SBML Model Report

Model name: "Ihekwaba2004_NFkB_Sensitivity"

May 5, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Adaoha EC Ihekwaba[2] at August 19th 2009 at 1:05 p. m. and last time modified at May 28th 2014 at one o' clock in the morning. 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	26
events	0	constraints	0
reactions	64	function definitions	0
global parameters	64	unit definitions	0
rules	0	initial assignments	0

Model Notes

This a model from the article:
Sensitivity analysis of parameters controlling oscillatory signalling in the NF-kappaB pathway: the roles of IKK and IkappaBalpha.

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Ihekwaba AE, Broomhead DS, Grimley RL, Benson N, Kell DB Syst Biol (Stevenage) [2004 Jun;1(1):93-103 17052119 ,

Abstract:
Analysis of cellular signalling interactions is expected to create an enormous informatics challenge, perhaps even greater than that of analysing the genome. A key step in the evolution towards a more quantitative understanding of signalling is to specify explicitly the kinetics of all chemical reaction steps in a pathway. We have reconstructed a model of the nuclear factor, kappaB (NF-kappaB) signalling pathway, containing 64 parameters and 26 variables, including steps in which the activation of the NF-kappaB transcription factor is intimately associated with the phosphorylation and ubiquitination of its inhibitor kappaB by a membrane-associated kinase, and its translocation from the cytoplasm to the nucleus. We apply sensitivity analysis to the model. This identifies those parameters in this (IkappaB)/NF-kappaB signalling system (containing only induced IkappaBalpha isoform) that most affect the oscillatory concentration of nuclear NF-kappaB (in terms of both period and amplitude). The intention is to provide guidance on which proteins are likely to be most significant as drug targets or should be exploited for further, more detailed experiments. The sensitivity coefficients were found to be strongly dependent upon the magnitude of the parameter change studied, indicating the highly non-linear nature of the system. Of the 64 parameters in the model, only eight to nine exerted a major control on nuclear NF-kappaB oscillations, and each of these involved as reaction participants either the IkappaB kinase (IKK) or IkappaBalpha, directly. This means that the dominant dynamics of the pathway can be reflected, in addition to that of nuclear NF-kappaB itself, by just two of the other pathway variables. This is conveniently observed in a phase-plane plot.

2 Unit Definitions

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

2.1 Unit `substance`

Notes Mole is the predefined SBML unit for `substance`.

Definition mol

2.2 Unit volume

Notes Litre is the predefined SBML unit for volume.

Definition l

2.3 Unit area

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

Definition m^2

2.4 Unit length

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

Definition m

2.5 Unit time

Notes Second is the predefined SBML unit for time.

Definition s

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
compartment	compartment		3	1	litre	☑	

3.1 Compartment compartment

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

Name compartment

4 Species

This model contains 26 species. The boundary condition of two of these species is set to `true` so that these species' amount cannot be changed by any reaction. Section 7 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
NFkB	NFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKKIkBa	IKKIkBa	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKKIkBaNFkB	IKKIkBaNFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKK	IKK	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBa	IkBa	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKKIkBb	IKKIkBb	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKKIkBbNFkB	IKKIkBbNFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBb	IkBb	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKKIkBe	IKKIkBe	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IKKIkBeNFkB	IKKIkBeNFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBe	IkBe	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBaNFkB	IkBaNFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBbNFkB	IkBbNFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBeNFkB	IkBeNFkB	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
source	source	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑	☑
IkBat	IkBat	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
sink	sink	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑	☑
NFkBn	NFkBn	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBan	IkBan	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBanNFkBn	IkBanNFkBn	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBbn	IkBbn	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
IkBbnNFkBn	IkBbnNFkBn	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBbt	IkBbt	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBen	IkBen	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBenNFkBn	IkBenNFkBn	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
IkBet	IkBet	compartment	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 64 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.500		☑
k2	k2		$5 \cdot 10^{-4}$		☑
k3	k3		0.500		☑
k4	k4		$5 \cdot 10^{-4}$		☑
k5	k5		0.500		☑
k6	k6		$5 \cdot 10^{-4}$		☑
k7	k7		0.500		☑
k8	k8		$5 \cdot 10^{-4}$		☑
k9	k9		0.020		☑
k10	k10		0.500		☑
k11	k11		$5 \cdot 10^{-4}$		☑
k12	k12		0.008		☑
k13	k13		0.500		☑
k14	k14		$5 \cdot 10^{-4}$		☑
k15	k15		0.011		☑
k16	k16		$2.25 \cdot 10^{-5}$		☑
k17	k17		$2.25 \cdot 10^{-5}$		☑
k18	k18		$2.25 \cdot 10^{-5}$		☑
k19	k19		0.090		☑
k20	k20		$8 \cdot 10^{-5}$		☑
k21	k21		0.500		☑
k22	k22		$5 \cdot 10^{-4}$		☑
k23	k23		0.500		☑
k24	k24		$5 \cdot 10^{-4}$		☑
k25	k25		0.500		☑
k26	k26		$5 \cdot 10^{-4}$		☑
k27	k27		$1.54 \cdot 10^{-6}$		☑
k28	k28		0.017		☑
k29	k29		$2.8 \cdot 10^{-4}$		☑
k30	k30		$1.78 \cdot 10^{-7}$		☑
k31	k31		$2.8 \cdot 10^{-4}$		☑
k32	k32		$1.27 \cdot 10^{-7}$		☑
k33	k33		$2.8 \cdot 10^{-4}$		☑
k34	k34		0.023		☑
k35	k35		0.001		☑
k36	k36		0.004		☑
k37	k37		$1.13 \cdot 10^{-4}$		☑

Id	Name	SBO	Value	Unit	Constant
k38	k38		$3 \cdot 10^{-4}$		☑
k39	k39		$2 \cdot 10^{-4}$		☑
k40	k40		0.006		☑
k41	k41		0.002		☑
k42	k42		0.004		☑
k43	k43		$1.13 \cdot 10^{-4}$		☑
k44	k44		$1.5 \cdot 10^{-4}$		☑
k45	k45		10^{-4}		☑
k46	k46		0.009		☑
k47	k47		0.002		☑
k48	k48		0.004		☑
k49	k49		$1.13 \cdot 10^{-4}$		☑
k50	k50		$1.5 \cdot 10^{-4}$		☑
k51	k51		10^{-4}		☑
k52	k52		0.185		☑
k53	k53		0.001		☑
k54	k54		0.014		☑
k55	k55		0.048		☑
k56	k56		0.002		☑
k57	k57		0.005		☑
k58	k58		0.070		☑
k59	k59		0.002		☑
k60	k60		0.005		☑
k61	k61		$1.2 \cdot 10^{-4}$		☑
k62	k62		0.004		☑
k63	k63		0.002		☑
k64	k64		0.002		☑

