km3PGA		1.620		☑
PGK_g_KmATP	PGK_g_KmATP		0.290		☑

6.12 Reaction PGAM_c

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

Name PGAM_c

Reaction equation

$$\text{\_3PGA\_c} \rightleftharpoons \text{\_2PGA\_c} \tag{34}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
_3PGA_c	_3PGA_c	

Modifiers

Table 50: Properties of each modifier.

Id	Name	SBO
_3PGA_c	_3PGA_c	
_2PGA_c	_2PGA_c	

Product

Table 51: Properties of each product.

Id	Name	SBO
_2PGA_c	_2PGA_c	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{v1sub1prod}\left(\text{PGAM\_c\_Vmax}, \text{PGAM\_c\_Keq}, [\text{\_3PGA\_c}], \text{PGAM\_c\_Km3PGA}, [\text{\_2PGA\_c}], \text{PGAM\_c\_Km2PGA}\right) \tag{35}$$

$$\text{v1sub1prod}\left(\text{Vfmax}, \text{Keq}, \text{S}, \text{Ks}, \text{P}, \text{Kp}\right) = \frac{\text{Vfmax} \cdot \text{S} \cdot \left(1 - \frac{\text{P}}{\text{Keq} \cdot \text{S}}\right)}{\text{Ks} \cdot \left(1 + \frac{\text{S}}{\text{Ks}} + \frac{\text{P}}{\text{Kp}}\right)} \tag{36}$$

Table 52: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
PGAM_c_Vmax	PGAM_c_Vmax		225.000		☑
PGAM_c_Keq	PGAM_c_Keq		0.185		☑
PGAM_c-_Km3PGA	PGAM_c-_Km3PGA		0.150		☑

Id	Name	SBO	Value	Unit	Constant
PGAM_c-_Km2PGA	PGAM_c-_Km2PGA		0.160		☑

6.13 Reaction G3PDH_g

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

Name G3PDH_g

Reaction equation

$$\mathrm{NADH\_g} + \mathrm{DHAP\_g} \xrightleftharpoons{\mathrm{DHAP\_g,\ NADH\_g,\ Gly3P\_g,\ NAD\_g}} \mathrm{Gly3P\_g} + \mathrm{NAD\_g} \qquad (37)$$

Reactants

Table 53: Properties of each reactant.

Id	Name	SBO
NADH_g	NADH_g	
DHAP_g	DHAP_g	

Modifiers

Table 54: Properties of each modifier.

Id	Name	SBO
DHAP_g	DHAP_g	
NADH_g	NADH_g	
Gly3P_g	Gly3P_g	
NAD_g	NAD_g	

Products

Table 55: Properties of each product.

Id	Name	SBO
Gly3P_g	Gly3P_g	
NAD_g	NAD_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{v2sub2prod}\,(\text{G3PDH\_g\_Vmax}, \text{G3PDH\_g\_Keq}, [\text{DHAP\_g}], \text{G3PDH\_g\_KmDHAP}, [\text{NADH\_g}], \text{G3PDH\_g\_KmNADH}, [\text{Gly3P\_g}], \text{G3PDH\_g\_KmGly3P}, [\text{NAD\_g}], \text{G3PDH\_g\_KmNAD}) \tag{38}$$

$$\text{v2sub2prod}\,(\text{Vfmax}, \text{Keq}, \text{S1}, \text{Ks1}, \text{S2}, \text{Ks2}, \text{P1}, \text{Kp1}, \text{P2}, \text{Kp2}) = \frac{\text{Vfmax} \cdot \text{S1} \cdot \text{S2} \cdot \left(1 - \frac{\text{P1} \cdot \text{P2}}{\text{Keq} \cdot \text{S1} \cdot \text{S2}}\right)}{\text{Ks1} \cdot \text{Ks2} \cdot \left(1 + \frac{\text{S2}}{\text{Ks2}} + \frac{\text{P2}}{\text{Kp2}}\right) \cdot \left(1 + \frac{\text{S1}}{\text{Ks1}} + \frac{\text{P1}}{\text{Kp1}}\right)} \tag{39}$$

Table 56: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
G3PDH_g_Vmax	G3PDH_g_Vmax		465.00		☑
G3PDH_g_Keq	G3PDH_g_Keq		2857.00		☑
G3PDH_g_KmDHAP	G3PDH_g_KmDHAP		0.10		☑
G3PDH_g_KmNADH	G3PDH_g_KmNADH		0.01		☑
G3PDH_g_KmGly3P	G3PDH_g_KmGly3P		2.00		☑
G3PDH_g_KmNAD	G3PDH_g_KmNAD		0.40		☑

6.14 Reaction ATPu_c

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

Name ATPu_c

Reaction equation

$$\text{ATP\_c} \overset{\text{ATP\_c, ADP\_c}}{\rightleftharpoons} \text{ADP\_c} \tag{40}$$

Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
ATP_c	ATP_c	

Modifiers

Table 58: Properties of each modifier.

