SBML Model Report

Model name: “Proctor2007 - Age related decline of proteolysis, ubiquitin-proteome system”

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by the following two authors: Carole Proctor[1] and Enuo He[2] at April second 2007 at 9:08 a. m. and last time modified at August eleventh 2014 at 2:38 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	39
events	0	constraints	0
reactions	94	function definitions	0
global parameters	17	unit definitions	1
rules	0	initial assignments	0

Model Notes

Proctor2007 - Age related decline of proteolysis, ubiquitin-proteome system

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This is a stochastic model of the ubiquitin-proteasome system for a generic pool of native proteins (NatP), which have a half-life of about 10 hours under normal conditions. It is assumed that these proteins are only degraded after they have lost their native structure due to a damage event. This is represented in the model by the misfolding reaction which depends on the level of reactive oxygen species (ROS) in the cell. Misfolded proteins (MisP) are first bound by an E3 ubiquitin ligase. Ubiquitin (Ub) is activated by E1 (ubiquitin-activating enzyme) and then passed to E2 (ubiquitin-conjugating enzyme). The E2 enzyme then passes the ubiquitin molecule to the E3/MisP complex with the net effect that the misfolded protein is monoubiquitinated and both E2 and E3 are released. Further ubiquitin molecules are added in a step-wise manner. When the chain of ubiquitin molecules is of length 4 or more, the polyubiquitinated misfolded protein may bind to the proteasome. The model also includes de-ubiquitinating enzymes (DUB) which cleave ubiquitin molecules from the chain in a step-wise manner. They work on chains attached to misfolded proteins both unbound and bound to the proteasomes. Misfolded proteins bound to the proteasome may be degraded releasing ubiquitin. Misfolded proteins including ubiquitinated proteins may also aggregate. Aggregates (AggP) may be sequestered (Seq_AggP) which takes them out of harm's way or they may bind to the proteasome (AggP_Proteasome). Proteasomes bound by aggregates are no longer available for protein degradation.

Figure 2 and Figure 3 has been simulated using Gillespie2.

This model is described in the article:An in silico model of the ubiquitin-proteasome system that incorporates normal homeostasis and age-related decline.Proctor CJ, Tsirigotis M, Gray DA.BMC Syst Biol 2007; 1: 17

Abstract:

BACKGROUND: The ubiquitin-proteasome system is responsible for homeostatic degradation of intact protein substrates as well as the elimination of damaged or misfolded proteins that might otherwise aggregate. During ageing there is a decline in proteasome activity and an increase in aggregated proteins. Many neurodegenerative diseases are characterised by the presence of distinctive ubiquitin-positive inclusion bodies in affected regions of the brain. These inclusions consist of insoluble, unfolded, ubiquitinated polypeptides that fail to be targeted and degraded by the proteasome. We are using a systems biology approach to try and determine the primary event in the decline in proteolytic capacity with age and whether there is in fact a vicious cycle of inhibition, with accumulating aggregates further inhibiting proteolysis, prompting accumulation of aggregates and so on. A stochastic model of the ubiquitin-proteasome system has been developed using the Systems Biology Mark-up Language (SBML). Simulations are carried out on the BASIS (Biology of Ageing e-Science Integration and Simulation) system and the model output is compared to experimental data wherein levels of ubiquitin and ubiquitinated substrates are monitored in cultured cells under various conditions. The model can be used to predict the effects of different experimental procedures such as inhibition of the proteasome or shutting down the enzyme cascade responsible for ubiquitin conjugation. RESULTS: The model output shows good agreement with experimental data under a number of different conditions. However, our model predicts that monomeric ubiquitin pools are always depleted under conditions of proteasome inhibition, whereas experimental data show that monomeric pools were depleted in IMR-90 cells but not in ts20 cells, suggesting that cell lines vary in their ability to replenish ubiquitin pools and there is the need to incorporate ubiquitin turnover into

the model. Sensitivity analysis of the model revealed which parameters have an important effect on protein turnover and aggregation kinetics. CONCLUSION: We have developed a model of the ubiquitin-proteasome system using an iterative approach of model building and validation against experimental data. Using SBML to encode the model ensures that it can be easily modified and extended as more data become available. Important aspects to be included in subsequent models are details of ubiquitin turnover, models of autophagy, the inclusion of a pool of short-lived proteins and further details of the aggregation process.

This model is hosted on BioModels Database and identified by: BIOMD0000000105.

