

SBML Model Report

Model name: “Palsson2013 - Fully-integrated immune response model (FIRM)”



April 25, 2016

1 General Overview

This is a document in SBML Level 3 Version 1 format. This model was created by the following three authors: Michael Hucka¹, Vijayalakshmi Chelliah² and Mary E Spilker³ at April 19th 2016 at 4:37 p. m. and last time modified at April 19th 2016 at 9:22 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	52
events	0	constraints	0
reactions	140	function definitions	0
global parameters	278	unit definitions	0
rules	111	initial assignments	6

Model Notes

Palsson2013 - Fully-integration immune response model (FIRM)

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FIRM (The Fully-integrated Immune Response Modeling) is a hybrid construct incorporating multiple existing models of the immune system [De Boer et al., (1985); Bell, (1970); Marino and Kirschner, (2004)]. FIRM used a pharmacokinetic / pharmacodynamic modelling approach to combine previously published individual models of humoral and cellular response with antigen exposure. This integrated model has a potential to simulate a range of responses under a variety of conditions, for example, the immune response against tuberculosis infection, blood borne pathogen infection, Spontaneous tumour rejection and influence of regulatory T cells (Treg) on tumour rejection.

The SBML model provided here was generated from the matlab code (provided by the authors). The matlab to SBML conversion was done using MOCCASIN version 1.1.0. This model describes the immune response against tuberculosis (TB) infection and reproduces figure 7 of the reference publication.

Note: The following minor edit to the original matlab code was done during the conversion to SBML: The model had two parameters named k3 and K3. To avoid case-insensitive issues during the conversion, K3 was changed to K3s in the original matlab code before using the conversion software. The matlab code of the model provided by the authors (with the above change) can be obtained from the curation tab.

This model is described in the article: [The development of a fully-integrated immune response model \(FIRM\) simulator of the immune response through integration of multiple subset models](#). Palsson S, Hickling TP, Bradshaw-Pierce EL, Zager M, Jooss K, O'Brien PJ, Spilker ME, Palsson BO, Vicini P. BMC Syst Biol. 2013 Sep 28;7:95.

Abstract:

BACKGROUND: The complexity and multiscale nature of the mammalian immune response provides an excellent test bed for the potential of mathematical modeling and simulation to facilitate mechanistic understanding. Historically, mathematical models of the immune response focused on subsets of the immune system and/or specific aspects of the response. Mathematical models have been developed for the humoral side of the immune response, or for the cellular side, or for cytokine kinetics, but rarely have they been proposed to encompass the overall system complexity. We propose here a framework for integration of subset models, based on a system biology approach. **RESULTS:** A dynamic simulator, the Fully-integrated Immune Response Model (FIRM), was built in a stepwise fashion by integrating published subset models and adding novel features. The approach used to build the model includes the formulation of the network of interacting species and the subsequent introduction of rate laws to describe each biological process. The resulting model represents a multi-organ structure, comprised of the target organ where the immune response takes place, circulating blood, lymphoid T, and lymphoid B tissue. The cell types accounted for include macrophages, a few T-cell lineages (cytotoxic, regulatory, helper 1, and helper 2), and B-cell activation to plasma cells. Four different cytokines were accounted for: IFN-, IL-4, IL-10 and IL-12. In addition, generic inflammatory signals are used to represent the kinetics of IL-1, IL-2, and TGF-. Cell recruitment, differentiation, replication, apoptosis and migration are described as appropriate for the different cell types. The model is a hybrid structure containing information from several mammalian species. The structure of the network was built to be physiologically and biochemically consistent. Rate laws for all the cellular fate processes, growth factor production rates and half-lives, together with anti-

body production rates and half-lives, are provided. The results demonstrate how this framework can be used to integrate mathematical models of the immune response from several published sources and describe qualitative predictions of global immune system response arising from the integrated, hybrid model. In addition, we show how the model can be expanded to include novel biological findings. Case studies were carried out to simulate TB infection, tumor rejection, response to a blood borne pathogen and the consequences of accounting for regulatory T-cells. **CONCLUSIONS:** The final result of this work is a postulated and increasingly comprehensive representation of the mammalian immune system, based on physiological knowledge and susceptible to further experimental testing and validation. We believe that the integrated nature of FIRM has the potential to simulate a range of responses under a variety of conditions, from modeling of immune responses after tuberculosis (TB) infection to tumor formation in tissues. FIRM also has the flexibility to be expanded to include both complex and novel immunological response features as our knowledge of the immune system advances.

This model is hosted on [BioModels Database](#) and identified by: [MODEL1603310000](#).

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2 Unit Definitions

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

2.1 Unit `substance`

Notes Mole is the predefined SBML unit for substance.

Definition mol

2.2 Unit `volume`

Notes Litre is the predefined SBML unit for volume.

Definition l

2.3 Unit `area`

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

Definition m²

2.4 Unit `length`

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

Definition `m`

2.5 Unit `time`

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

Definition `s`

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

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

3.1 Compartment `compartmentOne`

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

4 Species

This model contains 52 species. 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
x_1	x_1	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_2	x_2	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_3	x_3	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_4	x_4	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_5	x_5	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_6	x_6	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_7	x_7	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_8	x_8	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_9	x_9	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_10	x_10	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_11	x_11	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_12	x_12	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_13	x_13	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_14	x_14	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_15	x_15	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_16	x_16	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_17	x_17	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_18	x_18	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_19	x_19	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_20	x_20	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_21	x_21	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
x_22	x_22	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	\square	\square

Id	Name	Compartment	Derived Unit	Constant	Boundary Condi- tion
x_23	x_23	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_24	x_24	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_25	x_25	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_26	x_26	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_27	x_27	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_28	x_28	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_29	x_29	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_30	x_30	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_31	x_31	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_32	x_32	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_33	x_33	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_34	x_34	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_35	x_35	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_36	x_36	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_37	x_37	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_38	x_38	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_39	x_39	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_40	x_40	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_41	x_41	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_42	x_42	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_43	x_43	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_44	x_44	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_45	x_45	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_46	x_46	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_47	x_47	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_48	x_48	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_49	x_49	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>

Id	Name	Compartment	Derived Unit	Constant	Boundary Condi- tion
x_50	x_50	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_51	x_51	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
x_52	x_52	compartmentOne	$\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>

5 Parameters

This model contains 278 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Alpha4	Alpha4		0.500		✓
Alpha5	Alpha5		$1.25 \cdot 10^{-7}$		✓
Alpha6	Alpha6		$1.25 \cdot 10^{-8}$		✓
Alpha61	Alpha61		10.000		✓
Alpha62	Alpha62		10.000		✓
Beta90	Beta90		1000.000		✓
c2	c2		1000000.000		✓
c4	c4		0.150		✓
c12	c12		500000.000		✓
c15	c15		150000.000		✓
c17	c17		10000.000		✓
c22	c22		3000.000		✓
c24	c24		15000.000		✓
c25	c25		100000.000		✓
c52	c52		15000.000		✓
c55	c55		50.000		✓
c72	c72		51.000		✓
c80	c80		5000.000		✓
cF	cF		1000.000		✓
cf11	cf11		100.000		✓
cf12	cf12		150.000		✓
cf27	cf27		30.000		✓
cf28	cf28		50.000		✓
cf29	cf29		2.000		✓
cf86	cf86		50.000		✓
cI	cI		50.000		✓
ci12	ci12		1000.000		✓
ci72	ci72		0.050		✓
ci80	ci80		50.000		✓
cii80	cii80		100000.000		✓
Delta11	Delta11		0.360		✓
Delta12	Delta12		0.400		✓
Delta21	Delta21		10^{-4}		✓
Delta27	Delta27		0.100		✓
Delta29	Delta29		0.050		✓
Delta36	Delta36		2.400		✓
Delta38	Delta38		2.400		✓

Id	Name	SBO	Value	Unit	Constant
Delta39	Delta39		0.000		<input checked="" type="checkbox"/>
Delta43	Delta43		2.400		<input checked="" type="checkbox"/>
Delta50	Delta50		10^{-4}		<input checked="" type="checkbox"/>
Delta54	Delta54		0.001		<input checked="" type="checkbox"/>
Delta57	Delta57		0.000		<input checked="" type="checkbox"/>
Deltai12	Deltai12		0.009		<input checked="" type="checkbox"/>
Deltai27	Deltai27		0.001		<input checked="" type="checkbox"/>
endpoint	endpoint		400.000		<input checked="" type="checkbox"/>
Eta10	Eta10		0.050		<input checked="" type="checkbox"/>
Eta13	Eta13		1.000		<input checked="" type="checkbox"/>
Eta14	Eta14		0.000		<input checked="" type="checkbox"/>
Eta16	Eta16		0.010		<input checked="" type="checkbox"/>
Eta18	Eta18		0.020		<input checked="" type="checkbox"/>
Eta20	Eta20		0.102		<input checked="" type="checkbox"/>
Eta26	Eta26		0.333		<input checked="" type="checkbox"/>
Eta28	Eta28		0.333		<input checked="" type="checkbox"/>
Eta30	Eta30		0.333		<input checked="" type="checkbox"/>
Eta33	Eta33		0.333		<input checked="" type="checkbox"/>
Eta35	Eta35		2.400		<input checked="" type="checkbox"/>
Eta44	Eta44		1.200		<input checked="" type="checkbox"/>
Eta47	Eta47		0.002		<input checked="" type="checkbox"/>
Eta48	Eta48		0.024		<input checked="" type="checkbox"/>
Eta49	Eta49		0.048		<input checked="" type="checkbox"/>
Eta53	Eta53		0.020		<input checked="" type="checkbox"/>
Eta56	Eta56		0.020		<input checked="" type="checkbox"/>
Eta58	Eta58		0.000		<input checked="" type="checkbox"/>
Eta60	Eta60		0.001		<input checked="" type="checkbox"/>
Eta69	Eta69		2.770		<input checked="" type="checkbox"/>
Eta73	Eta73		3.697		<input checked="" type="checkbox"/>
Eta75	Eta75		1.188		<input checked="" type="checkbox"/>
Eta79	Eta79		1.000		<input checked="" type="checkbox"/>
Eta81	Eta81		3.000		<input checked="" type="checkbox"/>
Eta83	Eta83		0.000		<input checked="" type="checkbox"/>
Eta84	Eta84		0.333		<input checked="" type="checkbox"/>
Eta85	Eta85		0.020		<input checked="" type="checkbox"/>
Eta95	Eta95		4.800		<input checked="" type="checkbox"/>
Eta96	Eta96		4.800		<input checked="" type="checkbox"/>
Eta99	Eta99		4.800		<input checked="" type="checkbox"/>
Eta100	Eta100		4.800		<input checked="" type="checkbox"/>
fi12	fi12		2.333		<input checked="" type="checkbox"/>
fi27	fi27		4.100		<input checked="" type="checkbox"/>
fi29	fi29		0.120		<input checked="" type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
fii27	fii27		4.800		<input checked="" type="checkbox"/>
Gamma17	Gamma17		0.200		<input checked="" type="checkbox"/>
Gamma23	Gamma23		0.900		<input checked="" type="checkbox"/>
Gamma24	Gamma24		0.900		<input checked="" type="checkbox"/>
Gamma31	Gamma31		0.333		<input checked="" type="checkbox"/>
Gamma32	Gamma32		0.900		<input checked="" type="checkbox"/>
Gamma37	Gamma37		0.900		<input checked="" type="checkbox"/>
Gamma40	Gamma40		0.900		<input checked="" type="checkbox"/>
Gamma41	Gamma41		0.900		<input checked="" type="checkbox"/>
Gamma51	Gamma51		0.900		<input checked="" type="checkbox"/>
Gamma52	Gamma52		0.900		<input checked="" type="checkbox"/>
k2	k2		0.400		<input checked="" type="checkbox"/>
k3	k3		0.110		<input checked="" type="checkbox"/>
K3s	K3s		50.000		<input checked="" type="checkbox"/>
k7	k7		10^{-7}		<input checked="" type="checkbox"/>
k63	k63		2.000		<input checked="" type="checkbox"/>
K90	K90		100.000		<input checked="" type="checkbox"/>
K93	K93		100.000		<input checked="" type="checkbox"/>
Mu1	Mu1		0.005		<input checked="" type="checkbox"/>
Mu8	Mu8		0.100		<input checked="" type="checkbox"/>
Mu9	Mu9		0.040		<input checked="" type="checkbox"/>
Mu15	Mu15		0.020		<input checked="" type="checkbox"/>
Mu19	Mu19		0.100		<input checked="" type="checkbox"/>
Mu22	Mu22		0.900		<input checked="" type="checkbox"/>
Mu25	Mu25		0.400		<input checked="" type="checkbox"/>
Mu28	Mu28		1.000		<input checked="" type="checkbox"/>
Mu42	Mu42		2.400		<input checked="" type="checkbox"/>
Mu55	Mu55		1.000		<input checked="" type="checkbox"/>
Mu59	Mu59		1.000		<input checked="" type="checkbox"/>
Mu86	Mu86		1.000		<input checked="" type="checkbox"/>
MuI	MuI		9.000		<input checked="" type="checkbox"/>
Mui9	Mui9		125000.000		<input checked="" type="checkbox"/>
P46	P46		9.000		<input checked="" type="checkbox"/>
P87	P87		3.000		<input checked="" type="checkbox"/>
P88	P88		3.000		<input checked="" type="checkbox"/>
P89	P89		100000.000		<input checked="" type="checkbox"/>
q68a	q68a		0.003		<input checked="" type="checkbox"/>
q68b	q68b		0.022		<input checked="" type="checkbox"/>
q72a	q72a		0.006		<input checked="" type="checkbox"/>
q72b	q72b		$5 \cdot 10^{-5}$		<input checked="" type="checkbox"/>
q72c	q72c		10^{-4}		<input checked="" type="checkbox"/>
q72d	q72d		10^{-4}		<input checked="" type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
q72e	q72e		10^{-4}		<input checked="" type="checkbox"/>
q74	q74		0.004		<input checked="" type="checkbox"/>
q78a	q78a		$2.75 \cdot 10^{-6}$		<input checked="" type="checkbox"/>
q78b	q78b		$8 \cdot 10^{-4}$		<input checked="" type="checkbox"/>
q80	q80		0.020		<input checked="" type="checkbox"/>
q82	q82		0.000		<input checked="" type="checkbox"/>
Rho9	Rho9		5000.000		<input checked="" type="checkbox"/>
Rho15	Rho15		500.000		<input checked="" type="checkbox"/>
Rho19	Rho19		1000.000		<input checked="" type="checkbox"/>
Rho21	Rho21		100.000		<input checked="" type="checkbox"/>
Rho34	Rho34		10.000		<input checked="" type="checkbox"/>
Rho50	Rho50		100.000		<input checked="" type="checkbox"/>
Rho80	Rho80		700.000		<input checked="" type="checkbox"/>
v14	v14		0.000		<input checked="" type="checkbox"/>
v30	v30		0.000		<input checked="" type="checkbox"/>
v41	v41		0.000		<input checked="" type="checkbox"/>
v57	v57		0.000		<input checked="" type="checkbox"/>
v58	v58		0.000		<input checked="" type="checkbox"/>
v59	v59		0.000		<input checked="" type="checkbox"/>
v64	v64		0.000		<input checked="" type="checkbox"/>
v65	v65		0.000		<input checked="" type="checkbox"/>
v66	v66		0.000		<input checked="" type="checkbox"/>
v67	v67		0.000		<input checked="" type="checkbox"/>
v70	v70		0.000		<input checked="" type="checkbox"/>
v71	v71		0.000		<input checked="" type="checkbox"/>
v76	v76		0.000		<input checked="" type="checkbox"/>
v77	v77		0.000		<input checked="" type="checkbox"/>
v82	v82		0.000		<input checked="" type="checkbox"/>
v83	v83		0.000		<input checked="" type="checkbox"/>
v87	v87		0.000		<input checked="" type="checkbox"/>
volBlood	volBlood		4500.000		<input checked="" type="checkbox"/>
volLung	volLung		1000.000		<input checked="" type="checkbox"/>
volLymphB	volLymphB		150.000		<input checked="" type="checkbox"/>
volLymphT	volLymphT		10.000		<input checked="" type="checkbox"/>
volMA	volMA		$1.6 \cdot 10^{-8}$		<input checked="" type="checkbox"/>
volMI	volMI		$1.6 \cdot 10^{-8}$		<input checked="" type="checkbox"/>
volMR	volMR		$8 \cdot 10^{-9}$		<input checked="" type="checkbox"/>
volT	volT		$2 \cdot 10^{-9}$		<input checked="" type="checkbox"/>
volTB	volTB		10^{-12}		<input checked="" type="checkbox"/>
w9	w9		0.140		<input checked="" type="checkbox"/>
APC	APC		0.000		<input type="checkbox"/>
Beta91	Beta91		0.000		<input type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
Beta92	Beta92		0.000		<input type="checkbox"/>
Beta93	Beta93		0.000		<input type="checkbox"/>
Beta94	Beta94		0.000		<input type="checkbox"/>
Beta97	Beta97		0.000		<input type="checkbox"/>
Beta98	Beta98		0.000		<input type="checkbox"/>
FACTOR	FACTOR		0.000		<input type="checkbox"/>
INFLAM	INFLAM		0.000		<input type="checkbox"/>
K91	K91		0.000		<input type="checkbox"/>
K92	K92		0.000		<input type="checkbox"/>
K94	K94		0.000		<input type="checkbox"/>
K97	K97		0.000		<input type="checkbox"/>
K98	K98		0.000		<input type="checkbox"/>
MA	MA		0.000		<input type="checkbox"/>
MB	MB		0.000		<input type="checkbox"/>
MC	MC		0.000		<input type="checkbox"/>
MD	MD		0.000		<input type="checkbox"/>
ME	ME		0.000		<input type="checkbox"/>
MF	MF		0.000		<input type="checkbox"/>
MG	MG		0.000		<input type="checkbox"/>
MH	MH		0.000		<input type="checkbox"/>
MI	MI		0.000		<input type="checkbox"/>
MJ	MJ		0.000		<input type="checkbox"/>
MK	MK		0.000		<input type="checkbox"/>
q45c	q45c		0.000		<input type="checkbox"/>
v1	v1		0.000		<input type="checkbox"/>
v10	v10		0.000		<input type="checkbox"/>
v100	v100		0.000		<input type="checkbox"/>
v11	v11		0.000		<input type="checkbox"/>
v12	v12		0.000		<input type="checkbox"/>
v13	v13		0.000		<input type="checkbox"/>
v15	v15		0.000		<input type="checkbox"/>
v16	v16		0.000		<input type="checkbox"/>
v17	v17		0.000		<input type="checkbox"/>
v18	v18		0.000		<input type="checkbox"/>
v19	v19		0.000		<input type="checkbox"/>
v2	v2		0.000		<input type="checkbox"/>
v20	v20		0.000		<input type="checkbox"/>
v21	v21		0.000		<input type="checkbox"/>
v22	v22		0.000		<input type="checkbox"/>
v23	v23		0.000		<input type="checkbox"/>
v24	v24		0.000		<input type="checkbox"/>
v25	v25		0.000		<input type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
v26	v26		0.000		<input type="checkbox"/>
v27	v27		0.000		<input type="checkbox"/>
v28	v28		0.000		<input type="checkbox"/>
v29	v29		0.000		<input type="checkbox"/>
v3	v3		0.000		<input type="checkbox"/>
v31	v31		0.000		<input type="checkbox"/>
v32	v32		0.000		<input type="checkbox"/>
v33	v33		0.000		<input type="checkbox"/>
v34	v34		0.000		<input type="checkbox"/>
v35	v35		0.000		<input type="checkbox"/>
v36	v36		0.000		<input type="checkbox"/>
v37	v37		0.000		<input type="checkbox"/>
v38	v38		0.000		<input type="checkbox"/>
v39	v39		0.000		<input type="checkbox"/>
v4	v4		0.000		<input type="checkbox"/>
v40	v40		0.000		<input type="checkbox"/>
v42	v42		0.000		<input type="checkbox"/>
v43	v43		0.000		<input type="checkbox"/>
v44	v44		0.000		<input type="checkbox"/>
v45	v45		0.000		<input type="checkbox"/>
v46	v46		0.000		<input type="checkbox"/>
v47	v47		0.000		<input type="checkbox"/>
v48	v48		0.000		<input type="checkbox"/>
v49	v49		0.000		<input type="checkbox"/>
v5	v5		0.000		<input type="checkbox"/>
v50	v50		0.000		<input type="checkbox"/>
v51	v51		0.000		<input type="checkbox"/>
v52	v52		0.000		<input type="checkbox"/>
v53	v53		0.000		<input type="checkbox"/>
v54	v54		0.000		<input type="checkbox"/>
v55	v55		0.000		<input type="checkbox"/>
v56	v56		0.000		<input type="checkbox"/>
v6	v6		0.000		<input type="checkbox"/>
v60	v60		0.000		<input type="checkbox"/>
v61	v61		0.000		<input type="checkbox"/>
v62	v62		0.000		<input type="checkbox"/>
v63	v63		0.000		<input type="checkbox"/>
v68	v68		0.000		<input type="checkbox"/>
v69	v69		0.000		<input type="checkbox"/>
v7	v7		0.000		<input type="checkbox"/>
v72	v72		0.000		<input type="checkbox"/>
v73	v73		0.000		<input type="checkbox"/>

