

SBML Model Report

**Model name: “Markevich2004_MAPK-
_AllRandomElementary”**



May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by Nicolas Le Novre¹ at May 26th 2005 at 8:51 a. m. and last time modified at May 15th 2012 at 9:43 p. m. Table 1 gives an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	18
events	0	constraints	0
reactions	20	function definitions	0
global parameters	32	unit definitions	1
rules	0	initial assignments	0

Model Notes

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To cite BioModels Database, please use [Le Novre N., Bornstein B., Broicher A., Courtot M., Donizelli M., Dharuri H., Li L., Sauro H., Schilstra M., Shapiro B., Snoep J.L., Hucka M. \(2006\)](#)

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BioModels Database: A Free, Centralized Database of Curated, Published, Quantitative Kinetic Models of Biochemical and Cellular Systems *Nucleic Acids Res.*, 34: D689-D691.

2 Unit Definitions

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

2.1 Unit `substance`

Name nanomole (default)

Definition nmol

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
cell	cell		3	1	litre	<input checked="" type="checkbox"/>	

3.1 Compartment `cell`

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

Name `cell`

4 Species

This model contains 18 species. Section 7 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
M	MAPK	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpY	MAPK-PY	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpT	MAPK-PT	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
Mpp	MAPK-PP	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MAPKK	MAPKK	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MKP	MKP	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpY_MAPKK	MAPK-PY_MAPKK	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpT_MAPKK	MAPK-PT_MAPKK	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
M_MAPKK_Y	MAPK_MAPKK_Y	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
M_MAPKK_T	MAPK_MAPKK_T	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
Mpp_MKP_Y	MAPK-PP_MKP_T	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
Mpp_MKP_T	MAPK-PP_MKP_Y	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpY_MKP_Y	MAPK-PY_MKP_Y	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpY_MKP_T	MAPK-PY_MKP_T	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpT_MKP_Y	MAPK-PT_MKP_Y	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
MpT_MKP_T	MAPK-PT_MKP_T	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
M_MKP_T	MAPK_MKP_T	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square
M_MKP_Y	MAPK_MKP_Y	cell	$\text{nmol} \cdot \text{l}^{-1}$	\square	\square

5 Parameters

This model contains 32 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.020		<input checked="" type="checkbox"/>
k_1	k_1		1.000		<input checked="" type="checkbox"/>
k2	k2		0.010		<input checked="" type="checkbox"/>
k3	k3		0.032		<input checked="" type="checkbox"/>
k_3	k_3		1.000		<input checked="" type="checkbox"/>
k4	k4		15.000		<input checked="" type="checkbox"/>
k5	k5		0.020		<input checked="" type="checkbox"/>
k_5	k_5		1.000		<input checked="" type="checkbox"/>
k6	k6		0.010		<input checked="" type="checkbox"/>
k7	k7		0.032		<input checked="" type="checkbox"/>
k_7	k_7		1.000		<input checked="" type="checkbox"/>
k8	k8		15.000		<input checked="" type="checkbox"/>
h1	h1		0.045		<input checked="" type="checkbox"/>
h_1	h_1		1.000		<input checked="" type="checkbox"/>
h2	h2		0.092		<input checked="" type="checkbox"/>
h3	h3		1.000		<input checked="" type="checkbox"/>
h_3	h_3		0.010		<input checked="" type="checkbox"/>
h4	h4		0.010		<input checked="" type="checkbox"/>
h_4	h_4		1.000		<input checked="" type="checkbox"/>
h5	h5		0.500		<input checked="" type="checkbox"/>
h6	h6		0.086		<input checked="" type="checkbox"/>
h_6	h_6		0.001		<input checked="" type="checkbox"/>
h7	h7		0.010		<input checked="" type="checkbox"/>
h_7	h_7		1.000		<input checked="" type="checkbox"/>
h8	h8		0.470		<input checked="" type="checkbox"/>
h9	h9		0.140		<input checked="" type="checkbox"/>
h_9	h_9		0.002		<input checked="" type="checkbox"/>
h10	h10		0.045		<input checked="" type="checkbox"/>
h_10	h_10		1.000		<input checked="" type="checkbox"/>
h11	h11		0.092		<input checked="" type="checkbox"/>
h12	h12		1.000		<input checked="" type="checkbox"/>
h_12	h_12		0.010		<input checked="" type="checkbox"/>