6 Reactions

This model contains 64 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	v1	v1	NFkB + IKKIkBa ⟶ IKKIkBaNFkB	
2	v2	v2	IKKIkBaNFkB ⟶ NFkB + IKK	
3	v3	v3	IKKIkBaNFkB ⟶ NFkB + IKKIkBa	
4	v4	v4	IKK + IkBa ⟶ IKKIkBa	
5	v5	v5	IKKIkBa ⟶ IKK	
6	v6	v6	IKKIkBa ⟶ IKK + IkBa	
7	v7	v7	IKKIkBb + NFkB ⟶ IKKIkBbNFkB	
8	v8	v8	IKKIkBbNFkB ⟶ IKK + NFkB	
9	v9	v9	IKKIkBbNFkB ⟶ IKKIkBb + NFkB	
10	v10	v10	IkBb + IKK ⟶ IKKIkBb	
11	v11	v11	IKKIkBb ⟶ IKK	
12	v12	v12	IKKIkBb ⟶ IKK + IkBb	
13	v13	v13	NFkB + IKKIkBe ⟶ IKKIkBeNFkB	
14	v14	v14	IKKIkBeNFkB ⟶ NFkB + IKK	
15	v15	v15	IKKIkBeNFkB ⟶ NFkB + IKKIkBe	
16	v16	v16	IkBe + IKK ⟶ IKKIkBe	
17	v17	v17	IKKIkBe ⟶ IKK	
18	v18	v18	IKKIkBe ⟶ IkBe + IKK	
19	v19	v19	IkBaNFkB + IKK ⟶ IKKIkBaNFkB	
20	v20	v20	IKKIkBaNFkB ⟶ IkBaNFkB + IKK	
21	v21	v21	IkBbNFkB + IKK ⟶ IKKIkBbNFkB	
22	v22	v22	IKKIkBbNFkB ⟶ IkBbNFkB + IKK	
23	v23	v23	IKK + IkBeNFkB ⟶ IKKIkBeNFkB	

№	Id	Name	Reaction Equation	SBO
24	v24	v24	$\mathrm{IKKIkBeNFkB} \longrightarrow \mathrm{IKK} + \mathrm{IkBeNFkB}$	
25	v25	v25	$\mathrm{IkBa} + \mathrm{NFkB} \longrightarrow \mathrm{IkBaNFkB}$	
26	v26	v26	$2\,\mathrm{source} \xrightarrow{\mathrm{NFkBn}} \mathrm{IkBat} + 2\,\mathrm{sink}$	
27	v27	v27	$\mathrm{IkBaNFkB} \longrightarrow \mathrm{IkBa} + \mathrm{NFkB}$	
28	v28	v28	$\mathrm{NFkBn} + \mathrm{IkBan} \longrightarrow \mathrm{IkBanNFkBn}$	
29	v29	v29	$\mathrm{IkBanNFkBn} \longrightarrow \mathrm{NFkBn} + \mathrm{IkBan}$	
30	v30	v30	$\mathrm{IkBanNFkBn} \longrightarrow \mathrm{IkBaNFkB}$	
31	v31	v31	$\mathrm{IkBaNFkB} \longrightarrow \mathrm{NFkB}$	
32	v32	v32	$\mathrm{IkBat} \longrightarrow \mathrm{sink}$	
33	v33	v33	$\mathrm{IkBan} \longrightarrow \mathrm{IkBa}$	
34	v34	v34	$\mathrm{IkBa} \longrightarrow \mathrm{IkBan}$	
35	v35	v35	$\mathrm{source} \xrightarrow{\mathrm{IkBat}} \mathrm{IkBa} + \mathrm{sink}$	
36	v36	v36	$\mathrm{IkBb} + \mathrm{NFkB} \longrightarrow \mathrm{IkBbNFkB}$	
37	v37	v37	$\mathrm{IkBbNFkB} \longrightarrow \mathrm{IkBb} + \mathrm{NFkB}$	
38	v38	v38	$\mathrm{IkBbn} + \mathrm{NFkBn} \longrightarrow \mathrm{IkBbnNFkBn}$	
39	v39	v39	$\mathrm{IkBbnNFkBn} \longrightarrow \mathrm{IkBbn} + \mathrm{NFkBn}$	
40	v40	v40	$\mathrm{IkBbnNFkBn} \longrightarrow \mathrm{IkBbNFkB}$	
41	v41	v41	$\mathrm{IkBbNFkB} \longrightarrow \mathrm{NFkB}$	
42	v42	v42	$\mathrm{IkBbt} \longrightarrow \mathrm{sink}$	
43	v43	v43	$\mathrm{IkBbn} \longrightarrow \mathrm{IkBb}$	
44	v44	v44	$\mathrm{IkBb} \longrightarrow \mathrm{IkBbn}$	
45	v45	v45	$\mathrm{source} \xrightarrow{\mathrm{IkBbt}} \mathrm{IkBb} + \mathrm{sink}$	
46	v46	v46	$\mathrm{NFkB} + \mathrm{IkBe} \longrightarrow \mathrm{IkBeNFkB}$	
47	v47	v47	$\mathrm{IkBeNFkB} \longrightarrow \mathrm{NFkB} + \mathrm{IkBe}$	
48	v48	v48	$\mathrm{NFkBn} + \mathrm{IkBen} \longrightarrow \mathrm{IkBenNFkBn}$	
49	v49	v49	$\mathrm{IkBenNFkBn} \longrightarrow \mathrm{IkBen} + \mathrm{NFkBn}$	
50	v50	v50	$\mathrm{IkBenNFkBn} \longrightarrow \mathrm{IkBeNFkB}$	
51	v51	v51	$\mathrm{IkBeNFkB} \longrightarrow \mathrm{NFkB}$	

№	Id	Name	Reaction Equation	SBO
52	v52	v52	IkBet $\longrightarrow$ sink	
53	v53	v53	IkBen $\longrightarrow$ IkBe	
54	v54	v54	IkBe $\longrightarrow$ IkBen	
55	v55	v55	source $\xrightarrow{\text{IkBet}}$ IkBe + sink	
56	v56	v56	NFkBn $\longrightarrow$ NFkB	
57	v57	v57	NFkB $\longrightarrow$ NFkBn	
58	v58	v58	source $\longrightarrow$ IkBat	
59	v59	v59	source $\longrightarrow$ IkBbt	
60	v60	v60	source $\longrightarrow$ IkBet	
61	v61	v61	IkBa $\longrightarrow$ sink	
62	v62	v62	IkBb $\longrightarrow$ sink	
63	v63	v63	IkBe $\longrightarrow$ sink	
64	v64	v64	IKK $\longrightarrow$ sink	

6.1 Reaction v1

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

Name v1

Reaction equation

$$\mathrm{NFkB} + \mathrm{IKKIkBa} \longrightarrow \mathrm{IKKIkBaNFkB} \tag{1}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
NFkB	NFkB	
IKKIkBa	IKKIkBa	

Product

Table 7: Properties of each product.