Id	Name	SBO	Value	Unit	Constant
v74	v74		0.000		<input type="checkbox"/>
v75	v75		0.000		<input type="checkbox"/>
v78	v78		0.000		<input type="checkbox"/>
v79	v79		0.000		<input type="checkbox"/>
v8	v8		0.000		<input type="checkbox"/>
v80	v80		0.000		<input type="checkbox"/>
v81	v81		0.000		<input type="checkbox"/>
v84	v84		0.000		<input type="checkbox"/>
v85	v85		0.000		<input type="checkbox"/>
v86	v86		0.000		<input type="checkbox"/>
v88	v88		0.000		<input type="checkbox"/>
v89	v89		0.000		<input type="checkbox"/>
v9	v9		0.000		<input type="checkbox"/>
v90	v90		0.000		<input type="checkbox"/>
v91	v91		0.000		<input type="checkbox"/>
v92	v92		0.000		<input type="checkbox"/>
v93	v93		0.000		<input type="checkbox"/>
v94	v94		0.000		<input type="checkbox"/>
v95	v95		0.000		<input type="checkbox"/>
v96	v96		0.000		<input type="checkbox"/>
v97	v97		0.000		<input type="checkbox"/>
v98	v98		0.000		<input type="checkbox"/>
v99	v99		0.000		<input type="checkbox"/>
vMI	vMI		0.000		<input type="checkbox"/>
volSite	volSite		0.000		<input type="checkbox"/>
c59	c59		0.000		<input checked="" type="checkbox"/>
c61	c61		0.000		<input checked="" type="checkbox"/>
c62	c62		0.000		<input checked="" type="checkbox"/>
cAPC	cAPC		0.000		<input checked="" type="checkbox"/>
q45a	q45a		0.000		<input checked="" type="checkbox"/>
q45b	q45b		0.000		<input checked="" type="checkbox"/>

6 Initialassignments

This is an overview of six initialassignments.

6.1 Initialassignment c59

Derived unit contains undeclared units

Math $10^{10} \overline{10}$

6.2 Initialassignment c61

Derived unit contains undeclared units

Math $\frac{1000000}{10}$

6.3 Initialassignment c62

Derived unit contains undeclared units

Math $\frac{1000000}{10}$

6.4 Initialassignment cAPC

Derived unit contains undeclared units

Math $\frac{100000000}{10}$

6.5 Initialassignment q45a

Derived unit contains undeclared units

Math $\frac{10000000}{10}$

6.6 Initialassignment q45b

Derived unit contains undeclared units

Math $\frac{10000000}{10}$

7 Rules

This is an overview of 111 rules.

7.1 Rule APC

Rule APC is an assignment rule for parameter APC:

$$APC = \frac{([x_{.1}] + [x_{.2}]) \cdot [x_{.30}]}{cAPC + [x_{.30}]} \quad (1)$$

7.2 Rule Beta91

Rule Beta91 is an assignment rule for parameter Beta91:

$$Beta91 = Beta90 \quad (2)$$

7.3 Rule Beta92

Rule Beta92 is an assignment rule for parameter Beta92:

$$\text{Beta92} = \text{Beta90} \quad (3)$$

7.4 Rule Beta93

Rule Beta93 is an assignment rule for parameter Beta93:

$$\text{Beta93} = \text{Beta90} \quad (4)$$

7.5 Rule Beta94

Rule Beta94 is an assignment rule for parameter Beta94:

$$\text{Beta94} = \text{Beta90} \quad (5)$$

7.6 Rule Beta97

Rule Beta97 is an assignment rule for parameter Beta97:

$$\text{Beta97} = \text{Beta93} \quad (6)$$

7.7 Rule Beta98

Rule Beta98 is an assignment rule for parameter Beta98:

$$\text{Beta98} = \text{Beta93} \quad (7)$$

7.8 Rule FACTOR

Rule FACTOR is an assignment rule for parameter FACTOR:

$$\text{FACTOR} = [\text{x}_8] \cdot \frac{[\text{x}_{29}]}{\text{cF} + [\text{x}_{29}]} \quad (8)$$

7.9 Rule INFLAM

Rule INFLAM is an assignment rule for parameter INFLAM:

$$\text{INFLAM} = \frac{\text{MuI} \cdot \frac{[\text{x}_{29}]}{\text{cF} + [\text{x}_{29}]}}{\text{cI} + \frac{[\text{x}_{29}]}{\text{cF} + [\text{x}_{29}]}} \quad (9)$$

7.10 Rule K91

Rule K91 is an assignment rule for parameter K91:

$$\text{K91} = \text{K90} \quad (10)$$

7.11 Rule K92

Rule K92 is an assignment rule for parameter K92:

$$K92 = K90 \quad (11)$$

7.12 Rule K94

Rule K94 is an assignment rule for parameter K94:

$$K94 = K93 \quad (12)$$

7.13 Rule K97

Rule K97 is an assignment rule for parameter K97:

$$K97 = K93 \quad (13)$$

7.14 Rule K98

Rule K98 is an assignment rule for parameter K98:

$$K98 = K93 \quad (14)$$

7.15 Rule MA

Rule MA is an assignment rule for parameter MA:

$$MA = \frac{[x_5]}{[x_3]} \quad (15)$$

Derived unit dimensionless

7.16 Rule MB

Rule MB is an assignment rule for parameter MB:

$$MB = \frac{[x_5]}{[x_3]} \cdot MC \quad (16)$$

7.17 Rule MC

Rule MC is an assignment rule for parameter MC:

$$MC = \frac{\text{volLung}}{vMI} \quad (17)$$

7.18 Rule $_{MD}$

Rule MD is an assignment rule for parameter MD:

$$MD = \frac{volLung}{volLymphT} \quad (18)$$

7.19 Rule $_{ME}$

Rule ME is an assignment rule for parameter ME:

$$ME = \frac{volLymphT}{volBlood} \quad (19)$$

7.20 Rule $_{MF}$

Rule MF is an assignment rule for parameter MF:

$$MF = \frac{volBlood}{volLung} \quad (20)$$

7.21 Rule $_{MG}$

Rule MG is an assignment rule for parameter MG:

$$MG = \frac{volLung}{volBlood} \quad (21)$$

7.22 Rule $_{MH}$

Rule MH is an assignment rule for parameter MH:

$$MH = \frac{volBlood}{volLymphB} \quad (22)$$

7.23 Rule $_{MI}$

Rule MI is an assignment rule for parameter MI:

$$MI = \frac{volSite}{volBlood} \quad (23)$$

7.24 Rule $_{MJ}$

Rule MJ is an assignment rule for parameter MJ:

$$MJ = \frac{volLymphB}{volBlood} \quad (24)$$

7.25 Rule MK

Rule MK is an assignment rule for parameter MK:

$$MK = \frac{\text{volBlood}}{\text{volSite}} \quad (25)$$

7.26 Rule q45c

Rule q45c is an assignment rule for parameter q45c:

$$q45c = q45b \quad (26)$$

7.27 Rule v1

Rule v1 is an assignment rule for parameter v1:

$$v1 = \text{Mu1} \cdot \frac{[x_4]}{\text{volLung}} \quad (27)$$

7.28 Rule v10

Rule v10 is an assignment rule for parameter v10:

$$v10 = \text{Eta10} \cdot \frac{[x_1]}{\text{volLung}} \quad (28)$$

7.29 Rule v100

Rule v100 is an assignment rule for parameter v100:

$$v100 = \text{Eta100} \cdot \frac{[x_{52}]}{\text{volLung}} \quad (29)$$

7.30 Rule v11

Rule v11 is an assignment rule for parameter v11:

$$v11 = \frac{\text{Delta11} \cdot \frac{[x_2]}{\text{volLung}} \cdot [x_{35}]}{[x_{35}] + \text{cf11} \cdot \text{volLung}} \quad (30)$$

7.31 Rule v12

Rule v12 is an assignment rule for parameter v12:

$$v12 = \frac{\frac{\text{Delta12} \cdot \frac{[x_1]}{\text{volLung}} \cdot ([x_4] + [x_5])}{\text{c12} \cdot \text{volLung} + [x_4] + [x_5]} \cdot [x_{39}]}{[x_{39}] + \text{fi12} \cdot [x_{33}] + \text{cf12} \cdot \text{volLung}} + \text{Deltai12} \cdot \frac{[x_1]}{\text{volLung}} \cdot \frac{[x_{29}]}{\text{ci12} + [x_{29}]} \quad (31)$$

7.32 Rule v13

Rule v13 is an assignment rule for parameter v13:

$$v13 = \text{Eta13} \cdot \frac{[x_2]}{\text{volLung}} \quad (32)$$

7.33 Rule v15

Rule v15 is an assignment rule for parameter v15:

$$v15 = \text{Rho15} + \frac{\text{Mu15} \cdot [x_4]}{c15 \cdot \text{volLung} + [x_4]} + (\text{Rho21} + \text{Rho50}) \cdot \text{INFLAM} \quad (33)$$

7.34 Rule v16

Rule v16 is an assignment rule for parameter v16:

$$v16 = \text{Eta16} \cdot \frac{[x_6]}{\text{volLung}} \quad (34)$$

7.35 Rule v17

Rule v17 is an assignment rule for parameter v17:

$$v17 = \frac{\text{Gamma17} \cdot \frac{[x_6]}{\text{volLung}} \cdot [x_4]}{c17 \cdot \text{volLung} + [x_4]} + \text{Gamma17} \cdot \frac{[x_6]}{\text{volLung}} \cdot 1 \cdot \text{INFLAM} \quad (35)$$

7.36 Rule v18

Rule v18 is an assignment rule for parameter v18:

$$v18 = \text{Eta18} \cdot \frac{[x_10]}{\text{volLymphT}} \quad (36)$$

7.37 Rule v19

Rule v19 is an assignment rule for parameter v19:

$$v19 = \text{Rho19} + \text{Mu19} \cdot \frac{[x_10]}{\text{volLymphT}} \quad (37)$$

7.38 Rule v2

Rule v2 is an assignment rule for parameter v2:

$$v2 = \frac{k2 \cdot \frac{[x_1]}{\text{volLung}} \cdot [x_4]}{[x_4] + c2 \cdot \text{volLung}} \quad (38)$$

7.39 Rule v20

Rule v20 is an assignment rule for parameter v20:

$$v20 = \text{Eta20} \cdot \frac{[x_{-11}]}{\text{volLymphT}} \quad (39)$$

7.40 Rule v21

Rule v21 is an assignment rule for parameter v21:

$$v21 = \text{Rho21} + \text{Delta21} \cdot \frac{[x_{-11}]}{\text{volLymphT}} \cdot \frac{[x_{-10}]}{\text{volLymphT}} \quad (40)$$

7.41 Rule v22

Rule v22 is an assignment rule for parameter v22:

$$v22 = \frac{\text{Mu22} \cdot \frac{[x_{-12}]}{\text{volLymphT}}}{c22 + \left(\frac{[x_{-12}]}{\text{volLymphT}} \right)^2} \quad (41)$$

7.42 Rule v23

Rule v23 is an assignment rule for parameter v23:

$$v23 = \text{Gamma23} \cdot \frac{[x_{-12}]}{\text{volLymphT}} \quad (42)$$

7.43 Rule v24

Rule v24 is an assignment rule for parameter v24:

$$v24 = \frac{\text{Gamma24} \cdot \frac{[x_{-13}]}{\text{volBlood}} \cdot [x_{-2}]}{c24 \cdot \text{volLung} + [x_{-2}]} \quad (43)$$

7.44 Rule v25

Rule v25 is an assignment rule for parameter v25:

$$v25 = \frac{\text{Mu25} \cdot \frac{[x_{-7}]}{\text{volLung}} \cdot [x_{-2}]}{c25 \cdot \text{volLung} + [x_{-2}]} \quad (44)$$

7.45 Rule v26

Rule v26 is an assignment rule for parameter v26:

$$v26 = \text{Eta26} \cdot \frac{[x_{-7}]}{\text{volLung}} \quad (45)$$

7.46 Rule v27

Rule v27 is an assignment rule for parameter v27:

$$\begin{aligned} v27 = & \text{Delta27} \cdot \frac{[x_7]}{\text{volLung}} \cdot \frac{[x_38]}{\text{volLung}} \cdot \frac{[x_36]}{[x_36] + \text{fi27} \cdot [x_33] + \text{fii27} \cdot [x_35] + \text{cf27} \cdot \text{volLung}} \\ & + \text{Deltai27} \cdot \frac{[x_7]}{\text{volLung}} \cdot \text{APC} \end{aligned} \quad (46)$$

7.47 Rule v28

Rule v28 is an assignment rule for parameter v28:

$$v28 = \text{Eta28} \cdot \frac{[x_8]}{\text{volLung}} \quad (47)$$

7.48 Rule v29

Rule v29 is an assignment rule for parameter v29:

$$v29 = \frac{\text{Delta29} \cdot \frac{[x_7]}{\text{volLung}} \cdot [x_33]}{[x_33] + \text{fi29} \cdot [x_39] + \text{cf29} \cdot \text{volLung}} \quad (48)$$

7.49 Rule v3

Rule v3 is an assignment rule for parameter v3:

$$v3 = \frac{k3 \cdot \frac{[x_3]}{\text{volLung}} \cdot \left(\frac{[x_5]}{[x_3]} \right)^2}{\left(\frac{[x_5]}{[x_3]} \right)^2 + K3s^2} \quad (49)$$

7.50 Rule v31

Rule v31 is an assignment rule for parameter v31:

$$v31 = \text{Gamma31} \cdot \frac{[x_9]}{\text{volLung}} \quad (50)$$

7.51 Rule v32

Rule v32 is an assignment rule for parameter v32:

$$v32 = \text{Gamma32} \cdot \frac{[x_14]}{\text{volBlood}} \quad (51)$$

7.52 Rule v33

Rule v33 is an assignment rule for parameter v33:

$$v33 = \text{Eta33} \cdot \frac{[x_{15}]}{\text{volLymphB}} \quad (52)$$

7.53 Rule v34

Rule v34 is an assignment rule for parameter v34:

$$v34 = \text{Rho34} \quad (53)$$

7.54 Rule v35

Rule v35 is an assignment rule for parameter v35:

$$v35 = \text{Eta35} \cdot \frac{[x_{16}]}{\text{volSite}} \cdot \frac{[x_{43}]}{[x_{43}] + [x_{44}] + 1.0E - 5} \quad (54)$$