Id	Name	SBO
ATP_c	ATP_c	
ADP_c	ADP_c	

Product

Table 59: Properties of each product.

Id	Name	SBO
ADP_c	ADP_c	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \frac{[\text{ATP\_c}] \cdot \text{ATPu\_c\_k}}{[\text{ADP\_c}]} \tag{41}$$

Table 60: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
ATPu_c_k	ATPu_c_k		50.0		☑

6.15 Reaction GK_g

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

Name GK_g

Reaction equation

$$\mathrm{Gly3P\_g} + \mathrm{ADP\_g} \xrightleftharpoons{\mathrm{Gly3P\_g},\ \mathrm{ADP\_g},\ \mathrm{Gly\_g},\ \mathrm{ATP\_g}} \mathrm{Gly\_g} + \mathrm{ATP\_g} \tag{42}$$

Reactants

Table 61: Properties of each reactant.

Id	Name	SBO
Gly3P_g	Gly3P_g	
ADP_g	ADP_g	

Modifiers

Table 62: Properties of each modifier.

Id	Name	SBO
Gly3P_g	Gly3P_g	
ADP_g	ADP_g	
Gly_g	Gly_g	
ATP_g	ATP_g	

Products

Table 63: Properties of each product.

Id	Name	SBO
Gly_g	Gly_g	
ATP_g	ATP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \mathrm{v2sub2prod}\,(\mathrm{GK\_g\_Vmax}, \mathrm{GK\_g\_Keq}, [\mathrm{Gly3P\_g}], \mathrm{GK\_g\_KmGly3P}, [\mathrm{ADP\_g}], \mathrm{GK\_g\_KmADP}, [\mathrm{Gly\_g}], \mathrm{GK\_g\_KmGly}, [\mathrm{ATP\_g}], \mathrm{GK\_g\_KmATP}) \tag{43}$$

$$\mathrm{v2sub2prod}\,(\mathrm{Vfmax}, \mathrm{Keq}, \mathrm{S1}, \mathrm{Ks1}, \mathrm{S2}, \mathrm{Ks2}, \mathrm{P1}, \mathrm{Kp1}, \mathrm{P2}, \mathrm{Kp2}) = \frac{\mathrm{Vfmax} \cdot \mathrm{S1} \cdot \mathrm{S2} \cdot \left(1 - \frac{\mathrm{P1} \cdot \mathrm{P2}}{\mathrm{Keq} \cdot \mathrm{S1} \cdot \mathrm{S2}}\right)}{\mathrm{Ks1} \cdot \mathrm{Ks2} \cdot \left(1 + \frac{\mathrm{S2}}{\mathrm{Ks2}} + \frac{\mathrm{P2}}{\mathrm{Kp2}}\right) \cdot \left(1 + \frac{\mathrm{S1}}{\mathrm{Ks1}} + \frac{\mathrm{P1}}{\mathrm{Kp1}}\right)} \tag{44}$$

Table 64: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GK_g_Vmax	GK_g_Vmax		200.000		☑
GK_g_Keq	GK_g_Keq		$8 \cdot 10^{-4}$		☑
GK_g_KmGly3P	GK_g_KmGly3P		3.830		☑
GK_g_KmADP	GK_g_KmADP		0.560		☑
GK_g_KmGly	GK_g_KmGly		0.440		☑
GK_g_KmATP	GK_g_KmATP		0.240		☑

6.16 Reaction ALD_g

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

Name ALD_g

Reaction equation

$$\text{Fru16BP\_g} \xrightleftharpoons{\text{ATP\_g, ADP\_g, AMP\_g, Fru16BP\_g, GA3P\_g, DHAP\_g, ATP\_g, ADP\_g, AMP\_g}} \text{GA3P\_g} + \text{DHAP\_g} \tag{45}$$

Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
Fru16BP_g	Fru16BP_g	

Modifiers

Table 66: Properties of each modifier.