Id	Name	SBO
IKKIkBaNFkB	IKKIkBaNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{k7} \cdot [\mathrm{IKKIkBa}] \cdot [\mathrm{NFkB}] \tag{2}$$

6.2 Reaction v2

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

Name v2

Reaction equation

$$\mathrm{IKKIkBaNFkB} \longrightarrow \mathrm{NFkB} + \mathrm{IKK} \tag{3}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
IKKIkBaNFkB	IKKIkBaNFkB	

Products

Table 9: Properties of each product.

Id	Name	SBO
NFkB	NFkB	
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{k9} \cdot [\mathrm{IKKIkBaNFkB}] \tag{4}$$

6.3 Reaction v3

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

Name v3

Reaction equation

$$\mathrm{IKKIkBaNFkB} \longrightarrow \mathrm{NFkB} + \mathrm{IKKIkBa} \tag{5}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
IKKIkBaNFkB	IKKIkBaNFkB	

Products

Table 11: Properties of each product.

Id	Name	SBO
NFkB	NFkB	

Id	Name	SBO
IKKIkBa	IKKIkBa	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{k8} \cdot [\mathrm{IKKIkBaNFkB}] \tag{6}$$

6.4 Reaction v4

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

Name v4

Reaction equation

$$\mathrm{IKK} + \mathrm{IkBa} \longrightarrow \mathrm{IKKIkBa} \tag{7}$$

Reactants

Table 12: Properties of each reactant.

Id	Name	SBO
IKK	IKK	
IkBa	IkBa	

Product

Table 13: Properties of each product.

Id	Name	SBO
IKKIkBa	IKKIkBa	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{k34} \cdot [\mathrm{IKK}] \cdot [\mathrm{IkBa}] \tag{8}$$

6.5 Reaction v5

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

Name v5

Reaction equation

$$\text{IKKIkBa} \longrightarrow \text{IKK} \tag{9}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
IKKIkBa	IKKIkBa	

Product

Table 15: Properties of each product.

Id	Name	SBO
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{k62} \cdot [\text{IKKIkBa}] \tag{10}$$

6.6 Reaction v6

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

Name v6

Reaction equation

$$\text{IKKIkBa} \longrightarrow \text{IKK} + \text{IkBa} \tag{11}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
IKKIkBa	IKKIkBa	

Products

Table 17: Properties of each product.

Id	Name	SBO
IKK	IKK	
IkBa	IkBa	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \text{k35} \cdot [\text{IKKIkBa}] \tag{12}$$

6.7 Reaction v7

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

Name v7

Reaction equation

$$\text{IKKIkBb} + \text{NFkB} \longrightarrow \text{IKKIkBbNFkB} \tag{13}$$

Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
IKKIkBb	IKKIkBb	
NFkB	NFkB	

Product

Table 19: Properties of each product.

Id	Name	SBO
IKKIkBbNFkB	IKKIkBbNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{k10} \cdot [\mathrm{IKKIkBb}] \cdot [\mathrm{NFkB}] \tag{14}$$

6.8 Reaction v8

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

Name v8

Reaction equation

$$\mathrm{IKKIkBbNFkB} \longrightarrow \mathrm{IKK} + \mathrm{NFkB} \tag{15}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
IKKIkBbNFkB	IKKIkBbNFkB	

Products

Table 21: Properties of each product.

Id	Name	SBO
IKK	IKK	
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{k12} \cdot [\mathrm{IKKIkBbNFkB}] \tag{16}$$

6.9 Reaction v9

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

Name v9

Reaction equation

$$\mathrm{IKKIkBbNFkB} \longrightarrow \mathrm{IKKIkBb} + \mathrm{NFkB} \tag{17}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
IKKIkBbNFkB	IKKIkBbNFkB	

Products

Table 23: Properties of each product.

Id	Name	SBO
IKKIkBb	IKKIkBb	
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{k11} \cdot [\mathrm{IKKIkBbNFkB}] \tag{18}$$

6.10 Reaction v10

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

Name v10

Reaction equation

$$\mathrm{IkBb} + \mathrm{IKK} \longrightarrow \mathrm{IKKIkBb} \tag{19}$$

Reactants

Table 24: Properties of each reactant.

Id	Name	SBO
IkBb	IkBb	
IKK	IKK	

Product

Table 25: Properties of each product.

Id	Name	SBO
IKKIkBb	IKKIkBb	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{k40} \cdot [\text{IKK}] \cdot [\text{IkBb}] \tag{20}$$

6.11 Reaction v11

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

Name v11

Reaction equation

$$\text{IKKIkBb} \longrightarrow \text{IKK} \tag{21}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
IKKIkBb	IKKIkBb	

Product

Table 27: Properties of each product.

Id	Name	SBO
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{k63} \cdot [\text{IKKIkBb}] \tag{22}$$

6.12 Reaction v12

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

Name v12

Reaction equation

$$\text{IKKIkBb} \longrightarrow \text{IKK} + \text{IkBb} \tag{23}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
IKKIkBb	IKKIkBb	

Products

Table 29: Properties of each product.

Id	Name	SBO
IKK	IKK	
IkBb	IkBb	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{k41} \cdot [\text{IKKIkBb}] \tag{24}$$

6.13 Reaction v13

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

Name v13

Reaction equation

$$\text{NFkB} + \text{IKKIkBe} \longrightarrow \text{IKKIkBeNFkB} \tag{25}$$

Reactants

Table 30: Properties of each reactant.

Id	Name	SBO
NFkB	NFkB	
IKKIkBe	IKKIkBe	

Product

Table 31: Properties of each product.

Id	Name	SBO
IKKIkBeNFkB	IKKIkBeNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \mathrm{k13} \cdot [\mathrm{IKKIkBe}] \cdot [\mathrm{NFkB}] \tag{26}$$

6.14 Reaction v14

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

Name v14

Reaction equation

$$\mathrm{IKKIkBeNFkB} \longrightarrow \mathrm{NFkB} + \mathrm{IKK} \tag{27}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
IKKIkBeNFkB	IKKIkBeNFkB	

Products

Table 33: Properties of each product.