6 Reactions

This model contains 20 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

Nº	Id	Name	Reaction Equation	SBO
1	reaction- _0000001	binding MAPKK on Tyr site of MAPK	$M + \text{MAPKK} \rightleftharpoons M_MAPKK_Y$	
2	reaction- _0000002	tyr phosphorylation of MAPK	$M_MAPKK_Y \longrightarrow \text{MpY} + \text{MAPKK}$	
3	reaction- _0000003	binding of MAPKK on MAPK-PY	$\text{MpY} + \text{MAPKK} \rightleftharpoons \text{MpY_MAPKK}$	
4	reaction- _0000004	thr phosphorylation of MAPK	$\text{MpY_MAPKK} \longrightarrow \text{Mpp} + \text{MAPKK}$	
5	reaction- _0000005	binding of MAPKK on Thr site of MAPK	$M + \text{MAPKK} \rightleftharpoons M_MAPKK_T$	
6	reaction- _0000006	thr phosphorylation of MAPK	$M_MAPKK_T \longrightarrow \text{MpT} + \text{MAPKK}$	
7	reaction- _0000007	binding MAPK-PT and MAPKK	$\text{MpT} + \text{MAPKK} \rightleftharpoons \text{MpT_MAPKK}$	
8	reaction- _0000008	tyr phosphorylation of MAPK	$\text{MpT_MAPKK} \longrightarrow \text{Mpp} + \text{MAPKK}$	
9	reaction- _0000009	binding of MKP on Tyr site of MAPK-PP	$\text{Mpp} + \text{MKP} \rightleftharpoons \text{Mpp_MKP_Y}$	
10	reaction- _0000010	dephosphorylation of Tyr on MAPKK-PP	$\text{Mpp_MKP_Y} \longrightarrow \text{MpT_MKP_Y}$	
11	reaction- _0000011	dissociation MAPK-PT and MKP	$\text{MpT_MKP_Y} \rightleftharpoons \text{MpT} + \text{MKP}$	

Nº	Id	Name	Reaction Equation	SBO
12	reaction- _0000013	binding of MKP on Thr site of MAPK-PT	$\text{MpT} + \text{MKP} \rightleftharpoons \text{MpT_MKP_T}$	
13	reaction- _0000012	dephosphorylation of MAPK-PT	$\text{MpT_MKP_T} \longrightarrow \text{M_MKP_T}$	
14	reaction- _0000015	dissociation MAPK and MKP	$\text{M_MKP_T} \rightleftharpoons \text{M} + \text{MKP}$	
15	reaction- _0000017	binding of MKP on the Tyr site of MAPK-PY	$\text{MpY} + \text{MKP} \rightleftharpoons \text{MpY_MKP_Y}$	
16	reaction- _0000014	dephosphorylation of MAPK-PY	$\text{MpY_MKP_Y} \longrightarrow \text{M_MKP_Y}$	
17	reaction- _0000019	Dissociation MAPK and MKP	$\text{M_MKP_Y} \rightleftharpoons \text{M} + \text{MKP}$	
18	reaction- _0000020	binding of MKP on Thr site of MAPK-PP	$\text{Mpp} + \text{MKP} \rightleftharpoons \text{Mpp_MKP_T}$	
19	reaction- _0000021	dephosphorylation of Thr on MAPKK-PP	$\text{Mpp_MKP_T} \longrightarrow \text{MpY_MKP_T}$	
20	reaction- _0000022	dissociation MAPK-PY and MKP	$\text{MpY_MKP_T} \rightleftharpoons \text{MpY} + \text{MKP}$	

6.1 Reaction [reaction_0000001](#)

This is a reversible reaction of two reactants forming one product.

Name binding MAPKK on Tyr site of MAPK

Reaction equation



Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
M	MAPK	
MAPKK	MAPKK	

Product

Table 7: Properties of each product.

Id	Name	SBO
M_MAPKK_Y	MAPK_MAPKK_Y	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{vol}(\text{cell}) \cdot (k_1 \cdot [M] \cdot [\text{MAPKK}] - k_{-1} \cdot [M_MAPKK_Y]) \quad (2)$$

6.2 Reaction [reaction_0000002](#)

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

Name tyr phosphorylation of MAPK

Reaction equation



Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
M_MAPKK_Y	MAPK_MAPKK_Y	

Products

Table 9: Properties of each product.