Id	Name	SBO
ATP_g	ATP_g	
ADP_g	ADP_g	
AMP_g	AMP_g	
Fru16BP_g	Fru16BP_g	
GA3P_g	GA3P_g	
DHAP_g	DHAP_g	
ATP_g	ATP_g	
ADP_g	ADP_g	
AMP_g	AMP_g	

Id	Name	SBO

Products

Table 67: Properties of each product.

Id	Name	SBO
GA3P_g	GA3P_g	
DHAP_g	DHAP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \frac{[\text{Fru16BP}]}{\text{ALD\_g\_KmFru16BP} \cdot \left(1 + \frac{[\text{ATP\_g}]}{\text{ALD\_g\_KiATP}} + \frac{[\text{ADP\_g}]}{\text{ALD\_g\_KiADP}} + \frac{[\text{AMP\_g}]}{\text{ALD\_g\_KiAMP}}\right) \cdot \left(1 + \frac{[\text{GA3P\_g}]}{\text{ALD\_g\_KmGA3P}} + \frac{[\text{DHAP\_g}]}{\text{ALD\_g\_KmDHAP}} + \right.} \quad (46)$$

Table 68: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
ALD_g_Vmax	ALD_g_Vmax		560.000		☑
ALD_g-_KmFru16BP	ALD_g-_KmFru16BP		0.009		☑
ALD_g_KiATP	ALD_g_KiATP		0.680		☑
ALD_g_KiADP	ALD_g_KiADP		1.510		☑
ALD_g_KiAMP	ALD_g_KiAMP		3.650		☑
ALD_g_Keq	ALD_g_Keq		0.093		☑
ALD_g_KmGA3P	ALD_g_KmGA3P		0.067		☑
ALD_g_KmDHAP	ALD_g_KmDHAP		0.015		☑
ALD_g_KiGA3P	ALD_g_KiGA3P		0.098		☑

6.17 Reaction AK_c

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

Name AK_c

Reaction equation

$$2\,\mathrm{ADP\_c} \rightleftharpoons[\mathrm{ADP\_c},\ \mathrm{AMP\_c},\ \mathrm{ATP\_c}] \mathrm{AMP\_c} + \mathrm{ATP\_c} \tag{47}$$

Reactant

Table 69: Properties of each reactant.

Id	Name	SBO
ADP_c	ADP_c	

Modifiers

Table 70: Properties of each modifier.

Id	Name	SBO
ADP_c	ADP_c	
AMP_c	AMP_c	
ATP_c	ATP_c	

Products

Table 71: Properties of each product.

Id	Name	SBO
AMP_c	AMP_c	
ATP_c	ATP_c	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \mathrm{vAK}\left([\mathrm{ADP\_c}], [\mathrm{AMP\_c}], [\mathrm{ATP\_c}], \mathrm{AK\_c\_k1}, \mathrm{AK\_c\_k2}\right) \tag{48}$$

$$\mathrm{vAK}\left(\mathrm{ADP}, \mathrm{AMP}, \mathrm{ATP}, \mathrm{k1}, \mathrm{k2}\right) = \mathrm{k1} \cdot \mathrm{ADP}^2 - \mathrm{AMP} \cdot \mathrm{ATP} \cdot \mathrm{k2} \tag{49}$$

Table 72: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
AK_c_k1	AK_c_k1		442.0		☑
AK_c_k2	AK_c_k2		1000.0		☑

6.18 Reaction PGI_g

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

Name PGI_g

Reaction equation

$$\text{Glc6P\_g} \xrightleftharpoons{\text{Glc6P\_g, Fru6P\_g}} \text{Fru6P\_g} \tag{50}$$

Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
Glc6P_g	Glc6P_g	

Modifiers

Table 74: Properties of each modifier.

Id	Name	SBO
Glc6P_g	Glc6P_g	
Fru6P_g	Fru6P_g	

Product

Table 75: Properties of each product.