Id	Name	SBO
NFkB	NFkB	

Id	Name	SBO
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \mathrm{k15} \cdot [\mathrm{IKKIkBeNFkB}] \tag{28}$$

6.15 Reaction v15

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

Name v15

Reaction equation

$$\mathrm{IKKIkBeNFkB} \longrightarrow \mathrm{NFkB} + \mathrm{IKKIkBe} \tag{29}$$

Reactant

Table 34: Properties of each reactant.

Id	Name	SBO
IKKIkBeNFkB	IKKIkBeNFkB	

Products

Table 35: Properties of each product.

Id	Name	SBO
NFkB	NFkB	
IKKIkBe	IKKIkBe	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \mathrm{k14} \cdot [\mathrm{IKKIkBeNFkB}] \tag{30}$$

6.16 Reaction v16

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

Name v16

Reaction equation

$$\mathrm{IkBe} + \mathrm{IKK} \longrightarrow \mathrm{IKKIkBe} \tag{31}$$

Reactants

Table 36: Properties of each reactant.

Id	Name	SBO
IkBe	IkBe	
IKK	IKK	

Product

Table 37: Properties of each product.

Id	Name	SBO
IKKIkBe	IKKIkBe	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \mathrm{k46} \cdot [\mathrm{IKK}] \cdot [\mathrm{IkBe}] \tag{32}$$

6.17 Reaction v17

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

Name v17

Reaction equation

$$\mathrm{IKKIkBe} \longrightarrow \mathrm{IKK} \tag{33}$$

Reactant

Table 38: Properties of each reactant.

Id	Name	SBO
IKKIkBe	IKKIkBe	

Product

Table 39: Properties of each product.

Id	Name	SBO
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \mathrm{k64} \cdot [\mathrm{IKKIkBe}] \tag{34}$$

6.18 Reaction v18

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

Name v18

Reaction equation

$$\mathrm{IKKIkBe} \longrightarrow \mathrm{IkBe} + \mathrm{IKK} \tag{35}$$

Reactant

Table 40: Properties of each reactant.

Id	Name	SBO
IKKIkBe	IKKIkBe	

Products

Table 41: Properties of each product.

Id	Name	SBO
IkBe	IkBe	
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \mathrm{k47} \cdot [\mathrm{IKKIkBe}] \tag{36}$$

6.19 Reaction v19

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

Name v19

Reaction equation

$$\mathrm{IkBaNFkB} + \mathrm{IKK} \longrightarrow \mathrm{IKKIkBaNFkB} \tag{37}$$

Reactants

Table 42: Properties of each reactant.

Id	Name	SBO
IkBaNFkB	IkBaNFkB	
IKK	IKK	

Product

Table 43: Properties of each product.

Id	Name	SBO
IKKIkBaNFkB	IKKIkBaNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \mathrm{k52} \cdot [\mathrm{IKK}] \cdot [\mathrm{IkBaNFkB}] \tag{38}$$

6.20 Reaction v20

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

Name v20

Reaction equation

$$\mathrm{IKKIkBaNFkB} \longrightarrow \mathrm{IkBaNFkB} + \mathrm{IKK} \tag{39}$$

Reactant

Table 44: Properties of each reactant.

Id	Name	SBO
IKKIkBaNFkB	IKKIkBaNFkB	

Products

Table 45: Properties of each product.

Id	Name	SBO
IkBaNFkB	IkBaNFkB	
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \mathrm{k53} \cdot [\mathrm{IKKIkBaNFkB}] \tag{40}$$

6.21 Reaction v21

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

Name v21

Reaction equation

$$\mathrm{IkBbNFkB} + \mathrm{IKK} \longrightarrow \mathrm{IKKIkBbNFkB} \tag{41}$$

Reactants

Table 46: Properties of each reactant.

Id	Name	SBO
IkBbNFkB	IkBbNFkB	
IKK	IKK	

Product

Table 47: Properties of each product.

Id	Name	SBO
IKKIkBbNFkB	IKKIkBbNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \mathrm{k55} \cdot [\mathrm{IKK}] \cdot [\mathrm{IkBbNFkB}] \tag{42}$$

6.22 Reaction v22

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

Name v22

Reaction equation

$$\mathrm{IKKIkBbNFkB} \longrightarrow \mathrm{IkBbNFkB} + \mathrm{IKK} \tag{43}$$

Reactant

Table 48: Properties of each reactant.

Id	Name	SBO
IKKIkBbNFkB	IKKIkBbNFkB	

Products

Table 49: Properties of each product.

Id	Name	SBO
IkBbNFkB	IkBbNFkB	
IKK	IKK	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \mathrm{k56} \cdot [\mathrm{IKKIkBbNFkB}] \tag{44}$$

6.23 Reaction v23

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

Name v23

Reaction equation

$$\mathrm{IKK} + \mathrm{IkBeNFkB} \longrightarrow \mathrm{IKKIkBeNFkB} \tag{45}$$

Reactants

Table 50: Properties of each reactant.

Id	Name	SBO
IKK	IKK	
IkBeNFkB	IkBeNFkB	

Product

Table 51: Properties of each product.

Id	Name	SBO
IKKIkBeNFkB	IKKIkBeNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \mathrm{k58} \cdot [\mathrm{IKK}] \cdot [\mathrm{IkBeNFkB}] \tag{46}$$

6.24 Reaction v24

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

Name v24

Reaction equation

$$\mathrm{IKKIkBeNFkB} \longrightarrow \mathrm{IKK} + \mathrm{IkBeNFkB} \tag{47}$$

Reactant

Table 52: Properties of each reactant.

Id	Name	SBO
IKKIkBeNFkB	IKKIkBeNFkB	

Products

Table 53: Properties of each product.

Id	Name	SBO
IKK	IKK	
IkBeNFkB	IkBeNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{k59} \cdot [\text{IKKIkBeNFkB}] \tag{48}$$

6.25 Reaction v25

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

Name v25

Reaction equation

$$\text{IkBa} + \text{NFkB} \longrightarrow \text{IkBaNFkB} \tag{49}$$

Reactants

Table 54: Properties of each reactant.

Id	Name	SBO
IkBa	IkBa	
NFkB	NFkB	

Product

Table 55: Properties of each product.

Id	Name	SBO
IkBaNFkB	IkBaNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \mathrm{k1} \cdot [\mathrm{IkBa}] \cdot [\mathrm{NFkB}] \tag{50}$$

6.26 Reaction v26

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

Name v26

Reaction equation

$$2\,\mathrm{source} \xrightarrow{\mathrm{NFkBn}} \mathrm{IkBat} + 2\,\mathrm{sink} \tag{51}$$

Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
source	source	

Modifier

Table 57: Properties of each modifier.