7.55 Rule v36

Rule v36 is an assignment rule for parameter v36:

$$v36 = \text{Delta36} \cdot \frac{[x_{16}]}{\text{volSite}} \cdot \frac{[x_{44}]}{[x_{43}] + [x_{44}] + 1.0E - 5} \quad (55)$$

7.56 Rule v37

Rule v37 is an assignment rule for parameter v37:

$$v37 = \text{Gamma37} \cdot \frac{[x_{17}]}{\text{volSite}} \quad (56)$$

7.57 Rule v38

Rule v38 is an assignment rule for parameter v38:

$$v38 = \text{Delta38} \cdot \frac{\frac{[x_{18}]}{\text{volBlood}}}{2} \cdot \frac{[x_{47}]}{[x_{47}] + [x_{48}] + 1.0E - 5} \quad (57)$$

7.58 Rule v39

Rule v39 is an assignment rule for parameter v39:

$$v39 = \text{Eta47} \cdot \frac{[x_{19}]}{\text{volBlood}} \quad (58)$$

7.59 Rule v4

Rule v4 is an assignment rule for parameter v4:

$$v4 = \text{Alpha4} \cdot \frac{[x_3]}{\text{volLung}} \cdot \frac{\frac{[x_8]}{[x_3]}}{\frac{[x_8]}{[x_3]} + c4 \cdot \text{volLung}} \quad (59)$$

7.60 Rule v40

Rule v40 is an assignment rule for parameter v40:

$$v40 = \text{Gamma40} \cdot \frac{[x_18]}{\text{volBlood}} \quad (60)$$

7.61 Rule v42

Rule v42 is an assignment rule for parameter v42:

$$v42 = \text{Mu42} \cdot \frac{[x_20]}{\text{volLymphB}} \cdot \frac{[x_48]}{[x_47] + [x_48] + 1.0E - 5} \quad (61)$$

7.62 Rule v43

Rule v43 is an assignment rule for parameter v43:

$$v43 = \text{Delta43} \cdot \frac{\frac{[x_20]}{\text{volLymphB}}}{2} \cdot \frac{[x_47]}{[x_47] + [x_48] + 1.0E - 5} \quad (62)$$

7.63 Rule v44

Rule v44 is an assignment rule for parameter v44:

$$v44 = \text{Eta44} \cdot \frac{[x_21]}{\text{volLymphB}} \quad (63)$$

7.64 Rule v45

Rule v45 is an assignment rule for parameter v45:

$$v45 = q45a \cdot \frac{[x_18]}{\text{volBlood}} + q45b \cdot \frac{[x_20]}{\text{volBlood}} + q45c \cdot \frac{[x_21]}{\text{volBlood}} \quad (64)$$

7.65 Rule v46

Rule v46 is an assignment rule for parameter v46:

$$v46 = P46 \cdot \left(\frac{[x_22]}{\text{volBlood}} - \frac{[x_23]}{\text{volLung}} \right) \quad (65)$$

7.66 Rule v47

Rule v47 is an assignment rule for parameter v47:

$$v47 = \text{Eta47} \cdot \frac{[x_{19}]}{\text{volBlood}} \quad (66)$$

7.67 Rule v48

Rule v48 is an assignment rule for parameter v48:

$$v48 = \text{Eta48} \cdot \frac{[x_{20}]}{\text{volLymphB}} \quad (67)$$

7.68 Rule v49

Rule v49 is an assignment rule for parameter v49:

$$v49 = \text{Eta49} \cdot \frac{[x_{22}]}{\text{volBlood}} \quad (68)$$

7.69 Rule v5

Rule v5 is an assignment rule for parameter v5:

$$v5 = \text{Alpha5} \cdot \frac{[x_2]}{\text{volLung}} \cdot \frac{[x_4]}{\text{volLung}} \quad (69)$$

7.70 Rule v50

Rule v50 is an assignment rule for parameter v50:

$$v50 = \text{Rho50} + \text{Delta50} \cdot \frac{[x_{11}]}{\text{volLymphT}} \cdot \frac{[x_{10}]}{\text{volLymphT}} \quad (70)$$

7.71 Rule v51

Rule v51 is an assignment rule for parameter v51:

$$v51 = \text{Gamma51} \cdot \frac{[x_{24}]}{\text{volLymphT}} \quad (71)$$

7.72 Rule v52

Rule v52 is an assignment rule for parameter v52:

$$v52 = \frac{\text{Gamma52} \cdot \frac{[x_{25}]}{\text{volBlood}} \cdot [x_2]}{c52 \cdot \text{volLung} + [x_2]} \quad (72)$$

7.73 Rule v53

Rule v53 is an assignment rule for parameter v53:

$$v53 = \text{Eta53} \cdot \frac{[x_{26}]}{\text{volLung}} \quad (73)$$

7.74 Rule v54

Rule v54 is an assignment rule for parameter v54:

$$v54 = \text{Delta54} \cdot \frac{[x_{26}]}{\text{volLung}} \cdot \frac{[x_{29}]}{\text{volLung}} \quad (74)$$

7.75 Rule v55

Rule v55 is an assignment rule for parameter v55:

$$v55 = \text{Mu55} \cdot \frac{[x_{27}]}{\text{volLung}} \cdot \frac{\text{FACTOR}}{cF + \text{FACTOR}} \quad (75)$$

7.76 Rule v56

Rule v56 is an assignment rule for parameter v56:

$$v56 = \text{Eta56} \cdot \frac{[x_{27}]}{\text{volLung}} \quad (76)$$

7.77 Rule v6

Rule v6 is an assignment rule for parameter v6:

$$v6 = \text{Alpha6} \cdot \frac{[x_{1}]}{\text{volLung}} \cdot \frac{[x_{4}]}{\text{volLung}} \quad (77)$$

7.78 Rule v60

Rule v60 is an assignment rule for parameter v60:

$$v60 = \text{Eta60} \cdot \frac{[x_{29}]}{\text{volLung}} \quad (78)$$

7.79 Rule v61

Rule v61 is an assignment rule for parameter v61:

$$v61 = \text{Alpha61} \cdot \frac{[x_{2}]}{\text{volLung}} \cdot \frac{[x_{29}]}{c61 + [x_{29}]} \quad (79)$$

7.80 Rule v62

Rule v62 is an assignment rule for parameter v62:

$$v62 = \text{Alpha61} \cdot \frac{[x_27]}{\text{volLung}} \cdot \frac{[x_29]}{c61 + [x_29]} \quad (80)$$

7.81 Rule v63

Rule v63 is an assignment rule for parameter v63:

$$v63 = k63 \cdot \frac{[x_30]}{\text{volLung}} \quad (81)$$

7.82 Rule v68

Rule v68 is an assignment rule for parameter v68:

$$v68 = q68a \cdot \frac{[x_7]}{\text{volLung}} + q68b \cdot \frac{[x_9]}{\text{volLung}} \quad (82)$$

7.83 Rule v69

Rule v69 is an assignment rule for parameter v69:

$$v69 = \text{Eta69} \cdot \frac{[x_33]}{\text{volLung}} \quad (83)$$

7.84 Rule v7

Rule v7 is an assignment rule for parameter v7:

$$v7 = k7 \cdot \frac{[x_6]}{\text{volLung}} \cdot \frac{[x_4]}{\text{volLung}} \quad (84)$$

7.85 Rule v72

Rule v72 is an assignment rule for parameter v72:

$$v72 = q72a \cdot \frac{[x_2]}{\text{volLung}} \cdot \frac{c72 \cdot \text{volLung}}{[x_35] + ci72 \cdot [x_39] + c72 \cdot \text{volLung}} + q72b \cdot \frac{[x_8]}{\text{volLung}} + q72c \cdot \frac{[x_9]}{\text{volLung}} + q72d \cdot \frac{[x_7]}{\text{volLung}} + q72e \cdot \frac{[x_3]}{\text{volLung}} \quad (85)$$

7.86 Rule v73

Rule v73 is an assignment rule for parameter v73:

$$v73 = \text{Eta73} \cdot \frac{[x_35]}{\text{volLung}} \quad (86)$$

7.87 Rule v74

Rule v74 is an assignment rule for parameter v74:

$$v74 = q74 \cdot \frac{[x_{10}]}{volLymphT} \quad (87)$$

7.88 Rule v75

Rule v75 is an assignment rule for parameter v75:

$$v75 = Eta75 \cdot \frac{[x_{36}]}{volLymphT} \quad (88)$$

7.89 Rule v78

Rule v78 is an assignment rule for parameter v78:

$$v78 = q78a \cdot \frac{[x_1]}{volLung} + q78b \cdot \frac{[x_2]}{volLung} \quad (89)$$

7.90 Rule v79

Rule v79 is an assignment rule for parameter v79:

$$v79 = Eta79 \cdot \frac{[x_{38}]}{volLung} \quad (90)$$

7.91 Rule v8

Rule v8 is an assignment rule for parameter v8:

$$v8 = Mu8 \cdot \frac{[x_5]}{vMI} \cdot \left(1 - \frac{\left(\frac{[x_5]}{[x_3]} \right)^2}{\left(\frac{[x_5]}{[x_3]} \right)^2 + K3s^2} \right) \quad (91)$$

7.92 Rule v80

Rule v80 is an assignment rule for parameter v80:

$$v80 = Rho80 \cdot \frac{[x_4] + [x_5]}{c80 \cdot volLung + [x_4] + [x_5]} \cdot \frac{[x_{38}]}{ci80 \cdot volLung + [x_{38}]} + q80 \cdot [x_8] \cdot \frac{[x_2]}{cii80 \cdot volLung + [x_2]} \quad (92)$$

7.93 Rule v81

Rule v81 is an assignment rule for parameter v81:

$$v81 = \text{Eta81} \cdot \frac{[x_{39}]}{\text{volLung}} \quad (93)$$

7.94 Rule v84

Rule v84 is an assignment rule for parameter v84:

$$v84 = \text{Eta84} \cdot \frac{[x_{13}]}{\text{volBlood}} \quad (94)$$

7.95 Rule v85

Rule v85 is an assignment rule for parameter v85:

$$v85 = \text{Eta85} \cdot \frac{[x_{25}]}{\text{volBlood}} \quad (95)$$

7.96 Rule v86

Rule v86 is an assignment rule for parameter v86:

$$v86 = \text{Mu86} \cdot \frac{[x_8]}{\text{volLung}} \cdot \frac{\text{FACTOR}}{\text{cf86} + \text{FACTOR}} \quad (96)$$

7.97 Rule v88

Rule v88 is an assignment rule for parameter v88:

$$v88 = \text{P88} \cdot \left(\frac{[x_{30}]}{\text{volLung}} - \frac{[x_{41}]}{\text{volBlood}} \right) \quad (97)$$

7.98 Rule v89

Rule v89 is an assignment rule for parameter v89:

$$v89 = \text{P89} \cdot \left(\frac{[x_{41}]}{\text{volBlood}} - \frac{[x_{42}]}{\text{volSite}} \right) \quad (98)$$

7.99 Rule v9

Rule v9 is an assignment rule for parameter v9:

$$v9 = \text{Rho9} + \text{Mu9} \cdot \left(\frac{[x_2]}{\text{volLung}} + \frac{w9 \cdot [x_3]}{\text{volLung}} \right) + \text{Mui9} \cdot \text{INFLAM} \quad (99)$$

7.100 Rule v90

Rule v90 is an assignment rule for parameter v90:

$$v90 = \text{Beta90} \cdot \left(\frac{[x_{.42}]}{\text{volSite}} \cdot \frac{[x_{.43}]}{\text{volSite}} - \frac{\frac{[x_{.44}]}{\text{volSite}}}{K90} \right) \quad (100)$$

7.101 Rule v91

Rule v91 is an assignment rule for parameter v91:

$$v91 = \text{Beta91} \cdot \left(\frac{[x_{.42}]}{\text{volSite}} \cdot \frac{[x_{.45}]}{\text{volSite}} - \frac{\frac{[x_{.46}]}{\text{volSite}}}{K91} \right) \quad (101)$$

7.102 Rule v92

Rule v92 is an assignment rule for parameter v92:

$$v92 = \text{Beta92} \cdot \left(\frac{[x_{.41}]}{\text{volSite}} \cdot \frac{[x_{.47}]}{\text{volSite}} - \frac{\frac{[x_{.48}]}{\text{volSite}}}{K92} \right) \quad (102)$$

7.103 Rule v93

Rule v93 is an assignment rule for parameter v93:

$$v93 = \text{Beta93} \cdot \left(\frac{[x_{.41}]}{\text{volBlood}} \cdot \frac{[x_{.22}]}{\text{volBlood}} - \frac{\frac{[x_{.49}]}{\text{volBlood}}}{K93} \right) \quad (103)$$

7.104 Rule v94

Rule v94 is an assignment rule for parameter v94:

$$v94 = \text{Beta94} \cdot \left(\frac{[x_{.41}]}{\text{volBlood}} \cdot \frac{[x_{.49}]}{\text{volBlood}} - \frac{\frac{[x_{.50}]}{\text{volBlood}}}{K94} \right) \quad (104)$$

7.105 Rule v95

Rule v95 is an assignment rule for parameter v95:

$$v95 = \text{Eta95} \cdot \frac{[x_{.49}]}{\text{volBlood}} \quad (105)$$

7.106 Rule v96

Rule v96 is an assignment rule for parameter v96:

$$v96 = \text{Eta96} \cdot \frac{[x_{.50}]}{\text{volBlood}} \quad (106)$$

7.107 Rule v97

Rule v97 is an assignment rule for parameter v97:

$$v97 = \text{Beta97} \cdot \left(\frac{[x_4]}{\text{volLung}} \cdot \frac{[x_23]}{\text{volLung}} - \frac{\frac{[x_51]}{\text{volLung}}}{K97} \right) \quad (107)$$

7.108 Rule v98

Rule v98 is an assignment rule for parameter v98:

$$v98 = \text{Beta98} \cdot \left(\frac{[x_4]}{\text{volLung}} \cdot \frac{[x_51]}{\text{volLung}} - \frac{\frac{[x_52]}{\text{volLung}}}{K98} \right) \quad (108)$$

7.109 Rule v99

Rule v99 is an assignment rule for parameter v99:

$$v99 = \text{Eta99} \cdot \frac{[x_51]}{\text{volLung}} \quad (109)$$

7.110 Rule vMI

Rule vMI is an assignment rule for parameter vMI:

$$vMI = \text{volMI} \cdot [x_3] \quad (110)$$

7.111 Rule volSite

Rule volSite is an assignment rule for parameter volSite:

$$\text{volSite} = \text{volBlood} \quad (111)$$

8 Reactions

This model contains 140 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	R_1		$x_4 + x_{51} \longrightarrow x_{52}$	
2	R_2		$x_{52} \longrightarrow x_4 + x_{51}$	
3	R_3		$x_{52} \longrightarrow \emptyset$	
4	R_4		$x_{23} + x_4 \longrightarrow x_{51}$	
5	R_5		$x_{51} \longrightarrow x_{23} + x_4$	
6	R_6		$x_{51} \longrightarrow \emptyset$	
7	R_7		$x_{41} + x_{49} \longrightarrow x_{50}$	
8	R_8		$x_{50} \longrightarrow x_{41} + x_{49}$	
9	R_9		$x_{50} \longrightarrow \emptyset$	
10	R_10		$x_{22} + x_{41} \longrightarrow x_{49}$	
11	R_11		$x_{49} \longrightarrow x_{22} + x_{41}$	
12	R_12		$x_{49} \longrightarrow \emptyset$	
13	R_13		$x_{41} + x_{47} \longrightarrow x_{48}$	
14	R_14		$x_{48} \longrightarrow x_{41} + x_{47}$	
15	R_15		$x_{17} + 1000 x_{45} \longrightarrow x_{18} + 1000 x_{47}$	
16	R_16		$x_{20} \longrightarrow x_{18} + 1000 x_{47}$	
17	R_17		$x_{18} + 1000 x_{47} \longrightarrow x_{20}$	
18	R_18		$0 \cdot 5 x_{18} + 500 x_{47} + x_{48} \longrightarrow 0 \cdot 5 x_{19} + x_{48}$	
19	R_19		$x_{42} + x_{45} \longrightarrow x_{46}$	
20	R_20		$x_{46} \longrightarrow x_{42} + x_{45}$	
21	R_21		$x_{16} + 1000 x_{43} + x_{44} \longrightarrow x_{17} + x_{44} + 1000 x_{45}$	
22	R_22		$x_{42} + x_{43} \longrightarrow x_{44}$	

Nº	Id	Name	Reaction Equation	SBO
23	R_23		$x_{.44} \longrightarrow x_{.42} + x_{.43}$	
24	R_24		$\emptyset \longrightarrow x_{.16} + 1000 x_{.43}$	
25	R_25		$2 x_{.19} \longrightarrow x_{.16} + 1000 x_{.43}$	
26	R_26		$x_{.16} + 1000 x_{.43} + x_{.44} \longrightarrow x_{.44}$	
27	R_27		$x_{.41} \longrightarrow x_{.42}$	
28	R_28		$x_{.42} \longrightarrow x_{.41}$	
29	R_29		$x_{.4} \longrightarrow x_{.41}$	
30	R_30		$x_{.30} \longrightarrow x_{.41}$	
31	R_31		$x_{.41} \longrightarrow x_{.30}$	
32	R_32		$\emptyset \longrightarrow x_{.40}$	
33	R_33		$x_{.40} \longrightarrow \emptyset$	
34	R_34		$x_{.38} + x_{.4} + x_{.5} \longrightarrow x_{.38} + x_{.39} + x_{.4} + x_{.5}$	
35	R_35		$x_{.2} + x_{.8} \longrightarrow x_{.2} + x_{.39} + x_{.8}$	
36	R_36		$x_{.39} \longrightarrow \emptyset$	
37	R_37		$\emptyset \longrightarrow x_{.38}$	
38	R_38		$x_{.1} \longrightarrow x_{.1} + x_{.38}$	
39	R_39		$x_{.2} \longrightarrow x_{.2} + x_{.38}$	
40	R_40		$x_{.38} \longrightarrow \emptyset$	
41	R_41		$\emptyset \longrightarrow x_{.37}$	
42	R_42		$x_{.37} \longrightarrow \emptyset$	
43	R_43		$x_{.10} \longrightarrow x_{.10} + x_{.36}$	
44	R_44		$x_{.36} \longrightarrow \emptyset$	
45	R_45		$x_{.2} + x_{.35} + x_{.39} \longrightarrow x_{.2} + 2 x_{.35} + x_{.39}$	
46	R_46		$x_{.8} \longrightarrow x_{.35} + x_{.8}$	
47	R_47		$x_{.9} \longrightarrow x_{.35} + x_{.9}$	
48	R_48		$x_{.7} \longrightarrow x_{.35} + x_{.7}$	
49	R_49		$x_{.3} \longrightarrow x_{.3} + x_{.35}$	
50	R_50		$x_{.35} \longrightarrow \emptyset$	
51	R_51		$\emptyset \longrightarrow x_{.34}$	