Id	Name	SBO
MpY	MAPK-PY	
MAPKK	MAPKK	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{vol}(\text{cell}) \cdot k_2 \cdot [\text{M_MAPKK_Y}] \quad (4)$$

6.3 Reaction `reaction_0000003`

This is a reversible reaction of two reactants forming one product.

Name binding of MAPKK on MAPK-PY

Reaction equation



Reactants

Table 10: Properties of each reactant.

Id	Name	SBO
MpY	MAPK-PY	
MAPKK	MAPKK	

Product

Table 11: Properties of each product.

Id	Name	SBO
MpY_MAPKK	MAPK-PY_MAPKK	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{vol}(\text{cell}) \cdot (k_3 \cdot [\text{MpY}] \cdot [\text{MAPKK}] - k_{-3} \cdot [\text{MpY_MAPKK}]) \quad (6)$$

6.4 Reaction `reaction_0000004`

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

Name thr phosphorylation of MAPK

Reaction equation



Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
MpY_MAPKK	MAPK-PY_MAPKK	

Products

Table 13: Properties of each product.

Id	Name	SBO
Mpp	MAPK-PP	
MAPKK	MAPKK	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{vol}(\text{cell}) \cdot k_4 \cdot [\text{MpY_MAPKK}] \quad (8)$$

6.5 Reaction [reaction_0000005](#)

This is a reversible reaction of two reactants forming one product.

Name binding of MAPKK on Thr site of MAPK

Reaction equation



Reactants

Table 14: Properties of each reactant.

Id	Name	SBO
M	MAPK	
MAPKK	MAPKK	

Product

Table 15: Properties of each product.

Id	Name	SBO
M_MAPKK_T	MAPK_MAPKK_T	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{vol}(\text{cell}) \cdot (k_5 \cdot [M] \cdot [\text{MAPKK}] - k_{-5} \cdot [M_MAPKK_T]) \quad (10)$$

6.6 Reaction [reaction_0000006](#)

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

Name thr phosphorylation of MAPK

Reaction equation



Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
M_MAPKK_T	MAPK_MAPKK_T	

Products

Table 17: Properties of each product.

Id	Name	SBO
MpT	MAPK-PT	
MAPKK	MAPKK	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \text{vol}(\text{cell}) \cdot k_6 \cdot [\text{M_MAPKK_T}] \quad (12)$$

6.7 Reaction `reaction_0000007`

This is a reversible reaction of two reactants forming one product.

Name binding MAPK-PT and MAPKK

Reaction equation



Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
MpT	MAPK-PT	
MAPKK	MAPKK	

Product

Table 19: Properties of each product.

Id	Name	SBO
MpT_MAPKK	MAPK-PT_MAPKK	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \text{vol}(\text{cell}) \cdot (k_7 \cdot [\text{MpT}] \cdot [\text{MAPKK}] - k_{-7} \cdot [\text{MpT_MAPKK}]) \quad (14)$$

6.8 Reaction reaction_0000008

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

Name tyr phosphorylation of MAPK

Reaction equation



Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
MpT_MAPKK	MAPK-PT_MAPKK	

Products

Table 21: Properties of each product.

Id	Name	SBO
Mpp	MAPK-PP	
MAPKK	MAPKK	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{vol}(\text{cell}) \cdot k_8 \cdot [\text{MpT_MAPKK}] \quad (16)$$

6.9 Reaction [reaction_0000009](#)

This is a reversible reaction of two reactants forming one product.

Name binding of MKP on Tyr site of MAPK-PP

Reaction equation



Reactants

Table 22: Properties of each reactant.

Id	Name	SBO
Mpp	MAPK-PP	
MKP	MKP	

Product

Table 23: Properties of each product.

Id	Name	SBO
Mpp_MKP_Y	MAPK-PP_MKP_T	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{vol}(\text{cell}) \cdot (h_1 \cdot [\text{Mpp}] \cdot [\text{MKP}] - h_{-1} \cdot [\text{Mpp_MKP_Y}]) \quad (18)$$

6.10 Reaction [reaction_0000010](#)

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

Name dephosphorylation of Tyr on MAPKK-PP

Reaction equation



Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
Mpp_MKP_Y	MAPK-PP_MKP_T	

Product

Table 25: Properties of each product.