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

2 Unit Definitions

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

2.1 Unit `substance`

Definition item

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
`cytosol`			3	1	litre	☑	

3.1 Compartment `cytosol`

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

4 Species

This model contains 39 species. The boundary condition of four 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
NatP		cytosol	item	⊟	⊟
MisP		cytosol	item	⊟	⊟
Ub		cytosol	item	⊟	⊟
E1		cytosol	item	⊟	⊟
E2		cytosol	item	⊟	⊟
E3		cytosol	item	⊟	⊟
DUB		cytosol	item	⊟	⊟
Proteasome		cytosol	item	⊟	⊟
ROS		cytosol	item	⊟	⊟
E1_Ub		cytosol	item	⊟	⊟
E2_Ub		cytosol	item	⊟	⊟
E3_MisP		cytosol	item	⊟	⊟
MisP_Ub		cytosol	item	⊟	⊟
MisP_Ub2		cytosol	item	⊟	⊟
MisP_Ub3		cytosol	item	⊟	⊟
MisP_Ub4		cytosol	item	⊟	⊟
MisP_Ub5		cytosol	item	⊟	⊟
MisP_Ub6		cytosol	item	⊟	⊟
MisP_Ub7		cytosol	item	⊟	⊟
MisP_Ub8		cytosol	item	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
MisP_Ub4_Proteasome		cytosol	item	☐	☐
MisP_Ub5_Proteasome		cytosol	item	☐	☐
MisP_Ub6_Proteasome		cytosol	item	☐	☐
MisP_Ub7_Proteasome		cytosol	item	☐	☐
MisP_Ub8_Proteasome		cytosol	item	☐	☐
ATP		cytosol	item	☑	☑
ADP		cytosol	item	☑	☑
AMP		cytosol	item	☑	☑
Source		cytosol	item	☑	☑
degUb4		cytosol	item	☐	☐
degUb5		cytosol	item	☐	☐
degUb6		cytosol	item	☐	☐
degUb7		cytosol	item	☐	☐
degUb8		cytosol	item	☐	☐
totMisP		cytosol	item	☐	☐
refNatP		cytosol	item	☐	☐
AggP		cytosol	item	☐	☐
SeqAggP		cytosol	item	☐	☐
AggP_Proteasome		cytosol	item	☐	☐

5 Parameters

This model contains 17 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1			0.010		☑
k2			$2 \cdot 10^{-6}$		☑
k3			$4 \cdot 10^{-6}$		☑
k61			$1.7 \cdot 10^{-5}$		☑
k61r			$2 \cdot 10^{-4}$		☑
k62			$2 \cdot 10^{-4}$		☑
k63			0.001		☑
k64			0.001		☑
k65			0.010		☑
k66			10^{-5}		☑
k67			10^{-5}		☑
k68			10^{-5}		☑
k69			0.000		☑
k71			10^{-8}		☑
k72			10^{-8}		☑
k73			0.001		☑
k74			10^{-5}		☑

6 Reactions

This model contains 94 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	ProteinSynthesis		Source $\longrightarrow$ NatP	
2	Misfolding		NatP + ROS $\longrightarrow$ MisP + ROS + totMisP	
3	Refolding		MisP $\longrightarrow$ NatP + refNatP	
4	MisPE3Binding		MisP + E3 $\longrightarrow$ E3_MisP	
5	MisPE3Release		E3_MisP $\longrightarrow$ MisP + E3	
6	E1UbBinding		E1 + Ub + ATP $\longrightarrow$ E1_Ub + AMP	
7	E2UbBinding		E2 + E1_Ub $\longrightarrow$ E2_Ub + E1	
8	Monoubiquitination		E2_Ub + E3_MisP $\longrightarrow$ MisP_Ub + E2 + E3	
9	Polyubiquitination1		MisP_Ub + E2_Ub $\longrightarrow$ MisP_Ub2 + E2	
10	Polyubiquitination2		MisP_Ub2 + E2_Ub $\longrightarrow$ MisP_Ub3 + E2	
11	Polyubiquitination3		MisP_Ub3 + E2_Ub $\longrightarrow$ MisP_Ub4 + E2	
12	Polyubiquitination4		MisP_Ub4 + E2_Ub $\longrightarrow$ MisP_Ub5 + E2	
13	Polyubiquitination5		MisP_Ub5 + E2_Ub $\longrightarrow$ MisP_Ub6 + E2	
14	Polyubiquitination6		MisP_Ub6 + E2_Ub $\longrightarrow$ MisP_Ub7 + E2	
15	Polyubiquitination7		MisP_Ub7 + E2_Ub $\longrightarrow$ MisP_Ub8 + E2	
16	Deubiqutination1		MisP_Ub8 + DUB $\longrightarrow$ MisP_Ub7 + DUB + Ub	
17	Deubiqutination2		MisP_Ub7 + DUB $\longrightarrow$ MisP_Ub6 + DUB + Ub	
18	Deubiqutination3		MisP_Ub6 + DUB $\longrightarrow$ MisP_Ub5 + DUB + Ub	
19	Deubiqutination4		MisP_Ub5 + DUB $\longrightarrow$ MisP_Ub4 + DUB + Ub	
20	Deubiqutination5		MisP_Ub4 + DUB $\longrightarrow$ MisP_Ub3 + DUB + Ub	
21	Deubiqutination6		MisP_Ub3 + DUB $\longrightarrow$ MisP_Ub2 + DUB + Ub	
22	Deubiqutination7		MisP_Ub2 + DUB $\longrightarrow$ MisP_Ub + DUB + Ub	
23	Deubiqutination8		MisP_Ub + DUB $\longrightarrow$ MisP + DUB + Ub	