Nº	Id	Name	Reaction Equation	SBO
52	R_52		$x_{.34} \longrightarrow \emptyset$	
53	R_53		$x_{.7} \longrightarrow x_{.33} + x_{.7}$	
54	R_54		$x_{.9} \longrightarrow x_{.33} + x_{.9}$	
55	R_55		$x_{.33} \longrightarrow \emptyset$	
56	R_56		$\emptyset \longrightarrow x_{.32}$	
57	R_57		$x_{.32} \longrightarrow \emptyset$	
58	R_58		$\emptyset \longrightarrow x_{.31}$	
59	R_59		$x_{.31} \longrightarrow \emptyset$	
60	R_60		$x_{.29} \longrightarrow x_{.30}$	
61	R_61		$x_{.2} + x_{.29} \longrightarrow x_{.2} + x_{.30}$	
62	R_62		$x_{.27} + x_{.29} \longrightarrow x_{.27} + x_{.30}$	
63	R_63		$x_{.30} \longrightarrow \emptyset$	
64	R_64		$\emptyset \longrightarrow x_{.29}$	
65	R_65		$x_{.1} \longrightarrow x_{.28}$	
66	R_66		$x_{.28} \longrightarrow \emptyset$	
67	R_67		$x_{.26} + x_{.29} \longrightarrow x_{.27} + x_{.29}$	
68	R_68		$x_{.27} + x_{.29} + x_{.8} \longrightarrow 2 x_{.27} + x_{.29} + x_{.8}$	
69	R_69		$x_{.27} \longrightarrow \emptyset$	
70	R_70		$x_{.2} + x_{.25} \longrightarrow x_{.2} + x_{.26}$	
71	R_71		$x_{.26} \longrightarrow \emptyset$	
72	R_72		$x_{.24} \longrightarrow x_{.25}$	
73	R_73		$x_{.25} \longrightarrow \emptyset$	
74	R_74		$x_{.11} \longrightarrow x_{.24}$	
75	R_75		$x_{.10} + x_{.11} \longrightarrow x_{.10} + x_{.24}$	
76	R_76		$x_{.22} \longrightarrow x_{.23}$	
77	R_77		$x_{.23} \longrightarrow x_{.22}$	
78	R_78		$x_{.18} \longrightarrow x_{.18} + 1000000 x_{.22}$	
79	R_79		$x_{.20} \longrightarrow x_{.20} + 1000000 x_{.22}$	
80	R_80		$x_{.21} \longrightarrow x_{.21} + 1000000 x_{.22}$	

Nº	Id	Name	Reaction Equation	SBO
81	R_81		$x_{.22} \longrightarrow \emptyset$	
82	R_82		$0 \cdot 5 x_{.20} + x_{.47} + x_{.48} \longrightarrow 0 \cdot 5 x_{.21} + x_{.47} + x_{.48}$	
83	R_83		$x_{.21} \longrightarrow \emptyset$	
84	R_84		$x_{.20} + x_{.47} + x_{.48} \longrightarrow 2 x_{.20} + x_{.47} + x_{.48}$	
85	R_85		$x_{.20} \longrightarrow \emptyset$	
86	R_86		$x_{.14} \longrightarrow x_{.15}$	
87	R_87		$x_{.15} \longrightarrow \emptyset$	
88	R_88		$x_{.9} \longrightarrow x_{.14}$	
89	R_89		$x_{.12} \longrightarrow x_{.13}$	
90	R_90		$x_{.13} + x_{.2} \longrightarrow x_{.2} + x_{.7}$	
91	R_91		$x_{.13} \longrightarrow \emptyset$	
92	R_92		$x_{.11} \longrightarrow x_{.12}$	
93	R_93		$x_{.10} + x_{.11} \longrightarrow x_{.10} + x_{.12}$	
94	R_94		$x_{.12} \longrightarrow 2 x_{.12}$	
95	R_95		$\emptyset \longrightarrow x_{.11}$	
96	R_96		$x_{.10} \longrightarrow x_{.10} + x_{.11}$	
97	R_97		$x_{.11} \longrightarrow \emptyset$	
98	R_98		$x_{.4} + x_{.6} \longrightarrow x_{.10} + x_{.4}$	
99	R_99		$x_{.29} + x_{.6} \longrightarrow x_{.10} + x_{.29} + x_{.6}$	
100	R_100		$x_{.10} \longrightarrow \emptyset$	
101	R_101		$x_{.33} + x_{.39} + x_{.7} \longrightarrow x_{.33} + x_{.39} + x_{.9}$	
102	R_102		$x_{.9} \longrightarrow \emptyset$	
103	R_103		$x_{.33} + x_{.35} + x_{.36} + x_{.38} + x_{.7} \longrightarrow x_{.33} + x_{.35} + x_{.36} + x_{.38} + x_{.8}$	
104	R_104		$x_{.1} + x_{.30} + x_{.7} \longrightarrow x_{.1} + x_{.30} + x_{.8}$	
105	R_105		$x_{.2} + x_{.30} + x_{.7} \longrightarrow x_{.2} + x_{.30} + x_{.7} + x_{.8}$	
106	R_106		$x_{.29} + x_{.8} \longrightarrow x_{.29} + 2 x_{.8}$	
107	R_107		$x_{.8} \longrightarrow \emptyset$	
108	R_108		$x_{.2} + x_{.7} \longrightarrow x_{.2} + 2 x_{.7}$	

Nº	Id	Name	Reaction Equation	SBO
109	R_109		$x_7 \longrightarrow \emptyset$	
110	R_110		$x_2 + x_{30} + x_7 \longrightarrow x_2 + x_{30}$	
111	R_111		$\emptyset \longrightarrow x_6$	
112	R_112		$x_4 \longrightarrow x_4 + x_6$	
113	R_113		$x_{29} \longrightarrow x_{29} + x_6$	
114	R_114		$x_6 \longrightarrow \emptyset$	
115	R_115		$x_{29} + x_6 \longrightarrow x_{29}$	
116	R_116		$x_1 + x_3 + x_4 \longrightarrow x_1 + x_3 + x_4 + x_5$	
117	R_117		$x_3 + x_5 \longrightarrow x_3 + 2x_5$	
118	R_118		$x_3 + x_5 \longrightarrow x_3$	
119	R_119		$x_3 + x_5 + x_8 \longrightarrow x_3 + x_8$	
120	R_120		$x_4 \longrightarrow 2x_4$	
121	R_121		$x_3 + x_5 \longrightarrow x_3 + x_4 + x_5$	
122	R_122		$x_3 + x_5 + x_8 \longrightarrow x_3 + x_4 + x_5 + x_8$	
123	R_123		$x_2 + x_4 \longrightarrow x_2$	
124	R_124		$x_1 + x_4 \longrightarrow x_1$	
125	R_125		$x_4 + x_6 \longrightarrow x_6$	
126	R_126		$x_1 + 25x_4 \longrightarrow x_3$	
127	R_127		$x_3 \longrightarrow \emptyset$	
128	R_128		$x_3 + x_5 \longrightarrow x_5$	
129	R_129		$x_3 + x_8 \longrightarrow x_8$	
130	R_130		$x_1 + x_{33} + x_{39} + x_4 + x_5 \longrightarrow x_1 + x_2 + x_{33} + x_{39} + x_4 + x_5$	
131	R_131		$x_1 + x_{33} + x_{39} + x_4 + x_5 \longrightarrow x_2 + x_{33} + x_{39} + x_4 + x_5$	
132	R_132		$x_1 + x_{29} \longrightarrow x_2 + x_{29}$	
133	R_133		$x_2 \longrightarrow \emptyset$	
134	R_134		$x_2 + x_{35} \longrightarrow x_1 + x_{35}$	
135	R_135		$\emptyset \longrightarrow x_1$	

Nº	Id	Name	Reaction Equation	SBO
136	R_136		$x_2 \longrightarrow x_1 + x_2$	
137	R_137		$x_3 \longrightarrow x_1 + x_3$	
138	R_138		$x_{29} \longrightarrow x_1 + x_{29}$	
139	R_139		$x_1 \longrightarrow \emptyset$	
140	R_140		$x_1 + x_{33} + x_{39} + x_4 + x_5 \longrightarrow x_{33} + x_{39} + x_4 + x_5$	

8.1 Reaction R_1

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
x_4	x_4	
x_51	x_51	

Product

Table 7: Properties of each product.

Id	Name	SBO
x_52	x_52	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{Beta90} \cdot [x_4] \cdot \frac{[x_51]}{\text{volLung}} \quad (113)$$

8.2 Reaction R_2

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

Reaction equation



Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
x_52	x_52	

Products

Table 9: Properties of each product.

Id	Name	SBO
x_4	x_4	
x_51	x_51	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{Beta90} \cdot \frac{[x_{52}]}{K93} \quad (115)$$

8.3 Reaction R_3

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
x_52	x_52	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{Eta100} \cdot [x_{52}] \quad (117)$$

8.4 Reaction R_4

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 11: Properties of each reactant.

Id	Name	SBO
x_23	x_23	
x_4	x_4	

Product

Table 12: Properties of each product.

Id	Name	SBO
x_51	x_51	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{Beta90} \cdot [x_4] \cdot \frac{[x_23]}{\text{volLung}} \quad (119)$$

8.5 Reaction R_5

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

Reaction equation



Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
x_51	x_51	

Products

Table 14: Properties of each product.

Id	Name	SBO
x_23	x_23	
x_4	x_4	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{Beta90} \cdot \frac{[x_{51}]}{K93}$$

(121)

8.6 Reaction R_6

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 15: Properties of each reactant.

Id	Name	SBO
x_51	x_51	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \text{Eta99} \cdot [x_{51}]$$

(123)

8.7 Reaction R_7

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 16: Properties of each reactant.

Id	Name	SBO
x_41	x_41	
x_49	x_49	

Product

Table 17: Properties of each product.

Id	Name	SBO
x_50	x_50	

Kinetic Law

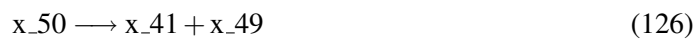
Derived unit contains undeclared units

$$v_7 = \text{Beta90} \cdot [x_41] \cdot \frac{[x_49]}{\text{volBlood}} \quad (125)$$

8.8 Reaction R_8

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

Reaction equation



Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
x_50	x_50	

Products

Table 19: Properties of each product.

Id	Name	SBO
x_41	x_41	
x_49	x_49	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{Beta90} \cdot \frac{[x_{50}]}{K93}$$

(127)

8.9 Reaction R_9

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
x_50	x_50	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{Eta96} \cdot [x_{50}]$$

(129)

8.10 Reaction R_10

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 21: Properties of each reactant.

Id	Name	SBO
x_22	x_22	
x_41	x_41	

Product

Table 22: Properties of each product.

Id	Name	SBO
x_49	x_49	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{Beta90} \cdot [x_41] \cdot \frac{[x_22]}{\text{volBlood}} \quad (131)$$

8.11 Reaction R_11

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

Reaction equation



Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
x_49	x_49	

Products

Table 24: Properties of each product.

Id	Name	SBO
x_22	x_22	
x_41	x_41	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{Beta90} \cdot \frac{[x_{49}]}{K93}$$

(133)

8.12 Reaction R_12

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 25: Properties of each reactant.

Id	Name	SBO
x_49	x_49	

Kinetic Law

Derived unit contains undeclared units

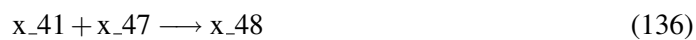
$$v_{12} = \text{Eta95} \cdot [x_{49}]$$

(135)

8.13 Reaction R_13

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 26: Properties of each reactant.

Id	Name	SBO
x_41	x_41	
x_47	x_47	

Product

Table 27: Properties of each product.

Id	Name	SBO
x_48	x_48	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{Beta90} \cdot [x_41] \cdot \frac{[x_47]}{\text{volBlood}} \quad (137)$$

8.14 Reaction R_14

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

Reaction equation



Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
x_48	x_48	

Products

Table 29: Properties of each product.

Id	Name	SBO
x_41	x_41	
x_47	x_47	

Kinetic Law

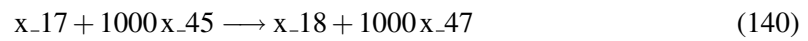
Derived unit contains undeclared units

$$v_{14} = \text{Beta90} \cdot \frac{[x_{48}]}{K90} \quad (139)$$

8.15 Reaction R_15

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 30: Properties of each reactant.

Id	Name	SBO
x_17	x_17	
x_45	x_45	

Products

Table 31: Properties of each product.

Id	Name	SBO
x_18	x_18	

Id	Name	SBO
x_47	x_47	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{Gamma37} \cdot [x_{17}] \quad (141)$$

8.16 Reaction R_16

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

Reaction equation



Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
x_20	x_20	

Products

Table 33: Properties of each product.

Id	Name	SBO
x_18	x_18	
x_47	x_47	

Kinetic Law

Derived unit not available

$$v_{16} = v_{41} \cdot \text{volLymphB} \quad (143)$$

8.17 Reaction R_17

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
x_18	x_18	
x_47	x_47	

Product

Table 35: Properties of each product.

Id	Name	SBO
x_20	x_20	

Kinetic Law

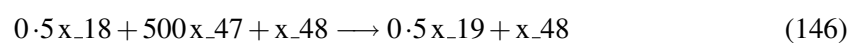
Derived unit contains undeclared units

$$v_{17} = \text{Gamma40} \cdot [x_{18}] \quad (145)$$

8.18 Reaction R_18

This is an irreversible reaction of three reactants forming two products.

Reaction equation



Reactants

Table 36: Properties of each reactant.

Id	Name	SBO
x_18	x_18	
x_47	x_47	
x_48	x_48	

Products

Table 37: Properties of each product.

Id	Name	SBO
x_19	x_19	
x_48	x_48	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{Delta38} \cdot [x_{18}] \cdot \frac{[x_{47}]}{[x_{47}] + [x_{48}] + 1.0E - 5} \quad (147)$$

8.19 Reaction R_19

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 38: Properties of each reactant.

Id	Name	SBO
x_42	x_42	
x_45	x_45	

Product

Table 39: Properties of each product.

Id	Name	SBO
x_46	x_46	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{Beta90} \cdot [x_{42}] \cdot \frac{[x_{45}]}{\text{volBlood}} \quad (149)$$

8.20 Reaction R_20

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

Reaction equation



Reactant

Table 40: Properties of each reactant.

Id	Name	SBO
x_46	x_46	

Products

Table 41: Properties of each product.

Id	Name	SBO
x_42	x_42	
x_45	x_45	

Kinetic Law

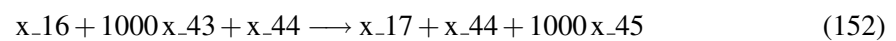
Derived unit contains undeclared units

$$v_{20} = \text{Beta90} \cdot \frac{[x_{46}]}{K90} \quad (151)$$

8.21 Reaction R_21

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 42: Properties of each reactant.

Id	Name	SBO
x_16	x_16	
x_43	x_43	
x_44	x_44	

Products

Table 43: Properties of each product.

Id	Name	SBO
x_17	x_17	
x_44	x_44	
x_45	x_45	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{Delta36} \cdot [x_{16}] \cdot \frac{[x_{44}]}{[x_{43}] + [x_{44}] + 1.0E - 5} \quad (153)$$

8.22 Reaction R_22

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 44: Properties of each reactant.

Id	Name	SBO
x_42	x_42	
x_43	x_43	

Product

Table 45: Properties of each product.

Id	Name	SBO
x_44	x_44	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{Beta90} \cdot [x_{42}] \cdot \frac{[x_{43}]}{\text{volBlood}} \tag{155}$$

8.23 Reaction R_23

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

Reaction equation



Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
x_44	x_44	

Products

Table 47: Properties of each product.

Id	Name	SBO
x_42	x_42	
x_43	x_43	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{Beta90} \cdot \frac{[x_{44}]}{K90} \tag{157}$$

8.24 Reaction R_24

This is an irreversible reaction of no reactant forming two products.

Reaction equation



Products

Table 48: Properties of each product.

Id	Name	SBO
x_16	x_16	
x_43	x_43	

Kinetic Law

Derived unit not available

$$v_{24} = \text{Rho34} \cdot \text{volBlood} \quad (159)$$

8.25 Reaction R_25

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

Reaction equation



Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
x_19	x_19	

Products

Table 50: Properties of each product.

Id	Name	SBO
x_16	x_16	

Id	Name	SBO
x_43	x_43	

Kinetic Law

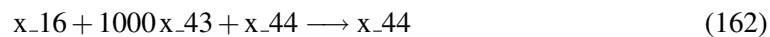
Derived unit contains undeclared units

$$v_{25} = \text{Eta47} \cdot [\text{x}_{19}] \quad (161)$$

8.26 Reaction R_26

This is an irreversible reaction of three reactants forming one product.