Id	Name	SBO
Fru6P_g	Fru6P_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{v1sub1prod}\left(\text{PGI\_g\_Vmax}, \text{PGI\_g\_Keq}, [\text{Glc6P\_g}], \text{PGI\_g\_KmGlc6P}, [\text{Fru6P\_g}], \text{PGI\_g\_KmFru6P}\right) \tag{51}$$

$$\text{v1sub1prod}\left(\text{Vfmax}, \text{Keq}, \text{S}, \text{Ks}, \text{P}, \text{Kp}\right) = \frac{\text{Vfmax} \cdot \text{S} \cdot \left(1 - \frac{\text{P}}{\text{Keq} \cdot \text{S}}\right)}{\text{Ks} \cdot \left(1 + \frac{\text{S}}{\text{Ks}} + \frac{\text{P}}{\text{Kp}}\right)} \tag{52}$$

Table 76: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
PGI_g_Vmax	PGI_g_Vmax		1305.00		☑
PGI_g_Keq	PGI_g_Keq		0.30		☑
PGI_g_KmGlc6P	PGI_g_KmGlc6P		0.40		☑
PGI_g_KmFru6P	PGI_g_KmFru6P		0.12		☑

6.19 Reaction GAPDH_g

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

Name GAPDH_g

Reaction equation

$$\mathrm{GA3P\_g} + \mathrm{NAD\_g} + \mathrm{Pi\_g} \xrightleftharpoons{\mathrm{GA3P\_g,\ NAD\_g,\ \_13BPGA\_g,\ NADH\_g}} \mathrm{NADH\_g} + \mathrm{\_13BPGA\_g} \tag{53}$$

Reactants

Table 77: Properties of each reactant.

Id	Name	SBO
GA3P_g	GA3P_g	
NAD_g	NAD_g	
Pi_g	Pi_g	

Modifiers

Table 78: Properties of each modifier.

Id	Name	SBO
GA3P_g	GA3P_g	
NAD_g	NAD_g	
_13BPGA_g	_13BPGA_g	
NADH_g	NADH_g	

Products

Table 79: Properties of each product.

Id	Name	SBO
NADH_g	NADH_g	
_13BPGA_g	_13BPGA_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{v2sub2prod}\,(\text{GAPDH\_g\_Vmax}, \text{GAPDH\_g\_Keq}, [\text{GA3P\_g}], \text{GAPDH\_g\_KmGA3P}, [\text{NAD\_g}], \text{GAPDH\_g\_KmNAD}, [\text{\_13BPGA\_g}], \text{GAPDH\_g\_Km13BPGA}, [\text{NADH\_g}], \text{GAPDH\_g\_KmNADH}) \tag{54}$$

$$\begin{aligned} &\text{v2sub2prod}\,(\text{Vfmax}, \text{Keq}, \text{S1}, \text{Ks1}, \text{S2}, \text{Ks2}, \text{P1}, \text{Kp1}, \text{P2}, \text{Kp2}) \\ &= \frac{\text{Vfmax} \cdot \text{S1} \cdot \text{S2} \cdot \left(1 - \frac{\text{P1} \cdot \text{P2}}{\text{Keq} \cdot \text{S1} \cdot \text{S2}}\right)}{\text{Ks1} \cdot \text{Ks2} \cdot \left(1 + \frac{\text{S2}}{\text{Ks2}} + \frac{\text{P2}}{\text{Kp2}}\right) \cdot \left(1 + \frac{\text{S1}}{\text{Ks1}} + \frac{\text{P1}}{\text{Kp1}}\right)} \end{aligned} \tag{55}$$

Table 80: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GAPDH_g_Vmax	GAPDH_g_Vmax		720.900		☑
GAPDH_g_Keq	GAPDH_g_Keq		0.044		☑
GAPDH_g_KmGA3P	GAPDH_g_KmGA3P		0.150		☑
GAPDH_g_KmNAD	GAPDH_g_KmNAD		0.450		☑
GAPDH_g_Km13BPGA	GAPDH_g_Km13BPGA		0.100		☑
GAPDH_g_KmNADH	GAPDH_g_KmNADH		0.020		☑

6.20 Reaction AK_g

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

Name AK_g

Reaction equation

$$2\,\mathrm{ADP\_g} \rightleftharpoons[\mathrm{ADP\_g},\ \mathrm{AMP\_g},\ \mathrm{ATP\_g}] \mathrm{AMP\_g} + \mathrm{ATP\_g} \tag{56}$$

Reactant

Table 81: Properties of each reactant.

Id	Name	SBO
ADP_g	ADP_g	

Modifiers

Table 82: Properties of each modifier.

Id	Name	SBO
ADP_g	ADP_g	
AMP_g	AMP_g	
ATP_g	ATP_g	

Products

Table 83: Properties of each product.