№	Id	Name	Reaction Equation	SBO
24	ProteasomeBinding1		MisP_Ub4 + Proteasome ⟶ MisP_Ub4_Proteasome	
25	ProteasomeBinding2		MisP_Ub5 + Proteasome ⟶ MisP_Ub5_Proteasome	
26	ProteasomeBinding3		MisP_Ub6 + Proteasome ⟶ MisP_Ub6_Proteasome	
27	ProteasomeBinding4		MisP_Ub7 + Proteasome ⟶ MisP_Ub7_Proteasome	
28	ProteasomeBinding5		MisP_Ub8 + Proteasome ⟶ MisP_Ub8_Proteasome	
29	DeubiquitinationBoundMisP5		MisP_Ub8_Proteasome + DUB ⟶ MisP_Ub7_Proteasome + Ub + DUB	
30	DeubiquitinationBoundMisP4		MisP_Ub7_Proteasome + DUB ⟶ MisP_Ub6_Proteasome + Ub + DUB	
31	DeubiquitinationBoundMisP3		MisP_Ub6_Proteasome + DUB ⟶ MisP_Ub5_Proteasome + Ub + DUB	
32	DeubiquitinationBoundMisP2		MisP_Ub5_Proteasome + DUB ⟶ MisP_Ub4_Proteasome + Ub + DUB	
33	DeubiquitinationBoundMisP1		MisP_Ub4_Proteasome + DUB ⟶ MisP_Ub3 + Proteasome + Ub + DUB	
34	ProteasomeActivity1		MisP_Ub4_Proteasome + ATP ⟶ 4 Ub + Proteasome + ADP + degUb4	
35	ProteasomeActivity2		MisP_Ub5_Proteasome + ATP ⟶ 5 Ub + Proteasome + ADP + degUb5	
36	ProteasomeActivity3		MisP_Ub6_Proteasome + ATP ⟶ 6 Ub + Proteasome + ADP + degUb6	
37	ProteasomeActivity4		MisP_Ub7_Proteasome + ATP ⟶ 7 Ub + Proteasome + ADP + degUb7	
38	ProteasomeActivity5		MisP_Ub8_Proteasome + ATP ⟶ 8 Ub + Proteasome + ADP + degUb8	
39	Aggregation1		2 MisP ⟶ AggP	
40	Aggregation2		MisP + AggP ⟶ 2 AggP	
41	Aggregation3		2 MisP_Ub ⟶ AggP	
42	Aggregation4		2 MisP_Ub2 ⟶ AggP	

№	Id	Name	Reaction Equation	SBO
43	Aggregation5		$2\,\mathrm{MisP\_Ub3} \longrightarrow \mathrm{AggP}$	
44	Aggregation6		$2\,\mathrm{MisP\_Ub4} \longrightarrow \mathrm{AggP}$	
45	Aggregation7		$2\,\mathrm{MisP\_Ub5} \longrightarrow \mathrm{AggP}$	
46	Aggregation8		$2\,\mathrm{MisP\_Ub6} \longrightarrow \mathrm{AggP}$	
47	Aggregation9		$2\,\mathrm{MisP\_Ub7} \longrightarrow \mathrm{AggP}$	
48	Aggregation10		$2\,\mathrm{MisP\_Ub8} \longrightarrow \mathrm{AggP}$	
49	Aggregation11		$\mathrm{MisP\_Ub} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
50	Aggregation12		$\mathrm{MisP\_Ub2} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
51	Aggregation13		$\mathrm{MisP\_Ub3} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
52	Aggregation14		$\mathrm{MisP\_Ub4} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
53	Aggregation15		$\mathrm{MisP\_Ub5} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
54	Aggregation16		$\mathrm{MisP\_Ub6} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
55	Aggregation17		$\mathrm{MisP\_Ub7} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
56	Aggregation18		$\mathrm{MisP\_Ub8} + \mathrm{MisP} \longrightarrow \mathrm{AggP}$	
57	Aggregation19		$\mathrm{MisP\_Ub} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
58	Aggregation20		$\mathrm{MisP\_Ub2} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
59	Aggregation21		$\mathrm{MisP\_Ub3} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
60	Aggregation22		$\mathrm{MisP\_Ub4} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
61	Aggregation23		$\mathrm{MisP\_Ub5} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
62	Aggregation24		$\mathrm{MisP\_Ub6} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
63	Aggregation25		$\mathrm{MisP\_Ub7} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
64	Aggregation26		$\mathrm{MisP\_Ub8} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP}$	
65	Aggregation27		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub2} \longrightarrow \mathrm{AggP}$	
66	Aggregation28		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub3} \longrightarrow \mathrm{AggP}$	
67	Aggregation29		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub4} \longrightarrow \mathrm{AggP}$	
68	Aggregation30		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub5} \longrightarrow \mathrm{AggP}$	
69	Aggregation31		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub6} \longrightarrow \mathrm{AggP}$	
70	Aggregation32		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub7} \longrightarrow \mathrm{AggP}$	
71	Aggregation33		$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub8} \longrightarrow \mathrm{AggP}$	

№	Id	Name	Reaction Equation	SBO
72	Aggregation34		MisP_Ub2 + MisP_Ub3 ⟶ AggP	
73	Aggregation35		MisP_Ub2 + MisP_Ub4 ⟶ AggP	
74	Aggregation36		MisP_Ub2 + MisP_Ub5 ⟶ AggP	
75	Aggregation37		MisP_Ub2 + MisP_Ub6 ⟶ AggP	
76	Aggregation38		MisP_Ub2 + MisP_Ub7 ⟶ AggP	
77	Aggregation39		MisP_Ub2 + MisP_Ub8 ⟶ AggP	
78	Aggregation40		MisP_Ub3 + MisP_Ub4 ⟶ AggP	
79	Aggregation41		MisP_Ub3 + MisP_Ub5 ⟶ AggP	
80	Aggregation42		MisP_Ub3 + MisP_Ub6 ⟶ AggP	
81	Aggregation43		MisP_Ub3 + MisP_Ub7 ⟶ AggP	
82	Aggregation44		MisP_Ub3 + MisP_Ub8 ⟶ AggP	
83	Aggregation45		MisP_Ub4 + MisP_Ub5 ⟶ AggP	
84	Aggregation46		MisP_Ub4 + MisP_Ub6 ⟶ AggP	
85	Aggregation47		MisP_Ub4 + MisP_Ub7 ⟶ AggP	
86	Aggregation48		MisP_Ub4 + MisP_Ub8 ⟶ AggP	
87	Aggregation49		MisP_Ub5 + MisP_Ub6 ⟶ AggP	
88	Aggregation50		MisP_Ub5 + MisP_Ub7 ⟶ AggP	
89	Aggregation51		MisP_Ub5 + MisP_Ub8 ⟶ AggP	
90	Aggregation52		MisP_Ub6 + MisP_Ub7 ⟶ AggP	
91	Aggregation53		MisP_Ub6 + MisP_Ub8 ⟶ AggP	
92	Aggregation54		MisP_Ub7 + MisP_Ub8 ⟶ AggP	
93	SequesteringOfAggregates		AggP ⟶ SeqAggP	
94	ProteasomeInhibtion		AggP + Proteasome ⟶ AggP_Proteasome	