Reaction equation



Reactants

Table 51: Properties of each reactant.

Id	Name	SBO
x_16	x_16	
x_43	x_43	
x_44	x_44	

Product

Table 52: Properties of each product.

Id	Name	SBO
x_44	x_44	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{Eta35} \cdot [\text{x}_{16}] \cdot \frac{[\text{x}_{43}]}{[\text{x}_{43}] + [\text{x}_{44}] + 1.0E - 5} \quad (163)$$

8.27 Reaction R_27

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

Reaction equation



Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
x_41	x_41	

Product

Table 54: Properties of each product.

Id	Name	SBO
x_42	x_42	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = P89 \cdot [x_41] \quad (165)$$

8.28 Reaction R_28

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

Reaction equation



Reactant

Table 55: Properties of each reactant.

Id	Name	SBO
x_42	x_42	

Product

Table 56: Properties of each product.

Id	Name	SBO
x_41	x_41	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = P89 \cdot [x_{42}] \tag{167}$$

8.29 Reaction R_29

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

Reaction equation



Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
x_4	x_4	

Product

Table 58: Properties of each product.

Id	Name	SBO
x_41	x_41	

Kinetic Law

Derived unit not available

$$v_{29} = v87 \cdot \text{volLung} \tag{169}$$

8.30 Reaction R_30

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

Reaction equation



Reactant

Table 59: Properties of each reactant.

Id	Name	SBO
x_30	x_30	

Product

Table 60: Properties of each product.

Id	Name	SBO
x_41	x_41	

Kinetic Law

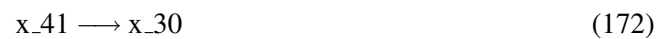
Derived unit contains undeclared units

$$v_{30} = P88 \cdot [x_{30}] \quad (171)$$

8.31 Reaction R_31

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

Reaction equation



Reactant

Table 61: Properties of each reactant.

Id	Name	SBO
x_41	x_41	

Product

Table 62: Properties of each product.

Id	Name	SBO
x_30	x_30	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{volLung} \cdot [x_{41}] \cdot \frac{P88}{\text{volBlood}} \tag{173}$$

8.32 Reaction R_32

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 63: Properties of each product.

Id	Name	SBO
x_40	x_40	

Kinetic Law

Derived unit not available

$$v_{32} = v82 \cdot \text{volLung} \tag{175}$$

8.33 Reaction R_33

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 64: Properties of each reactant.

Id	Name	SBO
x_40	x_40	

Kinetic Law

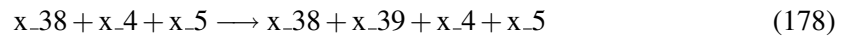
Derived unit not available

$$v_{33} = v_{83} \cdot \text{volLung} \quad (177)$$

8.34 Reaction R_34

This is an irreversible reaction of three reactants forming four products.

Reaction equation



Reactants

Table 65: Properties of each reactant.

Id	Name	SBO
x_38	x_38	
x_4	x_4	
x_5	x_5	

Products

Table 66: Properties of each product.

Id	Name	SBO
x_38	x_38	
x_39	x_39	
x_4	x_4	
x_5	x_5	

Kinetic Law

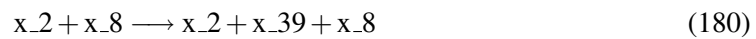
Derived unit contains undeclared units

$$\begin{aligned}
 v_{34} = & \text{Rho80} \cdot \text{volLung} \cdot \frac{\frac{[\text{x}_{38}] \cdot [\text{x}_4]}{\text{ci80} \cdot \text{volLung} + [\text{x}_{38}]} }{\text{c80} \cdot \text{volLung} + [\text{x}_4] + [\text{x}_5]} \\
 & + \text{Rho80} \cdot \text{volLung} \cdot \frac{\frac{[\text{x}_{38}] \cdot [\text{x}_5]}{\text{ci80} \cdot \text{volLung} + [\text{x}_{38}]} }{\text{c80} \cdot \text{volLung} + [\text{x}_4] + [\text{x}_5]}
 \end{aligned}
 \tag{179}$$

8.35 Reaction R_35

This is an irreversible reaction of two reactants forming three products.

Reaction equation



Reactants

Table 67: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_8	x_8	

Products

Table 68: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_{39}	x_{39}	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \text{volLung} \cdot [\text{x}_2] \cdot [\text{x}_8] \cdot \frac{q_{80}}{\text{cii80} \cdot \text{volLung} + [\text{x}_2]} \tag{181}$$

8.36 Reaction R_36

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 69: Properties of each reactant.

Id	Name	SBO
x_39	x_39	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \text{Eta81} \cdot [x_{39}]$$

(183)

8.37 Reaction R_37

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 70: Properties of each product.

Id	Name	SBO
x_38	x_38	

Kinetic Law

Derived unit not available

$$v_{37} = v_{77} \cdot \text{volLung}$$

(185)

8.38 Reaction R_38

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

Reaction equation



Reactant

Table 71: Properties of each reactant.

Id	Name	SBO
x_1	x_1	

Products

Table 72: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_38	x_38	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = q78a \cdot [x_1]$$

(187)

8.39 Reaction R_39

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

Reaction equation



Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
x_2	x_2	

Products

Table 74: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_38	x_38	

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = q78b \cdot [x_2] \tag{189}$$

8.40 Reaction R_40

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 75: Properties of each reactant.

Id	Name	SBO
x_38	x_38	

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \text{Eta}79 \cdot [x_{38}] \tag{191}$$

8.41 Reaction R_41

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 76: Properties of each product.

Id	Name	SBO
x_37	x_37	

Kinetic Law

Derived unit not available

$$v_{41} = v_{76} \cdot \text{volBlood} \tag{193}$$

8.42 Reaction R_42

This is an irreversible reaction of one reactant forming no product.

Reaction equation

$$x_{37} \longrightarrow \emptyset \tag{194}$$

Reactant

Table 77: Properties of each reactant.

Id	Name	SBO
x_37	x_37	

Kinetic Law

Derived unit not available

$$v_{42} = v_{77} \cdot \text{volBlood} \tag{195}$$

8.43 Reaction R_43

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

Reaction equation

$$x_{10} \longrightarrow x_{10} + x_{36} \tag{196}$$

Reactant

Table 78: Properties of each reactant.

Id	Name	SBO
x_10	x_10	

Products

Table 79: Properties of each product.

Id	Name	SBO
x_10	x_10	
x_36	x_36	

Kinetic Law

Derived unit contains undeclared units

$$v_{43} = q_{74} \cdot [x_{10}] \quad (197)$$

8.44 Reaction R_44

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 80: Properties of each reactant.

Id	Name	SBO
x_36	x_36	

Kinetic Law

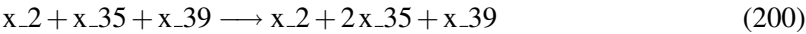
Derived unit not available

$$v_{44} = \text{Eta}_{75} \cdot [x_{36}] + v_{76} \cdot \text{volLymphT} \quad (199)$$

8.45 Reaction R_45

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 81: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_35	x_35	
x_39	x_39	

Products

Table 82: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_35	x_35	
x_39	x_39	

Kinetic Law

Derived unit contains undeclared units

$$v_{45} = c_{72} \cdot q_{72a} \cdot [x_{.2}] \cdot \frac{1}{[x_{.35}] + ci_{72} \cdot [x_{.39}] + c_{72} \cdot volLung}$$

(201)

8.46 Reaction R_46

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

Reaction equation



Reactant

Table 83: Properties of each reactant.

Id	Name	SBO
x_8	x_8	

Products

Table 84: Properties of each product.

Id	Name	SBO
x_35	x_35	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = q72b \cdot [x_8] \quad (203)$$

8.47 Reaction R_47

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

Reaction equation



Reactant

Table 85: Properties of each reactant.

Id	Name	SBO
x_9	x_9	

Products

Table 86: Properties of each product.

Id	Name	SBO
x_35	x_35	
x_9	x_9	

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = q72c \cdot [x_9] \quad (205)$$

8.48 Reaction R_48

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

Reaction equation



Reactant

Table 87: Properties of each reactant.

Id	Name	SBO
x_7	x_7	

Products

Table 88: Properties of each product.

Id	Name	SBO
x_35	x_35	
x_7	x_7	

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = q72d \cdot [x_7] \quad (207)$$

8.49 Reaction R_49

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

Reaction equation



Reactant

Table 89: Properties of each reactant.

Id	Name	SBO
x_3	x_3	

Products

Table 90: Properties of each product.

Id	Name	SBO
x_3	x_3	
x_35	x_35	

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = q72e \cdot [x_3] \quad (209)$$

8.50 Reaction R_50

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 91: Properties of each reactant.

Id	Name	SBO
x_35	x_35	

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = \text{Eta}73 \cdot [x_{35}] \quad (211)$$

8.51 Reaction R_51

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 92: Properties of each product.

Id	Name	SBO
x_34	x_34	

Kinetic Law

Derived unit not available

$$v_{51} = v70 \cdot \text{volLymphB}$$

(213)

8.52 Reaction R_52

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 93: Properties of each reactant.

Id	Name	SBO
x_34	x_34	

Kinetic Law

Derived unit not available

$$v_{52} = v71 \cdot \text{volLymphB}$$

(215)

8.53 Reaction R_53

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

Reaction equation



Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
x_7	x_7	

Products

Table 95: Properties of each product.

Id	Name	SBO
x_33	x_33	
x_7	x_7	

Kinetic Law

Derived unit contains undeclared units

$$v_{53} = q68a \cdot [x_7]$$

(217)

8.54 Reaction R_54

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

Reaction equation



Reactant

Table 96: Properties of each reactant.

Id	Name	SBO
x_9	x_9	

Products

Table 97: Properties of each product.

Id	Name	SBO
x_33	x_33	
x_9	x_9	

Kinetic Law

Derived unit contains undeclared units

$$v_{54} = q68b \cdot [x_9] \quad (219)$$

8.55 Reaction R_55

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 98: Properties of each reactant.

Id	Name	SBO
x_33	x_33	

Kinetic Law

Derived unit contains undeclared units

$$v_{55} = \text{Eta69} \cdot [x_{33}] \quad (221)$$

8.56 Reaction R_56

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 99: Properties of each product.

Id	Name	SBO
x_32	x_32	

Kinetic Law

Derived unit not available

$$v_{56} = v_{66} \cdot \text{volLung} \quad (223)$$

8.57 Reaction R_57

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 100: Properties of each reactant.

Id	Name	SBO
x_32	x_32	

Kinetic Law

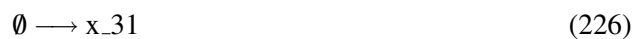
Derived unit not available

$$v_{57} = v_{67} \cdot \text{volLung} \quad (225)$$

8.58 Reaction R_58

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 101: Properties of each product.

Id	Name	SBO
x_31	x_31	

Kinetic Law

Derived unit not available

$$v_{58} = v_{64} \cdot \text{volLung} \quad (227)$$

8.59 Reaction R_59

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 102: Properties of each reactant.

Id	Name	SBO
x_31	x_31	

Kinetic Law

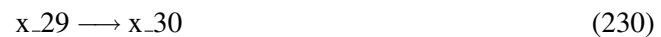
Derived unit not available

$$v_{59} = v_{65} \cdot \text{volLung} \quad (229)$$

8.60 Reaction R_60

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

Reaction equation



Reactant

Table 103: Properties of each reactant.

Id	Name	SBO
x_29	x_29	

Product

Table 104: Properties of each product.

Id	Name	SBO
x_30	x_30	

Kinetic Law

Derived unit contains undeclared units

$$v_{60} = \text{Eta60} \cdot [x_{29}] \quad (231)$$

8.61 Reaction R_61

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 105: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_29	x_29	

Products

Table 106: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_30	x_30	

Kinetic Law

Derived unit contains undeclared units

$$v_{61} = \text{Alpha61} \cdot [x_2] \cdot \frac{[x_29]}{100000 + [x_29]} \quad (233)$$

8.62 Reaction R_62

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 107: Properties of each reactant.

Id	Name	SBO
x_27	x_27	
x_29	x_29	

Products

Table 108: Properties of each product.

Id	Name	SBO
x_27	x_27	
x_30	x_30	

Kinetic Law

Derived unit contains undeclared units

$$v_{62} = \text{Alpha61} \cdot [x_27] \cdot \frac{[x_29]}{100000 + [x_29]} \quad (235)$$

8.63 Reaction R_63

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 109: Properties of each reactant.

Id	Name	SBO
x_30	x_30	

Kinetic Law

Derived unit contains undeclared units

$$v_{63} = k_{63} \cdot [x_{30}] \quad (237)$$

8.64 Reaction R_64

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 110: Properties of each product.

Id	Name	SBO
x_29	x_29	

Kinetic Law

Derived unit not available

$$v_{64} = v_{59} \cdot \text{volLung} \quad (239)$$

8.65 Reaction R_65

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

Reaction equation



Reactant

Table 111: Properties of each reactant.

Id	Name	SBO
x_1	x_1	

Product

Table 112: Properties of each product.

Id	Name	SBO
x_28	x_28	

Kinetic Law

Derived unit not available

$$v_{65} = v_{57} \cdot \text{volLung} \quad (241)$$

8.66 Reaction R_66

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 113: Properties of each reactant.

Id	Name	SBO
x_28	x_28	

Kinetic Law

Derived unit not available

$$v_{66} = v_{58} \cdot \text{volLung} \quad (243)$$

8.67 Reaction R_67

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 114: Properties of each reactant.

Id	Name	SBO
x_26	x_26	
x_29	x_29	

Products

Table 115: Properties of each product.

Id	Name	SBO
x_27	x_27	
x_29	x_29	

Kinetic Law

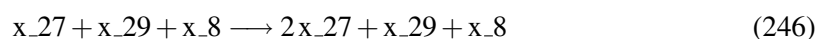
Derived unit contains undeclared units

$$v_{67} = [x_{26}] \cdot [x_{29}] \cdot \frac{\text{Delta54}}{\text{volLung}} \quad (245)$$

8.68 Reaction R_68

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 116: Properties of each reactant.

Id	Name	SBO
x_27	x_27	
x_29	x_29	
x_8	x_8	

Products

Table 117: Properties of each product.

Id	Name	SBO
x_27	x_27	
x_29	x_29	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{68} = \frac{\frac{[x_8] \cdot [x_{27}]}{\text{volLung}} \cdot [x_{29}] \cdot \text{volLung} \cdot \text{Mu55}}{cF + [x_{29}]} \quad (247)$$

8.69 Reaction R_69

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 118: Properties of each reactant.

Id	Name	SBO
x_27	x_27	

Kinetic Law

Derived unit contains undeclared units

$$v_{69} = \text{Eta56} \cdot [\text{x_27}] \quad (249)$$

8.70 Reaction R_70

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 119: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_25	x_25	

Products

Table 120: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_26	x_26	

Kinetic Law

Derived unit contains undeclared units

$$v_{70} = \text{Gamma52} \cdot [\text{x_25}] \cdot \frac{[\text{x_2}]}{\text{c52} \cdot \text{volLung} + [\text{x_2}]} \quad (251)$$

8.71 Reaction R_71

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 121: Properties of each reactant.

Id	Name	SBO
x_26	x_26	

Kinetic Law

Derived unit contains undeclared units

$$v_{71} = \text{Eta53} \cdot [\text{x_26}] \quad (253)$$

8.72 Reaction R_72

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

Reaction equation



Reactant

Table 122: Properties of each reactant.

Id	Name	SBO
x_24	x_24	

Product

Table 123: Properties of each product.

Id	Name	SBO
x_25	x_25	

Kinetic Law

Derived unit contains undeclared units

$$v_{72} = \text{Gamma51} \cdot [\text{x_24}] \quad (255)$$

8.73 Reaction R_73

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 124: Properties of each reactant.

Id	Name	SBO
x_25	x_25	

Kinetic Law

Derived unit contains undeclared units

$$v_{73} = \text{Eta85} \cdot [x_25] \quad (257)$$

8.74 Reaction R_74

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

Reaction equation



Reactant

Table 125: Properties of each reactant.

Id	Name	SBO
x_11	x_11	

Product

Table 126: Properties of each product.

Id	Name	SBO
x_24	x_24	

Kinetic Law

Derived unit not available

$$v_{74} = \text{Rho50} \cdot \text{volLymphT} \quad (259)$$

8.75 Reaction R_75

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 127: Properties of each reactant.

Id	Name	SBO
x_10	x_10	
x_11	x_11	

Products

Table 128: Properties of each product.

Id	Name	SBO
x_10	x_10	
x_24	x_24	

Kinetic Law

Derived unit contains undeclared units

$$v_{75} = [x_{10}] \cdot [x_{11}] \cdot \frac{\text{Delta50}}{\text{volLymphT}} \quad (261)$$

8.76 Reaction R_76

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

Reaction equation



Reactant

Table 129: Properties of each reactant.

Id	Name	SBO
x_22	x_22	

Product

Table 130: Properties of each product.

Id	Name	SBO
x_23	x_23	

Kinetic Law

Derived unit contains undeclared units

$$v_{76} = P_{46} \cdot [x_{22}] \quad (263)$$

8.77 Reaction R_77

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

Reaction equation



Reactant

Table 131: Properties of each reactant.

Id	Name	SBO
x_23	x_23	

Product

Table 132: Properties of each product.

Id	Name	SBO
x_22	x_22	

Kinetic Law

Derived unit contains undeclared units

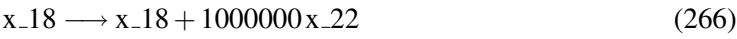
$$v_{77} = \text{volBlood} \cdot [\text{x}_{.23}] \cdot \frac{\text{P46}}{\text{volLung}}$$

(265)

8.78 Reaction R_78

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

Reaction equation



Reactant

Table 133: Properties of each reactant.