Id	Name	SBO
MpT_MKP_Y	MAPK-PT_MKP_Y	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{vol}(\text{cell}) \cdot h_2 \cdot [\text{Mpp_MKP_Y}] \quad (20)$$

6.11 Reaction `reaction_0000011`

This is a reversible reaction of one reactant forming two products.

Name dissociation MAPK-PT and MKP

Reaction equation



Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
MpT_MKP_Y	MAPK-PT_MKP_Y	

Products

Table 27: Properties of each product.

Id	Name	SBO
MpT	MAPK-PT	
MKP	MKP	

Id	Name	SBO
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Kinetic Law

Derived unit contains undeclared units

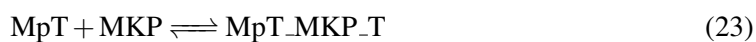
$$v_{11} = \text{vol}(\text{cell}) \cdot (h_3 \cdot [\text{MpT_MKP_Y}] - h_{-3} \cdot [\text{MpT}] \cdot [\text{MKP}]) \quad (22)$$

6.12 Reaction [reaction_0000013](#)

This is a reversible reaction of two reactants forming one product.

Name binding of MKP on Thr site of MAPK-PT

Reaction equation



Reactants

Table 28: Properties of each reactant.

Id	Name	SBO
MpT	MAPK-PT	
MKP	MKP	

Product

Table 29: Properties of each product.

Id	Name	SBO
MpT_MKP_T	MAPK-PT_MKP_T	

Kinetic Law

Derived unit contains undeclared units

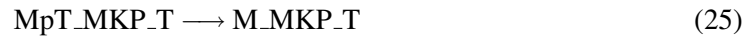
$$v_{12} = \text{vol}(\text{cell}) \cdot (h_4 \cdot [\text{MpT}] \cdot [\text{MKP}] - h_{-4} \cdot [\text{MpT_MKP_T}]) \quad (24)$$

6.13 Reaction [reaction_0000012](#)

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

Name dephosphorylation of MAPK-PT

Reaction equation



Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
MpT_MKP_T	MAPK-PT_MKP_T	

Product

Table 31: Properties of each product.

Id	Name	SBO
M_MKP_T	MAPK_MKP_T	

Kinetic Law

Derived unit contains undeclared units

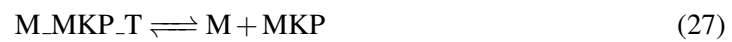
$$v_{13} = \text{vol}(\text{cell}) \cdot h5 \cdot [\text{MpT_MKP_T}] \quad (26)$$

6.14 Reaction [reaction_0000015](#)

This is a reversible reaction of one reactant forming two products.

Name dissociation MAPK and MKP

Reaction equation



Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
M_MKP_T	MAPK_MKP_T	

Products

Table 33: Properties of each product.

Id	Name	SBO
M	MAPK	
MKP	MKP	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{vol}(\text{cell}) \cdot (h_6 \cdot [\text{M_MKP_T}] - h_{-6} \cdot [\text{M}] \cdot [\text{MKP}]) \quad (28)$$

6.15 Reaction [reaction_0000017](#)

This is a reversible reaction of two reactants forming one product.

Name binding of MKP on the Tyr site of MAPK-PY

Reaction equation



Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
MpY	MAPK-PY	
MKP	MKP	

Product

Table 35: Properties of each product.

Id	Name	SBO
MpY_MKP_Y	MAPK-PY_MKP_Y	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{vol}(\text{cell}) \cdot (h_7 \cdot [\text{MpY}] \cdot [\text{MKP}] - h_{-7} \cdot [\text{MpY_MKP_Y}]) \quad (30)$$

6.16 Reaction [reaction_0000014](#)

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

Name dephosphorylation of MAPK-PY

Reaction equation



Reactant

Table 36: Properties of each reactant.

Id	Name	SBO
MpY_MKP_Y	MAPK-PY_MKP_Y	

Product

Table 37: Properties of each product.

Id	Name	SBO
M_MKP_Y	MAPK_MKP_Y	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{vol}(\text{cell}) \cdot h_8 \cdot [\text{MpY_MKP_Y}] \quad (32)$$

6.17 Reaction [reaction_0000019](#)

This is a reversible reaction of one reactant forming two products.

Name Dissociation MAPK and MKP

Reaction equation



Reactant

Table 38: Properties of each reactant.