Id	Name	SBO
NFkBn	NFkBn	

Products

Table 58: Properties of each product.

Id	Name	SBO
IkBat	IkBat	

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \mathrm{k28} \cdot [\mathrm{NFkBn}] \cdot [\mathrm{NFkBn}] \tag{52}$$

6.27 Reaction v27

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

Name v27

Reaction equation

$$\mathrm{IkBaNFkB} \longrightarrow \mathrm{IkBa} + \mathrm{NFkB} \tag{53}$$

Reactant

Table 59: Properties of each reactant.

Id	Name	SBO
IkBaNFkB	IkBaNFkB	

Products

Table 60: Properties of each product.

Id	Name	SBO
IkBa	IkBa	
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \mathrm{k2} \cdot [\mathrm{IkBaNFkB}] \tag{54}$$

6.28 Reaction v28

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

Name v28

Reaction equation

$$\mathrm{NFkBn} + \mathrm{IkBan} \longrightarrow \mathrm{IkBanNFkBn} \tag{55}$$

Reactants

Table 61: Properties of each reactant.

Id	Name	SBO
NFkBn	NFkBn	
IkBan	IkBan	

Product

Table 62: Properties of each product.

Id	Name	SBO
IkBanNFkBn	IkBanNFkBn	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \mathrm{k21} \cdot [\mathrm{IkBan}] \cdot [\mathrm{NFkBn}] \tag{56}$$

6.29 Reaction v29

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

Name v29

Reaction equation

$$\mathrm{IkBanNFkBn} \longrightarrow \mathrm{NFkBn} + \mathrm{IkBan} \tag{57}$$

Reactant

Table 63: Properties of each reactant.

Id	Name	SBO
IkBanNFkBn	IkBanNFkBn	

Products

Table 64: Properties of each product.

Id	Name	SBO
NFkBn	NFkBn	
IkBan	IkBan	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \mathrm{k22} \cdot [\mathrm{IkBanNFkBn}] \tag{58}$$

6.30 Reaction v30

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

Name v30

Reaction equation

$$\mathrm{IkBanNFkBn} \longrightarrow \mathrm{IkBaNFkB} \tag{59}$$

Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
IkBanNFkBn	IkBanNFkBn	

Product

Table 66: Properties of each product.

Id	Name	SBO
IkBaNFkB	IkBaNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \mathrm{k54} \cdot [\mathrm{IkBanNFkBn}] \tag{60}$$

6.31 Reaction v31

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

Name v31

Reaction equation

$$\text{IkBaNFkB} \longrightarrow \text{NFkB} \tag{61}$$

Reactant

Table 67: Properties of each reactant.

Id	Name	SBO
IkBaNFkB	IkBaNFkB	

Product

Table 68: Properties of each product.

Id	Name	SBO
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{k16} \cdot [\text{IkBaNFkB}] \tag{62}$$

6.32 Reaction v32

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

Name v32

Reaction equation

$$\text{IkBat} \longrightarrow \text{sink} \tag{63}$$

Reactant

Table 69: Properties of each reactant.

Id	Name	SBO
IkBat	IkBat	

Product

Table 70: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \text{k29} \cdot [\text{IkBat}] \tag{64}$$

6.33 Reaction v33

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

Name v33

Reaction equation

$$\text{IkBan} \longrightarrow \text{IkBa} \tag{65}$$

Reactant

Table 71: Properties of each reactant.

Id	Name	SBO
IkBan	IkBan	

Product

Table 72: Properties of each product.

Id	Name	SBO
IkBa	IkBa	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \mathrm{k39} \cdot [\mathrm{IkBan}] \tag{66}$$

6.34 Reaction v34

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

Name v34

Reaction equation

$$\mathrm{IkBa} \longrightarrow \mathrm{IkBan} \tag{67}$$

Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
IkBa	IkBa	

Product

Table 74: Properties of each product.

Id	Name	SBO
IkBan	IkBan	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \mathrm{k38} \cdot [\mathrm{IkBa}] \tag{68}$$

6.35 Reaction v35

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

Name v35

Reaction equation

$$\mathrm{source} \xrightarrow{\mathrm{IkBat}} \mathrm{IkBa} + \mathrm{sink} \tag{69}$$

Reactant

Table 75: Properties of each reactant.

Id	Name	SBO
source	source	

Modifier

Table 76: Properties of each modifier.

Id	Name	SBO
IkBat	IkBat	

Products

Table 77: Properties of each product.

Id	Name	SBO
IkBa	IkBa	
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \mathrm{k36} \cdot [\mathrm{IkBat}] \tag{70}$$

6.36 Reaction v36

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

Name v36

Reaction equation

$$\mathrm{IkBb} + \mathrm{NFkB} \longrightarrow \mathrm{IkBbNFkB} \tag{71}$$

Reactants

Table 78: Properties of each reactant.

Id	Name	SBO
IkBb	IkBb	
NFkB	NFkB	

Product

Table 79: Properties of each product.

Id	Name	SBO
IkBbNFkB	IkBbNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \mathrm{k3} \cdot [\mathrm{IkBb}] \cdot [\mathrm{NFkB}] \tag{72}$$

6.37 Reaction v37

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

Name v37

Reaction equation

$$\mathrm{IkBbNFkB} \longrightarrow \mathrm{IkBb} + \mathrm{NFkB} \tag{73}$$

Reactant

Table 80: Properties of each reactant.

Id	Name	SBO
IkBbNFkB	IkBbNFkB	

Products

Table 81: Properties of each product.

Id	Name	SBO
IkBb	IkBb	

Id	Name	SBO
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \mathrm{k4} \cdot [\mathrm{IkBbNFkB}] \tag{74}$$

6.38 Reaction v38

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

Name v38

Reaction equation

$$\mathrm{IkBbn} + \mathrm{NFkBn} \longrightarrow \mathrm{IkBbnNFkBn} \tag{75}$$

Reactants

Table 82: Properties of each reactant.

Id	Name	SBO
IkBbn	IkBbn	
NFkBn	NFkBn	

Product

Table 83: Properties of each product.

Id	Name	SBO
IkBbnNFkBn	IkBbnNFkBn	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \mathrm{k23} \cdot [\mathrm{IkBbn}] \cdot [\mathrm{NFkBn}] \tag{76}$$

6.39 Reaction v39

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

Name v39

Reaction equation

$$\text{IkBbnNFkBn} \longrightarrow \text{IkBbn} + \text{NFkBn} \tag{77}$$

Reactant

Table 84: Properties of each reactant.

Id	Name	SBO
IkBbnNFkBn	IkBbnNFkBn	

Products

Table 85: Properties of each product.