Id	Name	SBO
AMP_g	AMP_g	
ATP_g	ATP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \mathrm{vAK}\left([\mathrm{ADP\_g}], [\mathrm{AMP\_g}], [\mathrm{ATP\_g}], \mathrm{AK\_g\_k1}, \mathrm{AK\_g\_k2}\right) \tag{57}$$

$$\mathrm{vAK}\left(\mathrm{ADP}, \mathrm{AMP}, \mathrm{ATP}, \mathrm{k1}, \mathrm{k2}\right) = \mathrm{k1} \cdot \mathrm{ADP}^2 - \mathrm{AMP} \cdot \mathrm{ATP} \cdot \mathrm{k2} \tag{58}$$

Table 84: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
AK_g_k1	AK_g_k1		442.0		☑
AK_g_k2	AK_g_k2		1000.0		☑

6.21 Reaction GDA_g

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

Name GDA_g

Reaction equation

$$\text{Gly3P\_g} + \text{DHAP\_c} \xrightleftharpoons{\text{Gly3P\_g, DHAP\_c, Gly3P\_c, DHAP\_g}} \text{Gly3P\_c} + \text{DHAP\_g} \qquad (59)$$

Reactants

Table 85: Properties of each reactant.

Id	Name	SBO
Gly3P_g	Gly3P_g	
DHAP_c	DHAP_c	

Modifiers

Table 86: Properties of each modifier.

Id	Name	SBO
Gly3P_g	Gly3P_g	
DHAP_c	DHAP_c	
Gly3P_c	Gly3P_c	
DHAP_g	DHAP_g	

Products

Table 87: Properties of each product.

Id	Name	SBO
Gly3P_c	Gly3P_c	
DHAP_g	DHAP_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = [\text{Gly3P\_g}] \cdot [\text{DHAP\_c}] \cdot \text{GDA\_g\_k} - [\text{Gly3P\_c}] \cdot [\text{DHAP\_g}] \cdot \text{GDA\_g\_k} \qquad (60)$$

Table 88: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GDA_g_k	GDA_g_k		600.0		☑

6.22 Reaction GPO_c

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

Name GPO_c

Reaction equation

$$\text{Gly3P\_c} \overset{\text{Gly3P\_c}}{\rightleftharpoons} \text{DHAP\_c} \tag{61}$$

Reactant

Table 89: Properties of each reactant.

Id	Name	SBO
Gly3P_c	Gly3P_c	

Modifier

Table 90: Properties of each modifier.

Id	Name	SBO
Gly3P_c	Gly3P_c	

Product

Table 91: Properties of each product.

Id	Name	SBO
DHAP_c	DHAP_c	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{v1sub}\left(\text{GPO\_c\_Vmax}, [\text{Gly3P\_c}], \text{GPO\_c\_KmGly3P}\right) \tag{62}$$

$$\mathrm{v1sub}\left(\mathrm{Vfmax}, \mathrm{S}, \mathrm{Ks}\right) = \frac{\mathrm{Vfmax} \cdot \mathrm{S}}{\mathrm{Ks} \cdot \left(1 + \frac{\mathrm{S}}{\mathrm{Ks}}\right)} \tag{63}$$

Table 92: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
GPO_c_Vmax	GPO_c_Vmax		368.0		☑
GPO_c_KmGly3P	GPO_c_KmGly3P		1.7		☑

6.23 Reaction TPI_g

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

Name TPI_g

Reaction equation

$$\mathrm{DHAP\_g} \xrightleftharpoons{\mathrm{DHAP\_g},\ \mathrm{GA3P\_g}} \mathrm{GA3P\_g} \tag{64}$$

Reactant

Table 93: Properties of each reactant.

Id	Name	SBO
DHAP_g	DHAP_g	

Modifiers

Table 94: Properties of each modifier.

Id	Name	SBO
DHAP_g	DHAP_g	
GA3P_g	GA3P_g	

Product

Table 95: Properties of each product.