Id	Name	SBO
M_MKP_Y	MAPK_MKP_Y	

Products

Table 39: Properties of each product.

Id	Name	SBO
M	MAPK	
MKP	MKP	

Kinetic Law

Derived unit contains undeclared units

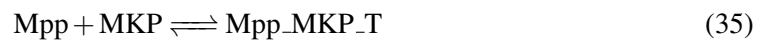
$$v_{17} = \text{vol}(\text{cell}) \cdot (h_9 \cdot [\text{M_MKP_Y}] - h_{-9} \cdot [\text{M}] \cdot [\text{MKP}]) \quad (34)$$

6.18 Reaction `reaction_0000020`

This is a reversible reaction of two reactants forming one product.

Name binding of MKP on Thr site of MAPK-PP

Reaction equation



Reactants

Table 40: Properties of each reactant.

Id	Name	SBO
Mpp	MAPK-PP	
MKP	MKP	

Product

Table 41: Properties of each product.

Id	Name	SBO
Mpp_MKP_T	MAPK-PP_MKP_Y	

Kinetic Law**Derived unit** contains undeclared units

$$v_{18} = \text{vol}(\text{cell}) \cdot (h_{10} \cdot [\text{Mpp}] \cdot [\text{MKP}] - h_{10} \cdot [\text{Mpp_MKP_T}]) \quad (36)$$

6.19 Reaction `reaction_0000021`

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

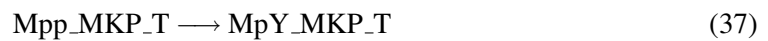
Name dephosphorylation of Thr on MAPKK-PP**Reaction equation****Reactant**

Table 42: Properties of each reactant.

Id	Name	SBO
Mpp_MKP_T	MAPK-PP_MKP_Y	

Product

Table 43: Properties of each product.

Id	Name	SBO
MpY_MKP_T	MAPK-PY_MKP_T	

Kinetic Law**Derived unit** contains undeclared units

$$v_{19} = \text{vol}(\text{cell}) \cdot h_{11} \cdot [\text{Mpp_MKP_T}] \quad (38)$$

6.20 Reaction `reaction_0000022`

This is a reversible reaction of one reactant forming two products.

Name dissociation MAPK-PY and MKP

Reaction equation



Reactant

Table 44: Properties of each reactant.

Id	Name	SBO
MpY_MKP_T	MAPK-PY_MKP_T	

Products

Table 45: Properties of each product.

Id	Name	SBO
MpY	MAPK-PY	
MKP	MKP	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{vol}(\text{cell}) \cdot (h_{12} \cdot [\text{MpY_MKP_T}] - h_{12} \cdot [\text{MpY}] \cdot [\text{MKP}]) \quad (40)$$

7 Derived Rate Equations

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

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

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

7.1 Species M

Name MAPK

Initial concentration $800 \text{ nmol} \cdot \text{l}^{-1}$

This species takes part in four reactions (as a reactant in [reaction_0000001](#), [reaction_0000005](#) and as a product in [reaction_0000015](#), [reaction_0000019](#)).

$$\frac{d}{dt}M = v_{14} + v_{17} - v_1 - v_5 \quad (41)$$

7.2 Species MpY

Name MAPK-PY

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

This species takes part in four reactions (as a reactant in [reaction_0000003](#), [reaction_0000017](#) and as a product in [reaction_0000002](#), [reaction_0000022](#)).

$$\frac{d}{dt}MpY = v_2 + v_{20} - v_3 - v_{15} \quad (42)$$

7.3 Species MpT

Name MAPK-PT

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

This species takes part in four reactions (as a reactant in [reaction_0000007](#), [reaction_0000013](#) and as a product in [reaction_0000006](#), [reaction_0000011](#)).

$$\frac{d}{dt}MpT = v_6 + v_{11} - v_7 - v_{12} \quad (43)$$

7.4 Species Mpp

Name MAPK-PP

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

This species takes part in four reactions (as a reactant in [reaction_0000009](#), [reaction_0000020](#) and as a product in [reaction_0000004](#), [reaction_0000008](#)).

$$\frac{d}{dt}Mpp = v_4 + v_8 - v_9 - v_{18} \quad (44)$$

7.5 Species MAPKK

Name MAPKK

Initial concentration 180 nmol · l⁻¹

This species takes part in eight reactions (as a reactant in [reaction_0000001](#), [reaction_0000003](#), [reaction_0000005](#), [reaction_0000007](#) and as a product in [reaction_0000002](#), [reaction_0000004](#), [reaction_0000006](#), [reaction_0000008](#)).