6.1 Reaction `ProteinSynthesis`

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

Reaction equation

$$\text{Source} \longrightarrow \text{NatP} \tag{1}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
`Source`		

Product

Table 7: Properties of each product.

Id	Name	SBO
`NatP`		

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{k1} \cdot \text{Source} \tag{2}$$

6.2 Reaction `Misfolding`

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

Reaction equation

$$\text{NatP} + \text{ROS} \longrightarrow \text{MisP} + \text{ROS} + \text{totMisP} \tag{3}$$

Reactants

Table 8: Properties of each reactant.

Id	Name	SBO
`NatP`		
`ROS`		

Products

Table 9: Properties of each product.

Id	Name	SBO
MisP		
ROS		
totMisP		

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{k2} \cdot \mathrm{NatP} \cdot \mathrm{ROS} \tag{4}$$

6.3 Reaction Refolding

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

Reaction equation

$$\mathrm{MisP} \longrightarrow \mathrm{NatP} + \mathrm{refNatP} \tag{5}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
MisP		

Products

Table 11: Properties of each product.

Id	Name	SBO
NatP		
refNatP		

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{k3} \cdot \mathrm{MisP} \tag{6}$$

6.4 Reaction MisPE3Binding

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

Reaction equation

$$\text{MisP} + \text{E3} \longrightarrow \text{E3\_MisP} \tag{7}$$

Reactants

Table 12: Properties of each reactant.

Id	Name	SBO
MisP		
E3		

Product

Table 13: Properties of each product.

Id	Name	SBO
E3_MisP		

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{k61} \cdot \text{MisP} \cdot \text{E3} \tag{8}$$

6.5 Reaction MisPE3Release

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

Reaction equation

$$\text{E3\_MisP} \longrightarrow \text{MisP} + \text{E3} \tag{9}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
E3_MisP		

Products

Table 15: Properties of each product.

Id	Name	SBO
MisP		
E3		

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{k61r} \cdot \mathrm{E3\_MisP} \tag{10}$$

6.6 Reaction E1UbBinding

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

Reaction equation

$$\mathrm{E1} + \mathrm{Ub} + \mathrm{ATP} \longrightarrow \mathrm{E1\_Ub} + \mathrm{AMP} \tag{11}$$

Reactants

Table 16: Properties of each reactant.

Id	Name	SBO
E1		
Ub		
ATP		

Products

Table 17: Properties of each product.

Id	Name	SBO
E1_Ub		
AMP		

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \frac{\text{k62} \cdot \text{E1} \cdot \text{Ub} \cdot \text{ATP}}{5000 + \text{ATP}} \tag{12}$$

6.7 Reaction E2UbBinding

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

Reaction equation

$$\text{E2} + \text{E1\_Ub} \longrightarrow \text{E2\_Ub} + \text{E1} \tag{13}$$

Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
E2		
E1_Ub		

Products

Table 19: Properties of each product.

Id	Name	SBO
E2_Ub		
E1		

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \text{k63} \cdot \text{E2} \cdot \text{E1\_Ub} \tag{14}$$

6.8 Reaction Monoubiquitination

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

Reaction equation

$$\text{E2\_Ub} + \text{E3\_MisP} \longrightarrow \text{MisP\_Ub} + \text{E2} + \text{E3} \tag{15}$$

Reactants

Table 20: Properties of each reactant.

Id	Name	SBO
E2_Ub		
E3_MisP		

Products

Table 21: Properties of each product.

Id	Name	SBO
MisP_Ub		
E2		
E3		

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{k64} \cdot \text{E2\_Ub} \cdot \text{E3\_MisP} \tag{16}$$

6.9 Reaction Polyubiquitination1

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

Reaction equation

$$\text{MisP\_Ub} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub2} + \text{E2} \tag{17}$$

Reactants

Table 22: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
E2_Ub		

Products

Table 23: Properties of each product.

Id	Name	SBO
MisP_Ub2		
E2		

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{k65} \cdot \text{MisP\_Ub} \cdot \text{E2\_Ub} \tag{18}$$

6.10 Reaction Polyubiquitination2

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

Reaction equation

$$\text{MisP\_Ub2} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub3} + \text{E2} \tag{19}$$

Reactants

Table 24: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
E2_Ub		

Products

Table 25: Properties of each product.