Id	Name	SBO
x_18	x_18	

Products

Table 134: Properties of each product.

Id	Name	SBO
x_18	x_18	
x_22	x_22	

Kinetic Law

Derived unit mol · l⁻¹

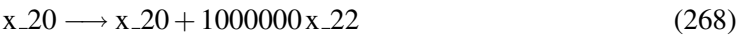
$$v_{78} = [\text{x}_{.18}]$$

(267)

8.79 Reaction R_79

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

Reaction equation



Reactant

Table 135: Properties of each reactant.

Id	Name	SBO
x_20	x_20	

Products

Table 136: Properties of each product.

Id	Name	SBO
x_20	x_20	
x_22	x_22	

Kinetic Law

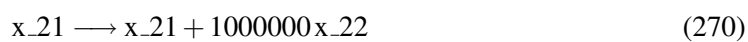
Derived unit $\text{mol} \cdot \text{l}^{-1}$

$$v_{79} = [\text{x_20}] \quad (269)$$

8.80 Reaction R_80

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

Reaction equation



Reactant

Table 137: Properties of each reactant.

Id	Name	SBO
x_21	x_21	

Products

Table 138: Properties of each product.

Id	Name	SBO
x_21	x_21	
x_22	x_22	

Kinetic Law

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

$$v_{80} = [\text{x_21}] \quad (271)$$

8.81 Reaction R_81

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 139: Properties of each reactant.

Id	Name	SBO
x_22	x_22	

Kinetic Law

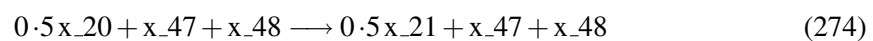
Derived unit contains undeclared units

$$v_{81} = \text{Eta49} \cdot [\text{x_22}] \quad (273)$$

8.82 Reaction R_82

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 140: Properties of each reactant.

Id	Name	SBO
x_20	x_20	
x_47	x_47	
x_48	x_48	

Products

Table 141: Properties of each product.

Id	Name	SBO
x_21	x_21	
x_47	x_47	
x_48	x_48	

Kinetic Law

Derived unit contains undeclared units

$$v_{82} = \text{Delta43} \cdot [x_{20}] \cdot \frac{[x_{47}]}{[x_{47}] + [x_{48}] + 1.0E - 5} \quad (275)$$

8.83 Reaction R_83

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 142: Properties of each reactant.

Id	Name	SBO
x_21	x_21	

Kinetic Law

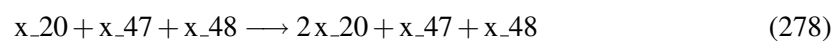
Derived unit contains undeclared units

$$v_{83} = \text{Eta44} \cdot [x_{21}] \quad (277)$$

8.84 Reaction R_84

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 143: Properties of each reactant.

Id	Name	SBO
x_20	x_20	
x_47	x_47	
x_48	x_48	

Products

Table 144: Properties of each product.

Id	Name	SBO
x_20	x_20	
x_47	x_47	
x_48	x_48	

Kinetic Law

Derived unit contains undeclared units

$$v_{84} = \text{Mu42} \cdot [x_{_20}] \cdot \frac{[x_{_48}]}{[x_{_47}] + [x_{_48}] + 1.0E - 5} \quad (279)$$

8.85 Reaction R_85

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 145: Properties of each reactant.

Id	Name	SBO
x_20	x_20	

Kinetic Law

Derived unit contains undeclared units

$$v_{85} = \text{Eta48} \cdot [\text{x_20}] \quad (281)$$

8.86 Reaction R_86

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

Reaction equation



Reactant

Table 146: Properties of each reactant.

Id	Name	SBO
x_14	x_14	

Product

Table 147: Properties of each product.

Id	Name	SBO
x_15	x_15	

Kinetic Law

Derived unit contains undeclared units

$$v_{86} = \text{Gamma32} \cdot [\text{x_14}] \quad (283)$$

8.87 Reaction R_87

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 148: Properties of each reactant.

Id	Name	SBO
x_15	x_15	

Kinetic Law

Derived unit contains undeclared units

$$v_{87} = \text{Eta33} \cdot [x_{15}] \quad (285)$$

8.88 Reaction R_88

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

Reaction equation



Reactant

Table 149: Properties of each reactant.

Id	Name	SBO
x_9	x_9	

Product

Table 150: Properties of each product.

Id	Name	SBO
x_14	x_14	

Kinetic Law

Derived unit contains undeclared units

$$v_{88} = \text{Gamma31} \cdot [x_9] \quad (287)$$

8.89 Reaction R_89

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

Reaction equation



Reactant

Table 151: Properties of each reactant.

Id	Name	SBO
x_12	x_12	

Product

Table 152: Properties of each product.

Id	Name	SBO
x_13	x_13	

Kinetic Law

Derived unit contains undeclared units

$$v_{89} = \text{Gamma23} \cdot [x_12] \quad (289)$$

8.90 Reaction R_90

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 153: Properties of each reactant.

Id	Name	SBO
x_13	x_13	
x_2	x_2	

Products

Table 154: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_7	x_7	

Kinetic Law

Derived unit contains undeclared units

$$v_{90} = \text{Gamma24} \cdot [\text{x_13}] \cdot \frac{[\text{x_2}]}{c24 \cdot \text{volLung} + [\text{x_2}]} \quad (291)$$

8.91 Reaction R_91

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 155: Properties of each reactant.

Id	Name	SBO
x_13	x_13	

Kinetic Law

Derived unit contains undeclared units

$$v_{91} = \text{Eta84} \cdot [\text{x_13}] \quad (293)$$

8.92 Reaction R_92

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

Reaction equation



Reactant

Table 156: Properties of each reactant.

Id	Name	SBO
x_11	x_11	

Product

Table 157: Properties of each product.

Id	Name	SBO
x_12	x_12	

Kinetic Law

Derived unit not available

$$v_{92} = \text{Rho21} \cdot \text{volLymphT} \quad (295)$$

8.93 Reaction R_93

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 158: Properties of each reactant.

Id	Name	SBO
x_10	x_10	
x_11	x_11	

Products

Table 159: Properties of each product.

Id	Name	SBO
x_10	x_10	
x_12	x_12	

Kinetic Law

Derived unit contains undeclared units

$$v_{93} = [x_{10}] \cdot [x_{11}] \cdot \frac{\text{Delta21}}{\text{volLymphT}} \quad (297)$$

8.94 Reaction R_94

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

Reaction equation



Reactant

Table 160: Properties of each reactant.

Id	Name	SBO
x_12	x_12	

Product

Table 161: Properties of each product.

Id	Name	SBO
x_12	x_12	

Kinetic Law

Derived unit contains undeclared units

$$v_{94} = [x_{12}] \cdot \frac{\text{Mu22}}{c_{22} + \left(\frac{[x_{12}]}{\text{volLymphT}} \right)^2} \quad (299)$$

8.95 Reaction R_95

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 162: Properties of each product.

Id	Name	SBO
x_11	x_11	

Kinetic Law

Derived unit not available

$$v_{95} = \text{Rho19} \cdot \text{volLymphT} \quad (301)$$

8.96 Reaction R_96

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

Reaction equation



Reactant

Table 163: Properties of each reactant.

Id	Name	SBO
x_10	x_10	

Products

Table 164: Properties of each product.

Id	Name	SBO
x_10	x_10	
x_11	x_11	

Kinetic Law

Derived unit contains undeclared units

$$v_{96} = \text{Mu19} \cdot [\text{x_10}] \quad (303)$$

8.97 Reaction R_97

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 165: Properties of each reactant.

Id	Name	SBO
x_11	x_11	

Kinetic Law

Derived unit contains undeclared units

$$v_{97} = \text{Eta20} \cdot [\text{x_11}] \quad (305)$$

8.98 Reaction R_98

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 166: Properties of each reactant.

Id	Name	SBO
x_4	x_4	
x_6	x_6	

Products

Table 167: Properties of each product.

Id	Name	SBO
x_10	x_10	
x_4	x_4	

Kinetic Law

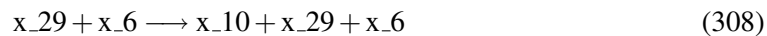
Derived unit contains undeclared units

$$v_{98} = \text{Gamma17} \cdot [x_6] \cdot \frac{[x_4]}{c17 \cdot \text{volLung} + [x_4]} \quad (307)$$

8.99 Reaction R_99

This is an irreversible reaction of two reactants forming three products.

Reaction equation



Reactants

Table 168: Properties of each reactant.

Id	Name	SBO
x_29	x_29	
x_6	x_6	

Products

Table 169: Properties of each product.

Id	Name	SBO
x_10	x_10	
x_29	x_29	
x_6	x_6	

Kinetic Law

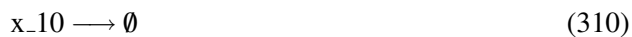
Derived unit contains undeclared units

$$v_{99} = \frac{\frac{\frac{[x_6]}{\text{volLymphT}}}{\text{volLung}} \cdot [x_{29}] \cdot \text{volLymphT} \cdot \text{volLung} \cdot \text{MuI} \cdot \text{Gamma17}}{c\text{I} + \frac{[x_{29}]}{c\text{F} + [x_{29}]}} \quad (309)$$

8.100 Reaction R_100

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 170: Properties of each reactant.

Id	Name	SBO
x_10	x_10	

Kinetic Law

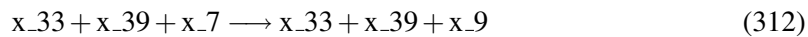
Derived unit contains undeclared units

$$v_{100} = \text{Eta18} \cdot [x_{10}] \quad (311)$$

8.101 Reaction R_101

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 171: Properties of each reactant.

Id	Name	SBO
x_33	x_33	
x_39	x_39	
x_7	x_7	

Products

Table 172: Properties of each product.

Id	Name	SBO
x_33	x_33	
x_39	x_39	
x_9	x_9	

Kinetic Law

Derived unit contains undeclared units

$$v_{101} = \text{Delta29} \cdot [x_7] \cdot \frac{[x_{33}]}{[x_{33}] + \text{fi29} \cdot [x_{39}] + \text{cf29} \cdot \text{volLung}} \quad (313)$$

8.102 Reaction R_102

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 173: Properties of each reactant.

Id	Name	SBO
x_9	x_9	

Kinetic Law

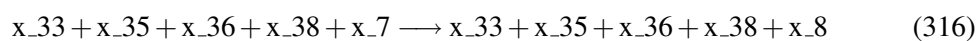
Derived unit not available

$$v_{102} = v_{30} \cdot \text{volLung} \quad (315)$$

8.103 Reaction R_103

This is an irreversible reaction of five reactants forming five products.

Reaction equation



Reactants

Table 174: Properties of each reactant.

Id	Name	SBO
x_33	x_33	
x_35	x_35	
x_36	x_36	
x_38	x_38	
x_7	x_7	

Products

Table 175: Properties of each product.

Id	Name	SBO
x_33	x_33	
x_35	x_35	
x_36	x_36	
x_38	x_38	
x_8	x_8	

Kinetic Law

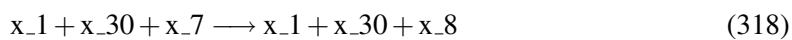
Derived unit contains undeclared units

$$v_{103} = [x_{36}] \cdot [x_{38}] \cdot \frac{\text{Delta27}}{\text{volLung}} \cdot \frac{[x_7]}{[x_{36}] + \text{fi27} \cdot [x_{33}] + \text{fi27} \cdot [x_{35}] + \text{cf27} \cdot \text{volLung}} \quad (317)$$

8.104 Reaction R_104

This is an irreversible reaction of three reactants forming three products.

Reaction equation



Reactants

Table 176: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_30	x_30	
x_7	x_7	

Products

Table 177: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_30	x_30	
x_8	x_8	

Kinetic Law

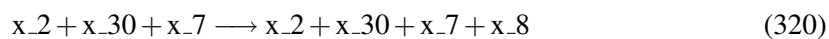
Derived unit contains undeclared units

$$v_{104} = \text{Deltai27} \cdot [x_1] \cdot [x_30] \cdot \frac{[x_7]}{10^7 + [x_30]} \quad (319)$$

8.105 Reaction R_105

This is an irreversible reaction of three reactants forming four products.

Reaction equation



Reactants

Table 178: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_30	x_30	
x_7	x_7	

Products

Table 179: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_30	x_30	
x_7	x_7	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{105} = \text{Delta}i27 \cdot [x_2] \cdot [x_{30}] \cdot \frac{[x_7]}{10^7 + [x_{30}]} \quad (321)$$

8.106 Reaction R_106

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 180: Properties of each reactant.

Id	Name	SBO
x_29	x_29	
x_8	x_8	

Products

Table 181: Properties of each product.

Id	Name	SBO
x_29	x_29	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{106} = \frac{\frac{[x_8] \cdot [x_8]}{\text{volLung}} \cdot [x_{29}] \cdot \text{volLung} \cdot \text{Mu86}}{cF + [x_{29}]} \cdot \text{cf86} + \text{FACTOR} \quad (323)$$

8.107 Reaction R_107

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 182: Properties of each reactant.

Id	Name	SBO
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{107} = \text{Eta28} \cdot [x_8] \quad (325)$$

8.108 Reaction R_108

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 183: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_7	x_7	

Products

Table 184: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_7	x_7	

Kinetic Law

Derived unit contains undeclared units

$$v_{108} = \text{Mu25} \cdot [x_7] \cdot \frac{[x_2]}{c25 \cdot \text{volLung} + [x_2]} \quad (327)$$

8.109 Reaction R_109

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 185: Properties of each reactant.

Id	Name	SBO
x_7	x_7	

Kinetic Law

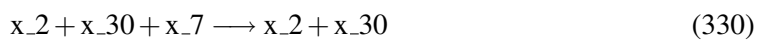
Derived unit contains undeclared units

$$v_{109} = \text{Eta26} \cdot [x_7] \quad (329)$$

8.110 Reaction R_110

This is an irreversible reaction of three reactants forming two products.

Reaction equation



Reactants

Table 186: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_30	x_30	
x_7	x_7	

Products

Table 187: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_30	x_30	

Kinetic Law

Derived unit contains undeclared units

$$v_{110} = \text{Deltai27} \cdot [x_2] \cdot [x_7] \cdot \frac{[x_30]}{10^7 + [x_30]} \quad (331)$$

8.111 Reaction R_111

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 188: Properties of each product.

Id	Name	SBO
x_6	x_6	

Kinetic Law

Derived unit not available

$$v_{111} = \text{Rho15} \cdot \text{volLung} \quad (333)$$

8.112 Reaction R_112

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

Reaction equation



Reactant

Table 189: Properties of each reactant.

Id	Name	SBO
x_4	x_4	

Products

Table 190: Properties of each product.

Id	Name	SBO
x_4	x_4	
x_6	x_6	

Kinetic Law

Derived unit contains undeclared units

$$v_{112} = \text{volLung} \cdot [x_4] \cdot \frac{\text{Mu15}}{c15 \cdot \text{volLung} + [x_4]} \quad (335)$$

8.113 Reaction R_113

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

Reaction equation



Reactant

Table 191: Properties of each reactant.

Id	Name	SBO
x_29	x_29	

Products

Table 192: Properties of each product.

Id	Name	SBO
x_29	x_29	
x_6	x_6	

Kinetic Law

Derived unit contains undeclared units

$$v_{113} = \frac{\frac{[x_{_29}] \cdot \text{volLung} \cdot \text{Rho21} \cdot \text{MuI}}{cF + [x_{_29}]}}{cI + \frac{[x_{_29}]}{cF + [x_{_29}]}} + \frac{\frac{[x_{_29}] \cdot \text{volLung} \cdot \text{Rho50} \cdot \text{MuI}}{cF + [x_{_29}]}}{cI + \frac{[x_{_29}]}{cF + [x_{_29}]}}$$

(337)

8.114 Reaction R_114

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 193: Properties of each reactant.

Id	Name	SBO
x_6	x_6	

Kinetic Law**Derived unit** contains undeclared units

$$v_{114} = \text{Eta16} \cdot [\text{x}_6] \quad (339)$$

8.115 Reaction R_115

This is an irreversible reaction of two reactants forming one product.

Reaction equation**Reactants**

Table 194: Properties of each reactant.

Id	Name	SBO
x_29	x_29	
x_6	x_6	

Product

Table 195: Properties of each product.

Id	Name	SBO
x_29	x_29	

Kinetic Law**Derived unit** contains undeclared units

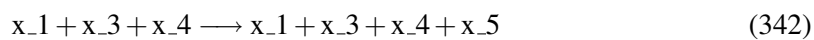
$$v_{115} = \frac{\frac{[\text{x}_6]}{\text{volLung}} \cdot [\text{x}_{29}] \cdot \text{volLung} \cdot \text{MuI} \cdot \text{Gamma17}}{\text{cF} + [\text{x}_{29}]} \quad (341)$$

$$\text{cI} + \frac{[\text{x}_{29}]}{\text{cF} + [\text{x}_{29}]}$$

8.116 Reaction R_116

This is an irreversible reaction of three reactants forming four products.

Reaction equation



Reactants

Table 196: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_3	x_3	
x_4	x_4	

Products

Table 197: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_3	x_3	
x_4	x_4	
x_5	x_5	

Kinetic Law

Derived unit contains undeclared units

$$v_{116} = \frac{\frac{[x_3] \cdot [x_1] \cdot [x_4] \cdot 25 \cdot k2}{[x_4] + c2 \cdot \text{volLung}}}{[x_3]} \quad (343)$$

8.117 Reaction R_117

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 198: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_5	x_5	

Products

Table 199: Properties of each product.

Id	Name	SBO
x_3	x_3	
x_5	x_5	

Kinetic Law

Derived unit contains undeclared units

$$v_{117} = \text{Mu8} \cdot [\text{x}_3] \cdot \frac{[\text{x}_5]}{[\text{x}_3]} \quad (345)$$

8.118 Reaction R_118

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 200: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_5	x_5	

Product

Table 201: Properties of each product.