Id	Name	SBO
IkBbn	IkBbn	
NFkBn	NFkBn	

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \text{k24} \cdot [\text{IkBbnNFkBn}] \tag{78}$$

6.40 Reaction v40

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

Name v40

Reaction equation

$$\text{IkBbnNFkBn} \longrightarrow \text{IkBbNFkB} \tag{79}$$

Reactant

Table 86: Properties of each reactant.

Id	Name	SBO
IkBbnNFkBn	IkBbnNFkBn	

Product

Table 87: Properties of each product.

Id	Name	SBO
IkBbNFkB	IkBbNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \text{k57} \cdot [\text{IkBbnNFkBn}] \tag{80}$$

6.41 Reaction v41

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

Name v41

Reaction equation

$$\text{IkBbNFkB} \longrightarrow \text{NFkB} \tag{81}$$

Reactant

Table 88: Properties of each reactant.

Id	Name	SBO
IkBbNFkB	IkBbNFkB	

Product

Table 89: Properties of each product.

Id	Name	SBO
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \text{k17} \cdot [\text{IkBbNFkB}] \tag{82}$$

6.42 Reaction v42

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

Name v42

Reaction equation

$$\text{IkBbt} \longrightarrow \text{sink} \tag{83}$$

Reactant

Table 90: Properties of each reactant.

Id	Name	SBO
IkBbt	IkBbt	

Product

Table 91: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = \text{k31} \cdot [\text{IkBbt}] \tag{84}$$

6.43 Reaction v43

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

Name v43

Reaction equation

$$\text{IkBbn} \longrightarrow \text{IkBb} \tag{85}$$

Reactant

Table 92: Properties of each reactant.

Id	Name	SBO
IkBbn	IkBbn	

Product

Table 93: Properties of each product.

Id	Name	SBO
IkBb	IkBb	

Kinetic Law

Derived unit contains undeclared units

$$v_{43} = \mathrm{k45} \cdot [\mathrm{IkBbn}] \tag{86}$$

6.44 Reaction v44

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

Name v44

Reaction equation

$$\mathrm{IkBb} \longrightarrow \mathrm{IkBbn} \tag{87}$$

Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
IkBb	IkBb	

Product

Table 95: Properties of each product.

Id	Name	SBO
IkBbn	IkBbn	

Kinetic Law

Derived unit contains undeclared units

$$v_{44} = \mathrm{k44} \cdot [\mathrm{IkBb}] \tag{88}$$

6.45 Reaction v45

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

Name v45

Reaction equation

$$\mathrm{source} \xrightarrow{\mathrm{IkBbt}} \mathrm{IkBb} + \mathrm{sink} \tag{89}$$

Reactant

Table 96: Properties of each reactant.

Id	Name	SBO
source	source	

Modifier

Table 97: Properties of each modifier.

Id	Name	SBO
IkBbt	IkBbt	

Products

Table 98: Properties of each product.

Id	Name	SBO
IkBb	IkBb	
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{45} = \mathrm{k42} \cdot [\mathrm{IkBbt}] \tag{90}$$

6.46 Reaction v46

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

Name v46

Reaction equation

$$\mathrm{NFkB} + \mathrm{IkBe} \longrightarrow \mathrm{IkBeNFkB} \tag{91}$$

Reactants

Table 99: Properties of each reactant.

Id	Name	SBO
NFkB	NFkB	
IkBe	IkBe	

Product

Table 100: Properties of each product.

Id	Name	SBO
IkBeNFkB	IkBeNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \mathrm{k5} \cdot [\mathrm{IkBe}] \cdot [\mathrm{NFkB}] \tag{92}$$

6.47 Reaction v47

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

Name v47

Reaction equation

$$\mathrm{IkBeNFkB} \longrightarrow \mathrm{NFkB} + \mathrm{IkBe} \tag{93}$$

Reactant

Table 101: Properties of each reactant.

Id	Name	SBO
IkBeNFkB	IkBeNFkB	

Products

Table 102: Properties of each product.

Id	Name	SBO
NFkB	NFkB	
IkBe	IkBe	

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = \mathrm{k6} \cdot [\mathrm{IkBeNFkB}] \tag{94}$$

6.48 Reaction v48

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

Name v48

Reaction equation

$$\mathrm{NFkBn} + \mathrm{IkBen} \longrightarrow \mathrm{IkBenNFkBn} \tag{95}$$

Reactants

Table 103: Properties of each reactant.

Id	Name	SBO
NFkBn	NFkBn	
IkBen	IkBen	

Product

Table 104: Properties of each product.

Id	Name	SBO
IkBenNFkBn	IkBenNFkBn	

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = \text{k25} \cdot [\text{IkBen}] \cdot [\text{NFkBn}] \tag{96}$$

6.49 Reaction v49

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

Name v49

Reaction equation

$$\text{IkBenNFkBn} \longrightarrow \text{IkBen} + \text{NFkBn} \tag{97}$$

Reactant

Table 105: Properties of each reactant.

Id	Name	SBO
IkBenNFkBn	IkBenNFkBn	

Products

Table 106: Properties of each product.

Id	Name	SBO
IkBen	IkBen	
NFkBn	NFkBn	

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = \text{k26} \cdot [\text{IkBenNFkBn}] \tag{98}$$

6.50 Reaction v50

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

Name v50

Reaction equation

$$\text{IkBenNFkBn} \longrightarrow \text{IkBeNFkB} \tag{99}$$

Reactant

Table 107: Properties of each reactant.

Id	Name	SBO
IkBenNFkBn	IkBenNFkBn	

Product

Table 108: Properties of each product.

Id	Name	SBO
IkBeNFkB	IkBeNFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = \text{k60} \cdot [\text{IkBenNFkBn}] \tag{100}$$

6.51 Reaction v51

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

Name v51

Reaction equation

$$\text{IkBeNFkB} \longrightarrow \text{NFkB} \tag{101}$$

Reactant

Table 109: Properties of each reactant.

Id	Name	SBO
IkBeNFkB	IkBeNFkB	

Product

Table 110: Properties of each product.

Id	Name	SBO
NFkB	NFkB	

Kinetic Law

Derived unit contains undeclared units

$$v_{51} = \mathrm{k18} \cdot [\mathrm{IkBeNFkB}] \tag{102}$$

6.52 Reaction v52

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

Name v52

Reaction equation

$$\mathrm{IkBet} \longrightarrow \mathrm{sink} \tag{103}$$

Reactant

Table 111: Properties of each reactant.

Id	Name	SBO
IkBet	IkBet	

Product

Table 112: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{52} = \text{k33} \cdot [\text{IkBet}] \tag{104}$$

6.53 Reaction v53

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

Name v53

Reaction equation

$$\text{IkBen} \longrightarrow \text{IkBe} \tag{105}$$

Reactant

Table 113: Properties of each reactant.