Id	Name	SBO
MisP_Ub3		
E2		

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{k65} \cdot \text{MisP\_Ub2} \cdot \text{E2\_Ub} \tag{20}$$

6.11 Reaction Polyubiquitination3

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

Reaction equation

$$\text{MisP\_Ub3} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub4} + \text{E2} \tag{21}$$

Reactants

Table 26: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
E2_Ub		

Products

Table 27: Properties of each product.

Id	Name	SBO
MisP_Ub4		
E2		

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{k65} \cdot \text{MisP\_Ub3} \cdot \text{E2\_Ub} \tag{22}$$

6.12 Reaction Polyubiquitination4

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

Reaction equation

$$\text{MisP\_Ub4} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub5} + \text{E2} \tag{23}$$

Reactants

Table 28: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
E2_Ub		

Products

Table 29: Properties of each product.

Id	Name	SBO
MisP_Ub5		
E2		

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{k65} \cdot \text{MisP\_Ub4} \cdot \text{E2\_Ub} \tag{24}$$

6.13 Reaction Polyubiquitination5

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

Reaction equation

$$\text{MisP\_Ub5} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub6} + \text{E2} \tag{25}$$

Reactants

Table 30: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		
E2_Ub		

Products

Table 31: Properties of each product.

Id	Name	SBO
MisP_Ub6		

Id	Name	SBO
E2		

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{k65} \cdot \text{MisP\_Ub5} \cdot \text{E2\_Ub} \tag{26}$$

6.14 Reaction `Polyubiquitination6`

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

Reaction equation

$$\text{MisP\_Ub6} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub7} + \text{E2} \tag{27}$$

Reactants

Table 32: Properties of each reactant.

Id	Name	SBO
`MisP_Ub6`		
`E2_Ub`		

Products

Table 33: Properties of each product.

Id	Name	SBO
`MisP_Ub7`		
`E2`		

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{k65} \cdot \text{MisP\_Ub6} \cdot \text{E2\_Ub} \tag{28}$$

6.15 Reaction `Polyubiquitination7`

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

Reaction equation

$$\text{MisP\_Ub7} + \text{E2\_Ub} \longrightarrow \text{MisP\_Ub8} + \text{E2} \tag{29}$$

Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		
E2_Ub		

Products

Table 35: Properties of each product.

Id	Name	SBO
MisP_Ub8		
E2		

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{k65} \cdot \text{MisP\_Ub7} \cdot \text{E2\_Ub} \tag{30}$$

6.16 Reaction Deubiqutination1

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

Reaction equation

$$\text{MisP\_Ub8} + \text{DUB} \longrightarrow \text{MisP\_Ub7} + \text{DUB} + \text{Ub} \tag{31}$$

Reactants

Table 36: Properties of each reactant.

Id	Name	SBO
MisP_Ub8		
DUB		

Products

Table 37: Properties of each product.

Id	Name	SBO
MisP_Ub7		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \text{k66} \cdot \text{MisP\_Ub8} \cdot \text{DUB} \tag{32}$$

6.17 Reaction Deubiqutination2

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

Reaction equation

$$\text{MisP\_Ub7} + \text{DUB} \longrightarrow \text{MisP\_Ub6} + \text{DUB} + \text{Ub} \tag{33}$$

Reactants

Table 38: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		
DUB		

Products

Table 39: Properties of each product.

Id	Name	SBO
MisP_Ub6		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \text{k66} \cdot \text{MisP\_Ub7} \cdot \text{DUB} \tag{34}$$

6.18 Reaction Deubiqutination3

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

Reaction equation

$$\text{MisP\_Ub6} + \text{DUB} \longrightarrow \text{MisP\_Ub5} + \text{DUB} + \text{Ub} \tag{35}$$

Reactants

Table 40: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		
DUB		

Products

Table 41: Properties of each product.

Id	Name	SBO
MisP_Ub5		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \text{k66} \cdot \text{MisP\_Ub6} \cdot \text{DUB} \tag{36}$$

6.19 Reaction Deubiqutination4

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

Reaction equation

$$\text{MisP\_Ub5} + \text{DUB} \longrightarrow \text{MisP\_Ub4} + \text{DUB} + \text{Ub} \tag{37}$$

Reactants

Table 42: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		
DUB		

Products

Table 43: Properties of each product.

Id	Name	SBO
MisP_Ub4		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{k66} \cdot \text{MisP\_Ub5} \cdot \text{DUB} \tag{38}$$

6.20 Reaction Deubiqutination5

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

Reaction equation

$$\text{MisP\_Ub4} + \text{DUB} \longrightarrow \text{MisP\_Ub3} + \text{DUB} + \text{Ub} \tag{39}$$

Reactants

Table 44: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
DUB		

Products

Table 45: Properties of each product.

Id	Name	SBO
MisP_Ub3		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \text{k66} \cdot \text{MisP\_Ub4} \cdot \text{DUB} \tag{40}$$

6.21 Reaction Deubiqutination6

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

Reaction equation

$$\text{MisP\_Ub3} + \text{DUB} \longrightarrow \text{MisP\_Ub2} + \text{DUB} + \text{Ub} \tag{41}$$

Reactants

Table 46: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
DUB		

Products

Table 47: Properties of each product.

Id	Name	SBO
MisP_Ub2		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \text{k66} \cdot \text{MisP\_Ub3} \cdot \text{DUB} \tag{42}$$

6.22 Reaction Deubiqutination7

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

Reaction equation

$$\text{MisP\_Ub2} + \text{DUB} \longrightarrow \text{MisP\_Ub} + \text{DUB} + \text{Ub} \tag{43}$$

Reactants

Table 48: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
DUB		

Products

Table 49: Properties of each product.