$$\frac{d}{dt}\text{MAPKK} = v_2 + v_4 + v_6 + v_8 - v_1 - v_3 - v_5 - v_7 \quad (45)$$

7.6 Species MKP

Name MKP

Initial concentration 100 nmol · l⁻¹

This species takes part in eight reactions (as a reactant in [reaction_0000009](#), [reaction_0000013](#), [reaction_0000017](#), [reaction_0000020](#) and as a product in [reaction_0000011](#), [reaction_0000015](#), [reaction_0000019](#), [reaction_0000022](#)).

$$\frac{d}{dt}\text{MKP} = v_{11} + v_{14} + v_{17} + v_{20} - v_9 - v_{12} - v_{15} - v_{18} \quad (46)$$

7.7 Species MpY_MAPKK

Name MAPK-PY_MAPKK

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000004](#) and as a product in [reaction_0000003](#)).

$$\frac{d}{dt}\text{MpY_MAPKK} = v_3 - v_4 \quad (47)$$

7.8 Species MpT_MAPKK

Name MAPK-PT_MAPKK

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000008](#) and as a product in [reaction_0000007](#)).

$$\frac{d}{dt}\text{MpT_MAPKK} = v_7 - v_8 \quad (48)$$

7.9 Species M_MAPKK_Y

Name MAPK_MAPKK_Y

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

This species takes part in two reactions (as a reactant in [reaction_0000002](#) and as a product in [reaction_0000001](#)).

$$\frac{d}{dt}M_MAPKK_Y = v_1 - v_2 \quad (49)$$

7.10 Species M_MAPKK_T

Name MAPK_MAPKK_T

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

This species takes part in two reactions (as a reactant in [reaction_0000006](#) and as a product in [reaction_0000005](#)).

$$\frac{d}{dt}M_MAPKK_T = v_5 - v_6 \quad (50)$$

7.11 Species Mpp_MKP_Y

Name MAPK-PP_MKP_T

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

This species takes part in two reactions (as a reactant in [reaction_0000010](#) and as a product in [reaction_0000009](#)).

$$\frac{d}{dt}Mpp_MKP_Y = v_9 - v_{10} \quad (51)$$

7.12 Species Mpp_MKP_T

Name MAPK-PP_MKP_Y

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

This species takes part in two reactions (as a reactant in [reaction_0000021](#) and as a product in [reaction_0000020](#)).

$$\frac{d}{dt}Mpp_MKP_T = v_{18} - v_{19} \quad (52)$$

7.13 Species MpY_MKP_Y

Name MAPK-PY_MKP_Y

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000014](#) and as a product in [reaction_0000017](#)).

$$\frac{d}{dt}\text{MpY_MKP_Y} = v_{15} - v_{16} \quad (53)$$

7.14 Species MpY_MKP_T

Name MAPK-PY_MKP_T

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000022](#) and as a product in [reaction_0000021](#)).

$$\frac{d}{dt}\text{MpY_MKP_T} = v_{19} - v_{20} \quad (54)$$

7.15 Species MpT_MKP_Y

Name MAPK-PT_MKP_Y

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000011](#) and as a product in [reaction_0000010](#)).

$$\frac{d}{dt}\text{MpT_MKP_Y} = v_{10} - v_{11} \quad (55)$$

7.16 Species MpT_MKP_T

Name MAPK-PT_MKP_T

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000012](#) and as a product in [reaction_0000013](#)).

$$\frac{d}{dt}\text{MpT_MKP_T} = v_{12} - v_{13} \quad (56)$$

7.17 Species M_MKP_T

Name MAPK_MKP_T

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000015](#) and as a product in [reaction_0000012](#)).

$$\frac{d}{dt}M_MKP_T = v_{13} - v_{14} \quad (57)$$

7.18 Species M_MKP_Y

Name MAPK_MKP_Y

Initial concentration 0 nmol · l⁻¹

This species takes part in two reactions (as a reactant in [reaction_0000019](#) and as a product in [reaction_0000014](#)).

$$\frac{d}{dt}M_MKP_Y = v_{16} - v_{17} \quad (58)$$

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