Id	Name	SBO
IkBen	IkBen	

Product

Table 114: Properties of each product.

Id	Name	SBO
IkBe	IkBe	

Kinetic Law

Derived unit contains undeclared units

$$v_{53} = \text{k51} \cdot [\text{IkBen}] \tag{106}$$

6.54 Reaction v54

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

Name v54

Reaction equation

$$\text{IkBe} \longrightarrow \text{IkBen} \tag{107}$$

Reactant

Table 115: Properties of each reactant.

Id	Name	SBO
IkBe	IkBe	

Product

Table 116: Properties of each product.

Id	Name	SBO
IkBen	IkBen	

Kinetic Law

Derived unit contains undeclared units

$$v_{54} = \mathrm{k50} \cdot [\mathrm{IkBe}] \tag{108}$$

6.55 Reaction v55

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

Name v55

Reaction equation

$$\mathrm{source} \xrightarrow{\mathrm{IkBet}} \mathrm{IkBe} + \mathrm{sink} \tag{109}$$

Reactant

Table 117: Properties of each reactant.

Id	Name	SBO
source	source	

Modifier

Table 118: Properties of each modifier.

Id	Name	SBO
IkBet	IkBet	

Products

Table 119: Properties of each product.

Id	Name	SBO
IkBe	IkBe	
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{55} = \text{k48} \cdot [\text{IkBet}] \tag{110}$$

6.56 Reaction v56

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

Name v56

Reaction equation

$$\text{NFkBn} \longrightarrow \text{NFkB} \tag{111}$$

Reactant

Table 120: Properties of each reactant.

Id	Name	SBO
NFkBn	NFkBn	

Product

Table 121: Properties of each product.

Id	Name	SBO
NFkB	NFkB	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_{56} = \text{k20} \cdot [\text{NFkBn}] \tag{112}$$

6.57 Reaction v57

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

Name v57

Reaction equation

$$\text{NFkB} \longrightarrow \text{NFkBn} \tag{113}$$

Reactant

Table 122: Properties of each reactant.

Id	Name	SBO
NFkB	NFkB	

Product

Table 123: Properties of each product.

Id	Name	SBO
NFkBn	NFkBn	

Kinetic Law

Derived unit contains undeclared units

$$v_{57} = \text{k19} \cdot [\text{NFkB}] \tag{114}$$

6.58 Reaction v58

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

Name v58

Reaction equation

$$\text{source} \longrightarrow \text{IkBat} \tag{115}$$

Reactant

Table 124: Properties of each reactant.

Id	Name	SBO
source	source	

Product

Table 125: Properties of each product.

Id	Name	SBO
IkBat	IkBat	

Kinetic Law

Derived unit contains undeclared units

$$v_{58} = \text{k27} \cdot [\text{source}] \tag{116}$$

6.59 Reaction v59

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

Name v59

Reaction equation

$$\text{source} \longrightarrow \text{IkBbt} \tag{117}$$

Reactant

Table 126: Properties of each reactant.

Id	Name	SBO
source	source	

Product

Table 127: Properties of each product.

Id	Name	SBO
IkBbt	IkBbt	

Kinetic Law

Derived unit contains undeclared units

$$v_{59} = \text{k30} \cdot [\text{source}] \tag{118}$$

6.60 Reaction v60

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

Name v60

Reaction equation

$$\text{source} \longrightarrow \text{IkBet} \tag{119}$$

Reactant

Table 128: Properties of each reactant.

Id	Name	SBO
source	source	

Product

Table 129: Properties of each product.

Id	Name	SBO
IkBet	IkBet	

Kinetic Law

Derived unit contains undeclared units

$$v_{60} = \text{k32} \cdot [\text{source}] \tag{120}$$

6.61 Reaction v61

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

Name v61

Reaction equation

$$\text{IkBa} \longrightarrow \text{sink} \tag{121}$$

Reactant

Table 130: Properties of each reactant.

Id	Name	SBO
IkBa	IkBa	

Product

Table 131: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{61} = \text{k37} \cdot [\text{IkBa}] \tag{122}$$

6.62 Reaction v62

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

Name v62

Reaction equation

$$\text{IkBb} \longrightarrow \text{sink} \tag{123}$$

Reactant

Table 132: Properties of each reactant.

Id	Name	SBO
IkBb	IkBb	

Product

Table 133: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{62} = \text{k43} \cdot [\text{IkBb}] \tag{124}$$

6.63 Reaction v63

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

Name v63

Reaction equation

$$\text{IkBe} \longrightarrow \text{sink} \tag{125}$$

Reactant

Table 134: Properties of each reactant.

Id	Name	SBO
IkBe	IkBe	

Product

Table 135: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{63} = \mathrm{k49} \cdot [\mathrm{IkBe}] \tag{126}$$

6.64 Reaction v64

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

Name v64

Reaction equation

$$\mathrm{IKK} \longrightarrow \mathrm{sink} \tag{127}$$

Reactant

Table 136: Properties of each reactant.

Id	Name	SBO
IKK	IKK	

Product

Table 137: Properties of each product.

Id	Name	SBO
sink	sink	

Kinetic Law

Derived unit contains undeclared units

$$v_{64} = \mathrm{k61} \cdot [\mathrm{IKK}] \tag{128}$$

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 `NFkB`

Name NFkB

Initial concentration $2.5081 \cdot 10^{-4}\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in 20 reactions (as a reactant in `v1`, `v7`, `v13`, `v25`, `v36`, `v46`, `v57` and as a product in `v2`, `v3`, `v8`, `v9`, `v14`, `v15`, `v27`, `v31`, `v37`, `v41`, `v47`, `v51`, `v56`).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{NFkB} = {} & v_2 + v_3 + v_8 + v_9 + v_{14} + v_{15} + v_{27} + v_{31} + v_{37} + v_{41} \\ & + v_{47} + v_{51} + v_{56} - v_1 - v_7 - v_{13} - v_{25} - v_{36} - v_{46} - v_{57}\end{aligned} \tag{129}$$

7.2 Species `IKKIkBa`

Name IKKIkBa

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

This species takes part in five reactions (as a reactant in `v1`, `v5`, `v6` and as a product in `v3`, `v4`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKKIkBa} = v_3 + v_4 - v_1 - v_5 - v_6 \tag{130}$$

7.3 Species `IKKIkBaNFkB`

Name IKKIkBaNFkB

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

This species takes part in five reactions (as a reactant in `v2`, `v3`, `v20` and as a product in `v1`, `v19`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKKIkBaNFkB} = v_1 + v_{19} - v_2 - v_3 - v_{20} \tag{131}$$