Id	Name	SBO
MisP_Ub		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{k66} \cdot \text{MisP\_Ub2} \cdot \text{DUB} \tag{44}$$

6.23 Reaction Deubiqutination8

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

Reaction equation

$$\text{MisP\_Ub} + \text{DUB} \longrightarrow \text{MisP} + \text{DUB} + \text{Ub} \tag{45}$$

Reactants

Table 50: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
DUB		

Products

Table 51: Properties of each product.

Id	Name	SBO
MisP		
DUB		
Ub		

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{k66} \cdot \text{MisP\_Ub} \cdot \text{DUB} \tag{46}$$

6.24 Reaction ProteasomeBinding1

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

Reaction equation

$$\text{MisP\_Ub4} + \text{Proteasome} \longrightarrow \text{MisP\_Ub4\_Proteasome} \tag{47}$$

Reactants

Table 52: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
Proteasome		

Product

Table 53: Properties of each product.

Id	Name	SBO
MisP_Ub4_Proteasome		

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \text{k67} \cdot \text{MisP\_Ub4} \cdot \text{Proteasome} \tag{48}$$

6.25 Reaction ProteasomeBinding2

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

Reaction equation

$$\text{MisP\_Ub5} + \text{Proteasome} \longrightarrow \text{MisP\_Ub5\_Proteasome} \tag{49}$$

Reactants

Table 54: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		
Proteasome		

Product

Table 55: Properties of each product.

Id	Name	SBO
MisP_Ub5_Proteasome		

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{k67} \cdot \text{MisP\_Ub5} \cdot \text{Proteasome} \tag{50}$$

6.26 Reaction ProteasomeBinding3

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

Reaction equation

$$\text{MisP\_Ub6} + \text{Proteasome} \longrightarrow \text{MisP\_Ub6\_Proteasome} \tag{51}$$

Reactants

Table 56: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		
Proteasome		

Product

Table 57: Properties of each product.

Id	Name	SBO
MisP_Ub6_Proteasome		

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \text{k67} \cdot \text{MisP\_Ub6} \cdot \text{Proteasome} \tag{52}$$

6.27 Reaction ProteasomeBinding4

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

Reaction equation

$$\text{MisP\_Ub7} + \text{Proteasome} \longrightarrow \text{MisP\_Ub7\_Proteasome} \tag{53}$$

Reactants

Table 58: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		
Proteasome		

Product

Table 59: Properties of each product.

Id	Name	SBO
MisP_Ub7_Proteasome		

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \text{k67} \cdot \text{MisP\_Ub7} \cdot \text{Proteasome} \tag{54}$$

6.28 Reaction ProteasomeBinding5

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

Reaction equation

$$\text{MisP\_Ub8} + \text{Proteasome} \longrightarrow \text{MisP\_Ub8\_Proteasome} \tag{55}$$

Reactants

Table 60: Properties of each reactant.

Id	Name	SBO
MisP_Ub8		
Proteasome		

Product

Table 61: Properties of each product.

Id	Name	SBO
MisP_Ub8_Proteasome		

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \text{k67} \cdot \text{MisP\_Ub8} \cdot \text{Proteasome} \tag{56}$$

6.29 Reaction DeubiquitinationBoundMisP5

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

Reaction equation

$$\text{MisP\_Ub8\_Proteasome} + \text{DUB} \longrightarrow \text{MisP\_Ub7\_Proteasome} + \text{Ub} + \text{DUB} \tag{57}$$

Reactants

Table 62: Properties of each reactant.

Id	Name	SBO
MisP_Ub8_Proteasome		
DUB		

Products

Table 63: Properties of each product.

Id	Name	SBO
MisP_Ub7_Proteasome		
Ub		
DUB		

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{k68} \cdot \text{MisP\_Ub8\_Proteasome} \cdot \text{DUB} \tag{58}$$

6.30 Reaction DeubiquitinationBoundMisP4

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

Reaction equation

$$\text{MisP\_Ub7\_Proteasome} + \text{DUB} \longrightarrow \text{MisP\_Ub6\_Proteasome} + \text{Ub} + \text{DUB} \tag{59}$$

Reactants

Table 64: Properties of each reactant.

Id	Name	SBO
MisP_Ub7_Proteasome		
DUB		

Products

Table 65: Properties of each product.

Id	Name	SBO
MisP_Ub6_Proteasome		
Ub		
DUB		

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \text{k68} \cdot \text{MisP\_Ub7\_Proteasome} \cdot \text{DUB} \tag{60}$$

6.31 Reaction DeubiquitinationBoundMisP3

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

Reaction equation

$$\text{MisP\_Ub6\_Proteasome} + \text{DUB} \longrightarrow \text{MisP\_Ub5\_Proteasome} + \text{Ub} + \text{DUB} \tag{61}$$

Reactants

Table 66: Properties of each reactant.

Id	Name	SBO
MisP_Ub6_Proteasome		
DUB		

Products

Table 67: Properties of each product.

Id	Name	SBO
MisP_Ub5_Proteasome		
Ub		
DUB		

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{k68} \cdot \text{MisP\_Ub6\_Proteasome} \cdot \text{DUB} \tag{62}$$

6.32 Reaction DeubiquitinationBoundMisP2

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

Reaction equation

$$\text{MisP\_Ub5\_Proteasome} + \text{DUB} \longrightarrow \text{MisP\_Ub4\_Proteasome} + \text{Ub} + \text{DUB} \tag{63}$$

Reactants

Table 68: Properties of each reactant.