Id	Name	SBO
GA3P_g	GA3P_g	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{v1sub1prod}\left(\text{TPI\_g\_Vmax}, \text{TPI\_g\_Keq}, [\text{DHAP\_g}], \text{TPI\_g\_KmDHAP}, [\text{GA3P\_g}], \text{TPI\_g\_KmGA3P}\right) \tag{65}$$

$$\text{v1sub1prod}\left(\text{Vfmax}, \text{Keq}, \text{S}, \text{Ks}, \text{P}, \text{Kp}\right) = \frac{\text{Vfmax} \cdot \text{S} \cdot \left(1 - \frac{\text{P}}{\text{Keq} \cdot \text{S}}\right)}{\text{Ks} \cdot \left(1 + \frac{\text{S}}{\text{Ks}} + \frac{\text{P}}{\text{Kp}}\right)} \tag{66}$$

Table 96: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
TPI_g_Vmax	TPI_g_Vmax		999.300		☑
TPI_g_Keq	TPI_g_Keq		0.045		☑
TPI_g_KmDHAP	TPI_g_KmDHAP		1.200		☑
TPI_g_KmGA3P	TPI_g_KmGA3P		0.250		☑

7 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.

7.1 Species _2PGA_c

Name _2PGA_c

Initial concentration $0.1\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in ENO_c and as a product in PGAM_c and as a modifier in ENO_c, PGAM_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\_2\mathrm{PGA\_c} = v_{12} - v_8 \tag{67}$$

7.2 Species ATP_g

Name ATP_g

Initial concentration $0.2405\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in twelve reactions (as a reactant in PFK_g, HXK_g and as a product in PGK_g, GK_g, AK_g and as a modifier in PFK_g, HXK_g, PGK_g, GK_g, ALD_g, ALD_g, AK_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ATP\_g} = v_{11} + v_{15} + v_{20} - v_7 - v_9 \tag{68}$$

7.3 Species ATP_c

Name ATP_c

Initial concentration $0.3417\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in ATPu_c and as a product in PYK_c, AK_c and as a modifier in PYK_c, ATPu_c, AK_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ATP\_c} = v_2 + v_{17} - v_{14} \tag{69}$$

7.4 Species Pyr_c

Name Pyr_c

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Pyr\_c} = v_2 - v_5 \tag{70}$$

7.5 Species DHAP_c

Name DHAP_c

Initial concentration $2.23132912\ \text{nmol} \cdot \mu\text{l}^{-1}$

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

$$\frac{\text{d}}{\text{d}t}\text{DHAP\_c} = v_{22} - v_{21} \tag{71}$$

7.6 Species Pyr_e

Name Pyr_e

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

This species takes part in one reaction (as a product in PyrT_c), which does not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\text{d}}{\text{d}t}\text{Pyr\_e} = 0 \tag{72}$$

7.7 Species Gly3P_c

Name Gly3P_c

Initial concentration $2.76867088\ \text{nmol} \cdot \mu\text{l}^{-1}$

This species takes part in four reactions (as a reactant in GPO_c and as a product in GDA_g and as a modifier in GDA_g, GPO_c).

$$\frac{\text{d}}{\text{d}t}\text{Gly3P\_c} = v_{21} - v_{22} \tag{73}$$

7.8 Species DHAP_g

Name DHAP_g

Initial concentration $8.483130623\ \text{nmol} \cdot \mu\text{l}^{-1}$

This species takes part in eight reactions (as a reactant in G3PDH_g, TPI_g and as a product in ALD_g, GDA_g and as a modifier in G3PDH_g, ALD_g, GDA_g, TPI_g).

$$\frac{\text{d}}{\text{d}t}\text{DHAP\_g} = v_{16} + v_{21} - v_{13} - v_{23} \tag{74}$$

7.9 Species NAD_g

Name NAD_g

Initial concentration $2\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in GAPDH_g and as a product in G3PDH_g and as a modifier in G3PDH_g, GAPDH_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{NAD\_g} = v_{13} - v_{19} \tag{75}$$

7.10 Species Glc6P_g

Name Glc6P_g

Initial concentration $0.5\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in PGI_g and as a product in HXK_g and as a modifier in HXK_g, PGI_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Glc6P\_g} = v_{9} - v_{18} \tag{76}$$

7.11 Species Fru16BP_g

Name Fru16BP_g

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

This species takes part in four reactions (as a reactant in ALD_g and as a product in PFK_g and as a modifier in PFK_g, ALD_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Fru16BP\_g} = v_{7} - v_{16} \tag{77}$$

7.12 Species ADP_c

Name ADP_c

Initial concentration $1.3165\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in PYK_c, AK_c and as a product in ATPu_c and as a modifier in PYK_c, ATPu_c, AK_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ADP\_c} = v_{14} - v_{2} - 2\,v_{17} \tag{78}$$