Id	Name	SBO
x_3	x_3	

Kinetic Law

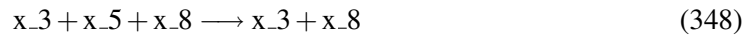
Derived unit contains undeclared units

$$v_{118} = \text{Mu8} \cdot \frac{\frac{[x_3] \cdot [x_5] \cdot \left(\frac{[x_5]}{[x_3]}\right)^2}{\left(\frac{[x_5]}{[x_3]}\right)^2 + K3s^2}}{[x_3]} + \frac{\frac{[x_3] \cdot [x_5] \cdot \text{volLung} \cdot v14}{[x_3]}}{[x_3]} + \frac{\frac{\frac{[x_3] \cdot [x_5] \cdot [x_3]}{[x_3]} \cdot \left(\frac{[x_5]}{[x_3]}\right)^2 \cdot k3}{\left(\frac{[x_5]}{[x_3]}\right)^2 + K3s^2}}{[x_3]} \quad (347)$$

8.119 Reaction R_119

This is an irreversible reaction of three reactants forming two products.

Reaction equation



Reactants

Table 202: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_5	x_5	
x_8	x_8	

Products

Table 203: Properties of each product.

Id	Name	SBO
x_3	x_3	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{119} = \frac{\frac{\frac{[x_3] \cdot [x_5] \cdot [x_3]}{[x_3]} \cdot [x_8] \cdot \text{Alpha4}}{[x_3]}}{\frac{[x_8]}{[x_3]} + c4 \cdot \text{volLung}} [x_3] \tag{349}$$

8.120 Reaction R_120

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

Reaction equation



Reactant

Table 204: Properties of each reactant.

Id	Name	SBO
x_4	x_4	

Product

Table 205: Properties of each product.

Id	Name	SBO
x_4	x_4	

Kinetic Law

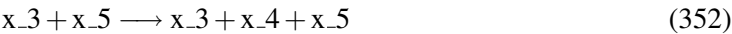
Derived unit contains undeclared units

$$v_{120} = \text{Mu1} \cdot [x_4] \tag{351}$$

8.121 Reaction R_121

This is an irreversible reaction of two reactants forming three products.

Reaction equation



Reactants

Table 206: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_5	x_5	

Products

Table 207: Properties of each product.

Id	Name	SBO
x_3	x_3	
x_4	x_4	
x_5	x_5	

Kinetic Law

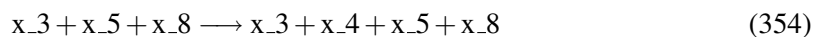
Derived unit contains undeclared units

$$v_{121} = \text{volLung} \cdot [x_5] \cdot \frac{v_{14}}{[x_3]} + k_3 \cdot [x_3] \cdot \frac{1}{\left(\frac{[x_5]}{[x_3]}\right)^2 + K_3 s^2} \cdot \frac{[x_5]}{[x_3]} \cdot \left(\frac{[x_5]}{[x_3]}\right)^2 \quad (353)$$

8.122 Reaction R_122

This is an irreversible reaction of three reactants forming four products.

Reaction equation



Reactants

Table 208: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_5	x_5	
x_8	x_8	

Products

Table 209: Properties of each product.

Id	Name	SBO
x_3	x_3	
x_4	x_4	
x_5	x_5	
x_8	x_8	

Kinetic Law

Derived unit contains undeclared units

$$v_{122} = \frac{\frac{\frac{[x_3][x_5]}{\text{volLung}} \cdot [x_8] \cdot \text{volLung} \cdot \text{Alpha4}}{[x_3]}}{\frac{[x_8]}{[x_3]} + c4 \cdot \text{volLung}} \quad (355)$$

8.123 Reaction R_123

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 210: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_4	x_4	

Product

Table 211: Properties of each product.

Id	Name	SBO
x_2	x_2	

Kinetic Law

Derived unit contains undeclared units

$$v_{123} = [x_2] \cdot [x_4] \cdot \frac{\text{Alpha5}}{\text{volLung}} \quad (357)$$

8.124 Reaction R_124

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 212: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_4	x_4	

Product

Table 213: Properties of each product.

Id	Name	SBO
x_1	x_1	

Kinetic Law

Derived unit contains undeclared units

$$v_{124} = [x_1] \cdot [x_4] \cdot \frac{\text{Alpha6}}{\text{volLung}} \quad (359)$$

8.125 Reaction R_125

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 214: Properties of each reactant.

Id	Name	SBO
x_4	x_4	
x_6	x_6	

Product

Table 215: Properties of each product.

Id	Name	SBO
x_6	x_6	

Kinetic Law

Derived unit contains undeclared units

$$v_{125} = [x_4] \cdot [x_6] \cdot \frac{k7}{volLung}$$

(361)

8.126 Reaction R_126

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 216: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_4	x_4	

Product

Table 217: Properties of each product.

Id	Name	SBO
x_3	x_3	

Kinetic Law

Derived unit contains undeclared units

$$v_{126} = k2 \cdot [x_1] \cdot \frac{[x_4]}{[x_4] + c2 \cdot \text{volLung}} \quad (363)$$

8.127 Reaction R_127

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 218: Properties of each reactant.

Id	Name	SBO
x_3	x_3	

Kinetic Law

Derived unit not available

$$v_{127} = v_{14} \cdot \text{volLung} \quad (365)$$

8.128 Reaction R_128

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 219: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_5	x_5	

Product

Table 220: Properties of each product.

Id	Name	SBO
x_5	x_5	

Kinetic Law

Derived unit contains undeclared units

$$v_{128} = k_3 \cdot \frac{[x_3]}{\left(\frac{[x_5]}{[x_3]}\right)^2 + K_3 s^2} \cdot \left(\frac{[x_5]}{[x_3]}\right)^2 \quad (367)$$

8.129 Reaction R_129

This is an irreversible reaction of two reactants forming one product.

Reaction equation



Reactants

Table 221: Properties of each reactant.

Id	Name	SBO
x_3	x_3	
x_8	x_8	

Product

Table 222: Properties of each product.

Id	Name	SBO
x_8	x_8	

Kinetic Law

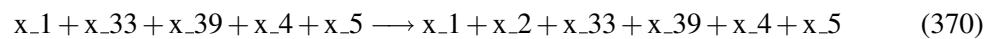
Derived unit contains undeclared units

$$v_{129} = \frac{\frac{[x_3]}{\text{volLung}} \cdot [x_8] \cdot \text{volLung} \cdot \text{Alpha4}}{\frac{[x_8]}{[x_3]} + c4 \cdot \text{volLung}} \quad (369)$$

8.130 Reaction R_130

This is an irreversible reaction of five reactants forming six products.

Reaction equation



Reactants

Table 223: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_33	x_33	
x_39	x_39	
x_4	x_4	
x_5	x_5	

Products

Table 224: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_2	x_2	
x_33	x_33	
x_39	x_39	
x_4	x_4	

Id	Name	SBO
x_5	x_5	

Kinetic Law

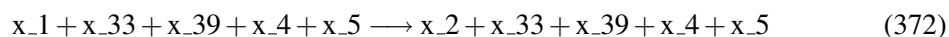
Derived unit contains undeclared units

$$v_{130} = \text{Delta12} \cdot [x_1] \cdot \frac{[x_39]}{[x_39] + \text{fi12} \cdot [x_33] + \text{cf12} \cdot \text{volLung}} \cdot \frac{[x_4]}{\text{c12} \cdot \text{volLung} + [x_4] + [x_5]} \quad (371)$$

8.131 Reaction R_131

This is an irreversible reaction of five reactants forming five products.

Reaction equation



Reactants

Table 225: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_33	x_33	
x_39	x_39	
x_4	x_4	
x_5	x_5	

Products

Table 226: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_33	x_33	
x_39	x_39	
x_4	x_4	
x_5	x_5	

Kinetic Law

Derived unit contains undeclared units

$$v_{131} = \text{Delta12} \cdot [x_1] \cdot \frac{[x_39]}{[x_39] + \text{fi12} \cdot [x_33] + \text{cf12} \cdot \text{volLung}} \cdot \frac{[x_5]}{\text{c12} \cdot \text{volLung} + [x_4] + [x_5]} \quad (373)$$

8.132 Reaction R_132

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 227: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_29	x_29	

Products

Table 228: Properties of each product.

Id	Name	SBO
x_2	x_2	
x_29	x_29	

Kinetic Law

Derived unit contains undeclared units

$$v_{132} = \text{Delta12} \cdot [x_1] \cdot \frac{[x_29]}{\text{ci12} + [x_29]} \quad (375)$$

8.133 Reaction R_133

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 229: Properties of each reactant.

Id	Name	SBO
x_2	x_2	

Kinetic Law

Derived unit contains undeclared units

$$v_{133} = \text{Eta13} \cdot [x_2] \quad (377)$$

8.134 Reaction R_134

This is an irreversible reaction of two reactants forming two products.

Reaction equation



Reactants

Table 230: Properties of each reactant.

Id	Name	SBO
x_2	x_2	
x_35	x_35	

Products

Table 231: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_35	x_35	

Kinetic Law

Derived unit contains undeclared units

$$v_{134} = \text{Delta11} \cdot [x_2] \cdot \frac{[x_35]}{[x_35] + \text{cf11} \cdot \text{volLung}} \quad (379)$$

8.135 Reaction R_135

This is an irreversible reaction of no reactant forming one product.

Reaction equation



Product

Table 232: Properties of each product.

Id	Name	SBO
x_1	x_1	

Kinetic Law

Derived unit not available

$$v_{135} = \text{Rho9} \cdot \text{volLung} \quad (381)$$

8.136 Reaction R_136

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

Reaction equation



Reactant

Table 233: Properties of each reactant.

Id	Name	SBO
x_2	x_2	

Products

Table 234: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_2	x_2	

Kinetic Law

Derived unit contains undeclared units

$$v_{136} = \text{Mu9} \cdot [\text{x}_2] \quad (383)$$

8.137 Reaction R_137

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

Reaction equation



Reactant

Table 235: Properties of each reactant.

Id	Name	SBO
x_3	x_3	

Products

Table 236: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_3	x_3	

Kinetic Law

Derived unit contains undeclared units

$$v_{137} = \text{Mu9} \cdot w_9 \cdot [\text{x}_3] \quad (385)$$

8.138 Reaction R_138

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

Reaction equation



Reactant

Table 237: Properties of each reactant.

Id	Name	SBO
x_29	x_29	

Products

Table 238: Properties of each product.

Id	Name	SBO
x_1	x_1	
x_29	x_29	

Kinetic Law

Derived unit contains undeclared units

$$v_{138} = \frac{\frac{[x_{29}] \cdot \text{volLung} \cdot \text{Mui9} \cdot \text{MuI}}{cF + [x_{29}]}}{cI + \frac{[x_{29}]}{cF + [x_{29}]}}$$

(387)

8.139 Reaction R_139

This is an irreversible reaction of one reactant forming no product.

Reaction equation



Reactant

Table 239: Properties of each reactant.

Id	Name	SBO
x_1	x_1	

Kinetic Law

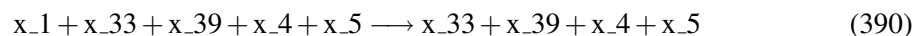
Derived unit contains undeclared units

$$v_{139} = \text{Eta10} \cdot [x_1] \quad (389)$$

8.140 Reaction R_140

This is an irreversible reaction of five reactants forming four products.

Reaction equation



Reactants

Table 240: Properties of each reactant.

Id	Name	SBO
x_1	x_1	
x_33	x_33	
x_39	x_39	
x_4	x_4	
x_5	x_5	

Products

Table 241: Properties of each product.

Id	Name	SBO
x_33	x_33	
x_39	x_39	
x_4	x_4	
x_5	x_5	

Kinetic Law

Derived unit contains undeclared units

$$v_{140} = \text{Delta12} \cdot [x_{39}] \cdot \frac{[x_1]}{[x_{39}] + \text{fi12} \cdot [x_{33}] + \text{cf12} \cdot \text{volLung}} \cdot \frac{[x_4]}{\text{c12} \cdot \text{volLung} + [x_4] + [x_5]} \quad (391)$$

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 `x_1`

Name `x_1`

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

This species takes part in 21 reactions (as a reactant in [R_38](#), [R_65](#), [R_104](#), [R_116](#), [R_124](#), [R_126](#), [R_130](#), [R_131](#), [R_132](#), [R_139](#), [R_140](#) and as a product in [R_38](#), [R_104](#), [R_116](#), [R_124](#), [R_130](#), [R_134](#), [R_135](#), [R_136](#), [R_137](#), [R_138](#)).

$$\begin{aligned} \frac{d}{dt}x_1 = & v_{38} + v_{104} + v_{116} + v_{124} + v_{130} + v_{134} + v_{135} + v_{136} + v_{137} + v_{138} - v_{38} \\ & - v_{65} - v_{104} - v_{116} - v_{124} - v_{126} - v_{130} - v_{131} - v_{132} - v_{139} - v_{140} \end{aligned} \quad (392)$$

9.2 Species `x_2`

Name `x_2`

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

This species takes part in 27 reactions (as a reactant in [R_35](#), [R_39](#), [R_45](#), [R_61](#), [R_70](#), [R_90](#), [R_105](#), [R_108](#), [R_110](#), [R_123](#), [R_133](#), [R_134](#), [R_136](#) and as a product in [R_35](#), [R_39](#), [R_45](#), [R_61](#), [R_70](#), [R_90](#), [R_105](#), [R_108](#), [R_110](#), [R_123](#), [R_130](#), [R_131](#), [R_132](#), [R_136](#)).

$$\begin{aligned} \frac{d}{dt}x_2 = & v_{35} + v_{39} + v_{45} + v_{61} + v_{70} + v_{90} + v_{105} + v_{108} + v_{110} \\ & + v_{123} + v_{130} + v_{131} + v_{132} + v_{136} - v_{35} - v_{39} - v_{45} - v_{61} \\ & - v_{70} - v_{90} - v_{105} - v_{108} - v_{110} - v_{123} - v_{133} - v_{134} - v_{136} \end{aligned} \quad (393)$$

9.3 Species x_3

Name x_3

Initial concentration $10^{-7} \text{ mol} \cdot \text{l}^{-1}$

This species takes part in 20 reactions (as a reactant in [R_49](#), [R_116](#), [R_117](#), [R_118](#), [R_119](#), [R_121](#), [R_122](#), [R_127](#), [R_128](#), [R_129](#), [R_137](#) and as a product in [R_49](#), [R_116](#), [R_117](#), [R_118](#), [R_119](#), [R_121](#), [R_122](#), [R_126](#), [R_137](#)).

$$\begin{aligned} \frac{d}{dt}x_3 = & v_{49} + v_{116} + v_{117} + v_{118} + v_{119} + v_{121} + v_{122} + v_{126} + v_{137} - v_{49} \\ & - v_{116} - v_{117} - v_{118} - v_{119} - v_{121} - v_{122} - v_{127} - v_{128} - v_{129} - v_{137} \end{aligned} \quad (394)$$

9.4 Species x_4

Name x_4

Initial concentration $100000 \text{ mol} \cdot \text{l}^{-1}$

This species takes part in 27 reactions (as a reactant in [R_1](#), [R_4](#), [R_29](#), [R_34](#), [R_98](#), [R_112](#), [R_116](#), [R_120](#), [R_123](#), [R_124](#), [R_125](#), [R_126](#), [R_130](#), [R_131](#), [R_140](#) and as a product in [R_2](#), [R_5](#), [R_34](#), [R_98](#), [R_112](#), [R_116](#), [R_120](#), [R_121](#), [R_122](#), [R_130](#), [R_131](#), [R_140](#)).

$$\begin{aligned} \frac{d}{dt}x_4 = & v_2 + v_5 + v_{34} + v_{98} + v_{112} + v_{116} + 2 v_{120} + v_{121} + v_{122} + v_{130} \\ & + v_{131} + v_{140} - v_1 - v_4 - v_{29} - v_{34} - v_{98} - v_{112} - v_{116} \\ & - v_{120} - v_{123} - v_{124} - v_{125} - 25 v_{126} - v_{130} - v_{131} - v_{140} \end{aligned} \quad (395)$$

9.5 Species x_5

Name x_5

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

This species takes part in 19 reactions (as a reactant in [R_34](#), [R_117](#), [R_118](#), [R_119](#), [R_121](#), [R_122](#), [R_128](#), [R_130](#), [R_131](#), [R_140](#) and as a product in [R_34](#), [R_116](#), [R_117](#), [R_121](#), [R_122](#), [R_128](#), [R_130](#), [R_131](#), [R_140](#)).

$$\begin{aligned} \frac{d}{dt}x_5 = & v_{34} + v_{116} + 2 v_{117} + v_{121} + v_{122} + v_{128} + v_{130} + v_{131} + v_{140} - v_{34} \\ & - v_{117} - v_{118} - v_{119} - v_{121} - v_{122} - v_{128} - v_{130} - v_{131} - v_{140} \end{aligned} \quad (396)$$

9.6 Species x_6

Name x_6

Initial concentration $5 \cdot 10^7 \text{ mol} \cdot \text{l}^{-1}$

This species takes part in ten reactions (as a reactant in [R_98](#), [R_99](#), [R_114](#), [R_115](#), [R_125](#) and as a product in [R_99](#), [R_111](#), [R_112](#), [R_113](#), [R_125](#)).

$$\frac{d}{dt}x_6 = v_{99} + v_{111} + v_{112} + v_{113} + v_{125} - v_{98} - v_{99} - v_{114} - v_{115} - v_{125} \quad (397)$$

9.7 Species x_7

Name x_7

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

This species takes part in 14 reactions (as a reactant in [R_48](#), [R_53](#), [R_101](#), [R_103](#), [R_104](#), [R_105](#), [R_108](#), [R_109](#), [R_110](#) and as a product in [R_48](#), [R_53](#), [R_90](#), [R_105](#), [R_108](#)).