Id	Name	SBO
MisP_Ub5_Proteasome		
DUB		

Products

Table 69: Properties of each product.

Id	Name	SBO
MisP_Ub4_Proteasome		
Ub		
DUB		

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \text{k68} \cdot \text{MisP\_Ub5\_Proteasome} \cdot \text{DUB} \tag{64}$$

6.33 Reaction DeubiquitinationBoundMisP1

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

Reaction equation

$$\text{MisP\_Ub4\_Proteasome} + \text{DUB} \longrightarrow \text{MisP\_Ub3} + \text{Proteasome} + \text{Ub} + \text{DUB} \tag{65}$$

Reactants

Table 70: Properties of each reactant.

Id	Name	SBO
MisP_Ub4_Proteasome		
DUB		

Products

Table 71: Properties of each product.

Id	Name	SBO
MisP_Ub3		
Proteasome		
Ub		
DUB		

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \text{k68} \cdot \text{MisP\_Ub4\_Proteasome} \cdot \text{DUB} \tag{66}$$

6.34 Reaction ProteasomeActivity1

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

Reaction equation

$$\text{MisP\_Ub4\_Proteasome} + \text{ATP} \longrightarrow 4\,\text{Ub} + \text{Proteasome} + \text{ADP} + \text{degUb4} \tag{67}$$

Reactants

Table 72: Properties of each reactant.

Id	Name	SBO
MisP_Ub4_Proteasome		
ATP		

Products

Table 73: Properties of each product.

Id	Name	SBO
Ub		
Proteasome		
ADP		
degUb4		

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \frac{\text{k69} \cdot \text{MisP\_Ub4\_Proteasome} \cdot \text{ATP}}{5000 + \text{ATP}} \tag{68}$$

6.35 Reaction ProteasomeActivity2

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

Reaction equation

$$\text{MisP\_Ub5\_Proteasome} + \text{ATP} \longrightarrow 5\,\text{Ub} + \text{Proteasome} + \text{ADP} + \text{degUb5} \tag{69}$$

Reactants

Table 74: Properties of each reactant.

Id	Name	SBO
MisP_Ub5_Proteasome		
ATP		

Products

Table 75: Properties of each product.

Id	Name	SBO
Ub		
Proteasome		
ADP		
degUb5		

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \frac{\text{k69} \cdot \text{MisP\_Ub5\_Proteasome} \cdot \text{ATP}}{5000 + \text{ATP}} \tag{70}$$

6.36 Reaction ProteasomeActivity3

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

Reaction equation

$$\text{MisP\_Ub6\_Proteasome} + \text{ATP} \longrightarrow 6\,\text{Ub} + \text{Proteasome} + \text{ADP} + \text{degUb6} \tag{71}$$

Reactants

Table 76: Properties of each reactant.

Id	Name	SBO
MisP_Ub6_Proteasome		
ATP		

Products

Table 77: Properties of each product.

Id	Name	SBO
Ub		
Proteasome		
ADP		
degUb6		

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \frac{\text{k69} \cdot \text{MisP\_Ub6\_Proteasome} \cdot \text{ATP}}{5000 + \text{ATP}} \tag{72}$$

6.37 Reaction `ProteasomeActivity4`

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

Reaction equation

$$\text{MisP\_Ub7\_Proteasome} + \text{ATP} \longrightarrow 7\,\text{Ub} + \text{Proteasome} + \text{ADP} + \text{degUb7} \tag{73}$$

Reactants

Table 78: Properties of each reactant.

Id	Name	SBO
`MisP_Ub7_Proteasome`		
`ATP`		

Products

Table 79: Properties of each product.

Id	Name	SBO
`Ub`		
`Proteasome`		
`ADP`		
`degUb7`		

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \frac{\text{k69} \cdot \text{MisP\_Ub7\_Proteasome} \cdot \text{ATP}}{5000 + \text{ATP}} \tag{74}$$

6.38 Reaction `ProteasomeActivity5`

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

Reaction equation

$$\text{MisP\_Ub8\_Proteasome} + \text{ATP} \longrightarrow 8\,\text{Ub} + \text{Proteasome} + \text{ADP} + \text{degUb8} \tag{75}$$

Reactants

Table 80: Properties of each reactant.

Id	Name	SBO
`MisP_Ub8_Proteasome`		
`ATP`		

Products

Table 81: Properties of each product.

Id	Name	SBO
`Ub`		
`Proteasome`		
`ADP`		
`degUb8`		

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \frac{\text{k69} \cdot \text{MisP\_Ub8\_Proteasome} \cdot \text{ATP}}{5000 + \text{ATP}} \tag{76}$$

6.39 Reaction `Aggregation1`

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

Reaction equation

$$2\,\text{MisP} \longrightarrow \text{AggP} \tag{77}$$

Reactant

Table 82: Properties of each reactant.

Id	Name	SBO
`MisP`		

Product

Table 83: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \mathrm{k71} \cdot \mathrm{MisP} \cdot (\mathrm{MisP} - 1) \cdot 0.5 \tag{78}$$

6.40 Reaction Aggregation2

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

Reaction equation

$$\mathrm{MisP} + \mathrm{AggP} \longrightarrow 2\,\mathrm{AggP} \tag{79}$$

Reactants

Table 84: Properties of each reactant.