7.4 Species `IKK`

Name IKK

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

This species takes part in 19 reactions (as a reactant in `v4`, `v10`, `v16`, `v19`, `v21`, `v23`, `v64` and as a product in `v2`, `v5`, `v6`, `v8`, `v11`, `v12`, `v14`, `v17`, `v18`, `v20`, `v22`, `v24`).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKK} = {} & v_2 + v_5 + v_6 + v_8 + v_{11} + v_{12} + v_{14} + v_{17} + v_{18} + v_{20} \\ & + v_{22} + v_{24} - v_4 - v_{10} - v_{16} - v_{19} - v_{21} - v_{23} - v_{64}\end{aligned} \tag{132}$$

7.5 Species IkBa

Name IkBa

Initial concentration $0.19028\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in v4, v25, v34, v61 and as a product in v6, v27, v33, v35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBa} = v_6 + v_{27} + v_{33} + v_{35} - v_4 - v_{25} - v_{34} - v_{61} \tag{133}$$

7.6 Species IKKIkBb

Name IKKIkBb

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

This species takes part in five reactions (as a reactant in v7, v11, v12 and as a product in v9, v10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKKIkBb} = v_9 + v_{10} - v_7 - v_{11} - v_{12} \tag{134}$$

7.7 Species IKKIkBbNFkB

Name IKKIkBbNFkB

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

This species takes part in five reactions (as a reactant in v8, v9, v22 and as a product in v7, v21).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKKIkBbNFkB} = v_7 + v_{21} - v_8 - v_9 - v_{22} \tag{135}$$

7.8 Species IkBb

Name IkBb

Initial concentration $0.021428\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in v10, v36, v44, v62 and as a product in v12, v37, v43, v45).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBb} = v_{12} + v_{37} + v_{43} + v_{45} - v_{10} - v_{36} - v_{44} - v_{62} \tag{136}$$

7.9 Species IKKIkBe

Name IKKIkBe

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

This species takes part in five reactions (as a reactant in v13, v17, v18 and as a product in v15, v16).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKKIkBe} = v_{15} + v_{16} - v_{13} - v_{17} - v_{18} \tag{137}$$

7.10 Species IKKIkBeNFkB

Name IKKIkBeNFkB

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

This species takes part in five reactions (as a reactant in v14, v15, v24 and as a product in v13, v23).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IKKIkBeNFkB} = v_{13} + v_{23} - v_{14} - v_{15} - v_{24} \tag{138}$$

7.11 Species IkBe

Name IkBe

Initial concentration $0.015307\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in v16, v46, v54, v63 and as a product in v18, v47, v53, v55).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBe} = v_{18} + v_{47} + v_{53} + v_{55} - v_{16} - v_{46} - v_{54} - v_{63} \tag{139}$$

7.12 Species IkBaNFkB

Name IkBaNFkB

Initial concentration $0.082062\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in v19, v27, v31 and as a product in v20, v25, v30).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBaNFkB} = v_{20} + v_{25} + v_{30} - v_{19} - v_{27} - v_{31} \tag{140}$$

7.13 Species IkBbNFkB

Name IkBbNFkB

Initial concentration $0.0090963\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in v21, v37, v41 and as a product in v22, v36, v40).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBbNFkB} = v_{22} + v_{36} + v_{40} - v_{21} - v_{37} - v_{41} \tag{141}$$

7.14 Species IkBeNFkB

Name IkBeNFkB

Initial concentration $0.0064977\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in v23, v47, v51 and as a product in v24, v46, v50).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBeNFkB} = v_{24} + v_{46} + v_{50} - v_{23} - v_{47} - v_{51} \tag{142}$$

7.15 Species source

Name source

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

This species takes part in seven reactions (as a reactant in v26, v35, v45, v55, v58, v59, v60), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{source} = 0 \tag{143}$$

7.16 Species IkBat

Name IkBat

Initial concentration $0.0054868\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v32 and as a product in v26, v58 and as a modifier in v35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBat} = v_{26} + v_{58} - v_{32} \tag{144}$$

7.17 Species sink

Name sink

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

This species takes part in eleven reactions (as a product in v26, v32, v35, v42, v45, v52, v55, v61, v62, v63, v64), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{sink} = 0 \tag{145}$$

7.18 Species NFkBn

Name NFkBn

Initial concentration $2.0366 \cdot 10^{-4}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in nine reactions (as a reactant in v28, v38, v48, v56 and as a product in v29, v39, v49, v57 and as a modifier in v26).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{NFkBn} = v_{29} + v_{39} + v_{49} + v_{57} - v_{28} - v_{38} - v_{48} - v_{56} \tag{146}$$

7.19 Species IkBan

Name IkBan

Initial concentration $0.19326\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v28, v33 and as a product in v29, v34).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBan} = v_{29} + v_{34} - v_{28} - v_{33} \tag{147}$$

7.20 Species IkBanNFkBn

Name IkBanNFkBn

Initial concentration $0.0013739\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v29, v30 and as a product in v28).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBanNFkBn} = v_{28} - v_{29} - v_{30} \tag{148}$$

7.21 Species IkBbn

Name IkBbn

Initial concentration $0.021887\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v38, v43 and as a product in v39, v44).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBbn} = v_{39} + v_{44} - v_{38} - v_{43} \tag{149}$$

7.22 Species IkBbnNFkBn

Name IkBbnNFkBn

Initial concentration $3.0061 \cdot 10^{-4}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v39, v40 and as a product in v38).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBbnNFkBn} = v_{38} - v_{39} - v_{40} \tag{150}$$

7.23 Species IkBbt

Name IkBbt

Initial concentration $6.3696 \cdot 10^{-4}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v42 and as a product in v59 and as a modifier in v45).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBbt} = v_{59} - v_{42} \tag{151}$$

7.24 Species IkBen

Name IkBen

Initial concentration $0.015635\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v48, v53 and as a product in v49, v54).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBen} = v_{49} + v_{54} - v_{48} - v_{53} \tag{152}$$

7.25 Species IkBenNFkBn

Name IkBenNFkBn

Initial concentration $2.1473 \cdot 10^{-4}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v49, v50 and as a product in v48).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBenNFkBn} = v_{48} - v_{49} - v_{50} \tag{153}$$

7.26 Species IkBet

Name IkBet

Initial concentration $4.55 \cdot 10^{-4}$ mol $\cdot$ l^{-1}

This species takes part in three reactions (as a reactant in v52 and as a product in v60 and as a modifier in v55).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IkBet} = v_{60} - v_{52} \tag{154}$$

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