7.13 Species _3PGA_c

Name _3PGA_c

Initial concentration $0.1\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in PGAM_c and as a product in _3PGAT_g and as a modifier in _3PGAT_g, PGAM_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{\_3PGA\_c} = v_{10} - v_{12} \tag{79}$$

7.14 Species Gly_g

Name Gly_g

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

This species takes part in four reactions (as a reactant in GlyT_g and as a product in GK_g and as a modifier in GlyT_g, GK_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Gly\_g} = v_{15} - v_{1} \tag{80}$$

7.15 Species Fru6P_g

Name Fru6P_g

Initial concentration $0.5\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in PFK_g and as a product in PGI_g and as a modifier in PFK_g, PGI_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Fru6P\_g} = v_{18} - v_{7} \tag{81}$$

7.16 Species Gly_e

Name Gly_e

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Gly\_e} = 0 \tag{82}$$

7.17 Species _3PGA_g

Name _3PGA_g

Initial concentration $0.1\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in _3PGAT_g and as a product in PGK_g and as a modifier in _3PGAT_g, PGK_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{\_3PGA\_g} = v_{11} - v_{10} \tag{83}$$

7.18 Species Gly_c

Name Gly_c

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

This species takes part in four reactions (as a reactant in GlyT_c and as a product in GlyT_g and as a modifier in GlyT_g, GlyT_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gly\_c} = v_1 - v_3 \tag{84}$$

7.19 Species Pi_g

Name Pi_g

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

This species takes part in one reaction (as a reactant in GAPDH_g), which does not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Pi\_g} = 0 \tag{85}$$

7.20 Species AMP_c

Name AMP_c

Initial concentration $2.2418\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AMP\_c} = v_{17} \tag{86}$$

7.21 Species O2_c

Name O2_c

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{O2\_c} = 0 \tag{87}$$

7.22 Species GA3P_g

Name GA3P_g

Initial concentration $2.5\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in GAPDH_g and as a product in ALD_g, TPI_g and as a modifier in ALD_g, GAPDH_g, TPI_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GA3P\_g} = v_{16} + v_{23} - v_{19} \tag{88}$$

7.23 Species Gly3P_g

Name Gly3P_g

Initial concentration $10.51686938\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in GK_g, GDA_g and as a product in G3PDH_g and as a modifier in G3PDH_g, GK_g, GDA_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gly3P\_g} = v_{13} - v_{15} - v_{21} \tag{89}$$

7.24 Species ADP_g

Name ADP_g

Initial concentration $1.519\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in eleven reactions (as a reactant in PGK_g, GK_g, AK_g and as a product in PFK_g, HXK_g and as a modifier in HXK_g, PGK_g, GK_g, ALD_g, ALD_g, AK_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ADP\_g} = v_7 + v_9 - v_{11} - v_{15} - 2\,v_{20} \tag{90}$$

7.25 Species PEP_c

Name PEP_c

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

This species takes part in four reactions (as a reactant in PYK_c and as a product in ENO_c and as a modifier in PYK_c, ENO_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PEP\_c} = v_8 - v_2 \tag{91}$$

7.26 Species AMP_g

Name AMP_g

Initial concentration $4.2405\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a product in AK_g and as a modifier in ALD_g, ALD_g, AK_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AMP\_g} = v_{20} \tag{92}$$

7.27 Species _13BPGA_g

Name _13BPGA_g

Initial concentration $0.5\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in PGK_g and as a product in GAPDH_g and as a modifier in PGK_g, GAPDH_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{\_13BPGA\_g} = v_{19} - v_{11} \tag{93}$$

7.28 Species Glc_c

Name Glc_c

Initial concentration $0.01\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in GlcT_g and as a product in GlcT_c and as a modifier in GlcT_g, GlcT_c).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Glc\_c} = v_6 - v_4 \tag{94}$$

7.29 Species Glc_e

Name Glc_e

Initial concentration $5\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Glc\_e} = 0 \tag{95}$$

7.30 Species Glc_g

Name Glc_g

Initial concentration $0.01\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in HXK_g and as a product in GlcT_g and as a modifier in GlcT_g, HXK_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Glc\_g} = v_4 - v_9 \tag{96}$$

7.31 Species NADH_g

Name NADH_g

Initial concentration $2\ \mathrm{nmol} \cdot \mu\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in G3PDH_g and as a product in GAPDH_g and as a modifier in G3PDH_g, GAPDH_g).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{NADH\_g} = v_{19} - v_{13} \tag{97}$$

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