$$\begin{aligned} \frac{d}{dt}x_7 = & v_{48} + v_{53} + v_{90} + v_{105} + 2 v_{108} - v_{48} - v_{53} \\ & - v_{101} - v_{103} - v_{104} - v_{105} - v_{108} - v_{109} - v_{110} \end{aligned} \quad (398)$$

9.8 Species x_8

Name x_8

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

This species takes part in 18 reactions (as a reactant in [R_35](#), [R_46](#), [R_68](#), [R_106](#), [R_107](#), [R_119](#), [R_122](#), [R_129](#) and as a product in [R_35](#), [R_46](#), [R_68](#), [R_103](#), [R_104](#), [R_105](#), [R_106](#), [R_119](#), [R_122](#), [R_129](#)).

$$\begin{aligned} \frac{d}{dt}x_8 = & v_{35} + v_{46} + v_{68} + v_{103} + v_{104} + v_{105} + 2 v_{106} + v_{119} + v_{122} \\ & + v_{129} - v_{35} - v_{46} - v_{68} - v_{106} - v_{107} - v_{119} - v_{122} - v_{129} \end{aligned} \quad (399)$$

9.9 Species x_9

Name x_9

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

This species takes part in seven reactions (as a reactant in [R_47](#), [R_54](#), [R_88](#), [R_102](#) and as a product in [R_47](#), [R_54](#), [R_101](#)).

$$\frac{d}{dt}x_9 = v_{47} + v_{54} + v_{101} - v_{47} - v_{54} - v_{88} - v_{102} \quad (400)$$

9.10 Species x_10

Name x_10

Initial concentration 0 mol · l⁻¹

This species takes part in eleven reactions (as a reactant in [R_43](#), [R_75](#), [R_93](#), [R_96](#), [R_100](#) and as a product in [R_43](#), [R_75](#), [R_93](#), [R_96](#), [R_98](#), [R_99](#)).

$$\frac{d}{dt}x_{10} = v_{43} + v_{75} + v_{93} + v_{96} + v_{98} + v_{99} - v_{43} - v_{75} - v_{93} - v_{96} - v_{100} \quad (401)$$

9.11 Species x_11

Name x_11

Initial concentration 78431.3726 mol · l⁻¹

This species takes part in seven reactions (as a reactant in [R_74](#), [R_75](#), [R_92](#), [R_93](#), [R_97](#) and as a product in [R_95](#), [R_96](#)).

$$\frac{d}{dt}x_{11} = v_{95} + v_{96} - v_{74} - v_{75} - v_{92} - v_{93} - v_{97} \quad (402)$$

9.12 Species x_12

Name x_12

Initial concentration 1111.18351 mol · l⁻¹

This species takes part in five reactions (as a reactant in [R_89](#), [R_94](#) and as a product in [R_92](#), [R_93](#), [R_94](#)).

$$\frac{d}{dt}x_{12} = v_{92} + v_{93} + 2 v_{94} - v_{89} - v_{94} \quad (403)$$

9.13 Species x_13

Name x_13

Initial concentration 3000.49554 mol · l⁻¹

This species takes part in three reactions (as a reactant in [R_90](#), [R_91](#) and as a product in [R_89](#)).

$$\frac{d}{dt}x_{13} = v_{89} - v_{90} - v_{91} \quad (404)$$

9.14 Species x_{14}

Name x_{14}

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

This species takes part in two reactions (as a reactant in [R_86](#) and as a product in [R_88](#)).

$$\frac{d}{dt}x_{14} = v_{88} - v_{86} \quad (405)$$

9.15 Species x_{15}

Name x_{15}

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

This species takes part in two reactions (as a reactant in [R_87](#) and as a product in [R_86](#)).

$$\frac{d}{dt}x_{15} = v_{86} - v_{87} \quad (406)$$

9.16 Species x_{16}

Name x_{16}

Initial concentration $18750 \text{ mol} \cdot \text{l}^{-1}$

This species takes part in four reactions (as a reactant in [R_21](#), [R_26](#) and as a product in [R_24](#), [R_25](#)).

$$\frac{d}{dt}x_{16} = v_{24} + v_{25} - v_{21} - v_{26} \quad (407)$$

9.17 Species x_{17}

Name x_{17}

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

This species takes part in two reactions (as a reactant in [R_15](#) and as a product in [R_21](#)).

$$\frac{d}{dt}x_{17} = v_{21} - v_{15} \quad (408)$$

9.18 Species x_{18}

Name x_{18}

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

This species takes part in six reactions (as a reactant in [R_17](#), [R_18](#), [R_78](#) and as a product in [R_15](#), [R_16](#), [R_78](#)).

$$\frac{d}{dt}x_{18} = v_{15} + v_{16} + v_{78} - v_{17} - 0.5 v_{18} - v_{78} \quad (409)$$

9.19 Species x_{19}

Name x_{19}

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

This species takes part in two reactions (as a reactant in [R_25](#) and as a product in [R_18](#)).

$$\frac{d}{dt}x_{19} = 0.5 v_{18} - 2 v_{25} \quad (410)$$

9.20 Species x_{20}

Name x_{20}

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

This species takes part in eight reactions (as a reactant in [R_16](#), [R_79](#), [R_82](#), [R_84](#), [R_85](#) and as a product in [R_17](#), [R_79](#), [R_84](#)).

$$\frac{d}{dt}x_{20} = v_{17} + v_{79} + 2 v_{84} - v_{16} - v_{79} - 0.5 v_{82} - v_{84} - v_{85} \quad (411)$$

9.21 Species x_{21}

Name x_{21}

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

This species takes part in four reactions (as a reactant in [R_80](#), [R_83](#) and as a product in [R_80](#), [R_82](#)).

$$\frac{d}{dt}x_{21} = v_{80} + 0.5 v_{82} - v_{80} - v_{83} \quad (412)$$

9.22 Species x₂₂

Name x₂₂

Initial concentration 0 mol · l⁻¹

This species takes part in eight reactions (as a reactant in [R_10](#), [R_76](#), [R_81](#) and as a product in [R_11](#), [R_77](#), [R_78](#), [R_79](#), [R_80](#)).

$$\frac{d}{dt}x_{22} = v_{11} + v_{77} + 1000000 v_{78} + 1000000 v_{79} + 1000000 v_{80} - v_{10} - v_{76} - v_{81} \quad (413)$$

9.23 Species x₂₃

Name x₂₃

Initial concentration 0 mol · l⁻¹

This species takes part in four reactions (as a reactant in [R_4](#), [R_77](#) and as a product in [R_5](#), [R_76](#)).

$$\frac{d}{dt}x_{23} = v_5 + v_{76} - v_4 - v_{77} \quad (414)$$

9.24 Species x₂₄

Name x₂₄

Initial concentration 1111.11111 mol · l⁻¹

This species takes part in three reactions (as a reactant in [R_72](#) and as a product in [R_74](#), [R_75](#)).

$$\frac{d}{dt}x_{24} = v_{74} + v_{75} - v_{72} \quad (415)$$

9.25 Species x₂₅

Name x₂₅

Initial concentration 50000 mol · l⁻¹

This species takes part in three reactions (as a reactant in [R_70](#), [R_73](#) and as a product in [R_72](#)).

$$\frac{d}{dt}x_{25} = v_{72} - v_{70} - v_{73} \quad (416)$$

9.26 Species x_{26}

Name x_{26}

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

This species takes part in three reactions (as a reactant in [R_67](#), [R_71](#) and as a product in [R_70](#)).

$$\frac{d}{dt}x_{26} = v_{70} - v_{67} - v_{71} \quad (417)$$

9.27 Species x_{27}

Name x_{27}

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

This species takes part in six reactions (as a reactant in [R_62](#), [R_68](#), [R_69](#) and as a product in [R_62](#), [R_67](#), [R_68](#)).

$$\frac{d}{dt}x_{27} = v_{62} + v_{67} + 2 v_{68} - v_{62} - v_{68} - v_{69} \quad (418)$$

9.28 Species x_{28}

Name x_{28}

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

This species takes part in two reactions (as a reactant in [R_66](#) and as a product in [R_65](#)).

$$\frac{d}{dt}x_{28} = v_{65} - v_{66} \quad (419)$$

9.29 Species x_{29}

Name x_{29}

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

This species takes part in 20 reactions (as a reactant in [R_60](#), [R_61](#), [R_62](#), [R_67](#), [R_68](#), [R_99](#), [R_106](#), [R_113](#), [R_115](#), [R_132](#), [R_138](#) and as a product in [R_64](#), [R_67](#), [R_68](#), [R_99](#), [R_106](#), [R_113](#), [R_115](#), [R_132](#), [R_138](#)).

$$\begin{aligned} \frac{d}{dt}x_{29} = & v_{64} + v_{67} + v_{68} + v_{99} + v_{106} + v_{113} + v_{115} + v_{132} + v_{138} - v_{60} \\ & - v_{61} - v_{62} - v_{67} - v_{68} - v_{99} - v_{106} - v_{113} - v_{115} - v_{132} - v_{138} \end{aligned} \quad (420)$$

9.30 Species x_{30}

Name x_{30}

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

This species takes part in twelve reactions (as a reactant in [R_30](#), [R_63](#), [R_104](#), [R_105](#), [R_110](#) and as a product in [R_31](#), [R_60](#), [R_61](#), [R_62](#), [R_104](#), [R_105](#), [R_110](#)).

$$\begin{aligned} \frac{d}{dt}x_{30} = & v_{31} + v_{60} + v_{61} + v_{62} + v_{104} + v_{105} \\ & + v_{110} - v_{30} - v_{63} - v_{104} - v_{105} - v_{110} \end{aligned} \quad (421)$$

9.31 Species x_{31}

Name x_{31}

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

This species takes part in two reactions (as a reactant in [R_59](#) and as a product in [R_58](#)).

$$\frac{d}{dt}x_{31} = v_{58} - v_{59} \quad (422)$$

9.32 Species x_{32}

Name x_{32}

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

This species takes part in two reactions (as a reactant in [R_57](#) and as a product in [R_56](#)).

$$\frac{d}{dt}x_{32} = v_{56} - v_{57} \quad (423)$$

9.33 Species x_{33}

Name x_{33}

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

This species takes part in 13 reactions (as a reactant in [R_55](#), [R_101](#), [R_103](#), [R_130](#), [R_131](#), [R_140](#) and as a product in [R_53](#), [R_54](#), [R_101](#), [R_103](#), [R_130](#), [R_131](#), [R_140](#)).

$$\begin{aligned} \frac{d}{dt}x_{33} = & v_{53} + v_{54} + v_{101} + v_{103} + v_{130} + v_{131} + v_{140} \\ & - v_{55} - v_{101} - v_{103} - v_{130} - v_{131} - v_{140} \end{aligned} \quad (424)$$

9.34 Species x_{34}

Name x_{34}

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

This species takes part in two reactions (as a reactant in [R_52](#) and as a product in [R_51](#)).

$$\frac{d}{dt}x_{34} = v_{51} - v_{52} \quad (425)$$

9.35 Species x_{35}

Name x_{35}

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

This species takes part in eleven reactions (as a reactant in [R_45](#), [R_50](#), [R_103](#), [R_134](#) and as a product in [R_45](#), [R_46](#), [R_47](#), [R_48](#), [R_49](#), [R_103](#), [R_134](#)).

$$\frac{d}{dt}x_{35} = 2v_{45} + v_{46} + v_{47} + v_{48} + v_{49} + v_{103} + v_{134} - v_{45} - v_{50} - v_{103} - v_{134} \quad (426)$$

9.36 Species x_{36}

Name x_{36}

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

This species takes part in four reactions (as a reactant in [R_44](#), [R_103](#) and as a product in [R_43](#), [R_103](#)).

$$\frac{d}{dt}x_{36} = v_{43} + v_{103} - v_{44} - v_{103} \quad (427)$$

9.37 Species x_{37}

Name x_{37}

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

This species takes part in two reactions (as a reactant in [R_42](#) and as a product in [R_41](#)).

$$\frac{d}{dt}x_{37} = v_{41} - v_{42} \quad (428)$$

9.38 Species x_{38}

Name x_{38}

Initial concentration $275 \text{ mol} \cdot \text{l}^{-1}$

This species takes part in eight reactions (as a reactant in [R_34](#), [R_40](#), [R_103](#) and as a product in [R_34](#), [R_37](#), [R_38](#), [R_39](#), [R_103](#)).

$$\frac{d}{dt}x_{38} = v_{34} + v_{37} + v_{38} + v_{39} + v_{103} - v_{34} - v_{40} - v_{103} \quad (429)$$

9.39 Species x_{39}

Name x_{39}

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

This species takes part in 13 reactions (as a reactant in [R_36](#), [R_45](#), [R_101](#), [R_130](#), [R_131](#), [R_140](#) and as a product in [R_34](#), [R_35](#), [R_45](#), [R_101](#), [R_130](#), [R_131](#), [R_140](#)).

$$\begin{aligned} \frac{d}{dt}x_{39} = & v_{34} + v_{35} + v_{45} + v_{101} + v_{130} + v_{131} + v_{140} \\ & - v_{36} - v_{45} - v_{101} - v_{130} - v_{131} - v_{140} \end{aligned} \quad (430)$$

9.40 Species x_{40}

Name x_{40}

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

This species takes part in two reactions (as a reactant in [R_33](#) and as a product in [R_32](#)).

$$\frac{d}{dt}x_{40} = v_{32} - v_{33} \quad (431)$$

9.41 Species x_{41}

Name x_{41}

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

This species takes part in eleven reactions (as a reactant in [R_7](#), [R_10](#), [R_13](#), [R_27](#), [R_31](#) and as a product in [R_8](#), [R_11](#), [R_14](#), [R_28](#), [R_29](#), [R_30](#)).

$$\frac{d}{dt}x_{41} = v_8 + v_{11} + v_{14} + v_{28} + v_{29} + v_{30} - v_7 - v_{10} - v_{13} - v_{27} - v_{31} \quad (432)$$

9.42 Species x_42

Name x_42

Initial concentration 0 mol · l⁻¹

This species takes part in six reactions (as a reactant in R_19, R_22, R_28 and as a product in R_20, R_23, R_27).

$$\frac{d}{dt}x_{42} = v_{20} + v_{23} + v_{27} - v_{19} - v_{22} - v_{28} \quad (433)$$

9.43 Species x_43

Name x_43

Initial concentration 1.875 · 10⁷ mol · l⁻¹

This species takes part in six reactions (as a reactant in R_21, R_22, R_26 and as a product in R_23, R_24, R_25).

$$\frac{d}{dt}x_{43} = v_{23} + 1000 v_{24} + 1000 v_{25} - 1000 v_{21} - v_{22} - 1000 v_{26} \quad (434)$$

9.44 Species x_44

Name x_44

Initial concentration 0 mol · l⁻¹

This species takes part in six reactions (as a reactant in R_21, R_23, R_26 and as a product in R_21, R_22, R_26).

$$\frac{d}{dt}x_{44} = v_{21} + v_{22} + v_{26} - v_{21} - v_{23} - v_{26} \quad (435)$$

9.45 Species x_45

Name x_45

Initial concentration 0 mol · l⁻¹

This species takes part in four reactions (as a reactant in R_15, R_19 and as a product in R_20, R_21).

$$\frac{d}{dt}x_{45} = v_{20} + 1000 v_{21} - 1000 v_{15} - v_{19} \quad (436)$$

9.46 Species x_46

Name x_46

Initial concentration 0 mol · l⁻¹

This species takes part in two reactions (as a reactant in R_20 and as a product in R_19).

$$\frac{d}{dt}x_{46} = v_{19} - v_{20} \quad (437)$$

9.47 Species x_47

Name x_47

Initial concentration 0 mol · l⁻¹

This species takes part in ten reactions (as a reactant in R_13, R_17, R_18, R_82, R_84 and as a product in R_14, R_15, R_16, R_82, R_84).

$$\begin{aligned} \frac{d}{dt}x_{47} = & v_{14} + 1000 v_{15} + 1000 v_{16} + v_{82} + v_{84} \\ & - v_{13} - 1000 v_{17} - 500 v_{18} - v_{82} - v_{84} \end{aligned} \quad (438)$$

9.48 Species x_48

Name x_48

Initial concentration 0 mol · l⁻¹

This species takes part in eight reactions (as a reactant in R_14, R_18, R_82, R_84 and as a product in R_13, R_18, R_82, R_84).

$$\frac{d}{dt}x_{48} = v_{13} + v_{18} + v_{82} + v_{84} - v_{14} - v_{18} - v_{82} - v_{84} \quad (439)$$

9.49 Species x_49

Name x_49

Initial concentration 0 mol · l⁻¹

This species takes part in five reactions (as a reactant in R_7, R_11, R_12 and as a product in R_8, R_10).

$$\frac{d}{dt}x_{49} = v_8 + v_{10} - v_7 - v_{11} - v_{12} \quad (440)$$

9.50 Species x_50

Name x_50

Initial concentration 0 mol · l⁻¹

This species takes part in three reactions (as a reactant in R_8, R_9 and as a product in R_7).

$$\frac{d}{dt}x_{50} = v_7 - v_8 - v_9 \quad (441)$$

9.51 Species x_51

Name x_51

Initial concentration 0 mol · l⁻¹

This species takes part in five reactions (as a reactant in R_1, R_5, R_6 and as a product in R_2, R_4).

$$\frac{d}{dt}x_{51} = v_2 + v_4 - v_1 - v_5 - v_6 \quad (442)$$

9.52 Species x_52

Name x_52

Initial concentration 0 mol · l⁻¹

This species takes part in three reactions (as a reactant in R_2, R_3 and as a product in R_1).

$$\frac{d}{dt}x_{52} = v_1 - v_2 - v_3 \quad (443)$$

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