Id	Name	SBO
MisP		
AggP		

Product

Table 85: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \mathrm{k71} \cdot \mathrm{MisP} \cdot \mathrm{AggP} \tag{80}$$

6.41 Reaction Aggregation3

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

Reaction equation

$$2\,\text{MisP\_Ub} \longrightarrow \text{AggP} \tag{81}$$

Reactant

Table 86: Properties of each reactant.

Id	Name	SBO
MisP_Ub		

Product

Table 87: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \text{k72} \cdot \text{MisP\_Ub} \cdot (\text{MisP\_Ub} - 1) \cdot 0.5 \tag{82}$$

6.42 Reaction Aggregation4

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

Reaction equation

$$2\,\text{MisP\_Ub2} \longrightarrow \text{AggP} \tag{83}$$

Reactant

Table 88: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		

Product

Table 89: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = \mathrm{k72} \cdot \mathrm{MisP\_Ub2} \cdot (\mathrm{MisP\_Ub2} - 1) \cdot 0.5 \tag{84}$$

6.43 Reaction Aggregation5

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

Reaction equation

$$2\,\mathrm{MisP\_Ub3} \longrightarrow \mathrm{AggP} \tag{85}$$

Reactant

Table 90: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		

Product

Table 91: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{43} = \mathrm{k72} \cdot \mathrm{MisP\_Ub3} \cdot (\mathrm{MisP\_Ub3} - 1) \cdot 0.5 \tag{86}$$

6.44 Reaction Aggregation6

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

Reaction equation

$$2\,\text{MisP\_Ub4} \longrightarrow \text{AggP} \tag{87}$$

Reactant

Table 92: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		

Product

Table 93: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{44} = \text{k72} \cdot \text{MisP\_Ub4} \cdot (\text{MisP\_Ub4} - 1) \cdot 0.5 \tag{88}$$

6.45 Reaction Aggregation7

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

Reaction equation

$$2\,\text{MisP\_Ub5} \longrightarrow \text{AggP} \tag{89}$$

Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		

Product

Table 95: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{45} = \mathrm{k72} \cdot \mathrm{MisP\_Ub5} \cdot (\mathrm{MisP\_Ub5} - 1) \cdot 0.5 \tag{90}$$

6.46 Reaction Aggregation8

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

Reaction equation

$$2\,\mathrm{MisP\_Ub6} \longrightarrow \mathrm{AggP} \tag{91}$$

Reactant

Table 96: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		

Product

Table 97: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \mathrm{k72} \cdot \mathrm{MisP\_Ub6} \cdot (\mathrm{MisP\_Ub6} - 1) \cdot 0.5 \tag{92}$$

6.47 Reaction Aggregation9

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

Reaction equation

$$2\,\text{MisP\_Ub7} \longrightarrow \text{AggP} \tag{93}$$

Reactant

Table 98: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		

Product

Table 99: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = \text{k72} \cdot \text{MisP\_Ub7} \cdot (\text{MisP\_Ub7} - 1) \cdot 0.5 \tag{94}$$

6.48 Reaction Aggregation10

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

Reaction equation

$$2\,\text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{95}$$

Reactant

Table 100: Properties of each reactant.

Id	Name	SBO
MisP_Ub8		

Product

Table 101: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = \text{k72} \cdot \text{MisP\_Ub8} \cdot (\text{MisP\_Ub8} - 1) \cdot 0.5 \tag{96}$$

6.49 Reaction Aggregation11

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP} \longrightarrow \text{AggP} \tag{97}$$

Reactants

Table 102: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP		

Product

Table 103: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{MisP} \tag{98}$$

6.50 Reaction Aggregation12

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP} \longrightarrow \text{AggP} \tag{99}$$

Reactants

Table 104: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP		

Product

Table 105: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP} \tag{100}$$

6.51 Reaction Aggregation13

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

Reaction equation

$$\text{MisP\_Ub3} + \text{MisP} \longrightarrow \text{AggP} \tag{101}$$

Reactants

Table 106: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		

Id	Name	SBO
MisP		

Product

Table 107: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{51} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{MisP} \tag{102}$$

6.52 Reaction Aggregation14

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

Reaction equation

$$\text{MisP\_Ub4} + \text{MisP} \longrightarrow \text{AggP} \tag{103}$$

Reactants

Table 108: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
MisP		

Product

Table 109: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{52} = \text{k72} \cdot \text{MisP\_Ub4} \cdot \text{MisP} \tag{104}$$

6.53 Reaction `Aggregation15`

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

Reaction equation

$$\text{MisP\_Ub5} + \text{MisP} \longrightarrow \text{AggP} \tag{105}$$

Reactants

Table 110: Properties of each reactant.

Id	Name	SBO
`MisP_Ub5`		
`MisP`		

Product

Table 111: Properties of each product.

Id	Name	SBO
`AggP`		

Kinetic Law

Derived unit contains undeclared units

$$v_{53} = \text{k72} \cdot \text{MisP\_Ub5} \cdot \text{MisP} \tag{106}$$

6.54 Reaction `Aggregation16`

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

Reaction equation

$$\text{MisP\_Ub6} + \text{MisP} \longrightarrow \text{AggP} \tag{107}$$

Reactants

Table 112: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		
MisP		

Product

Table 113: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{54} = \mathrm{k72} \cdot \mathrm{MisP\_Ub6} \cdot \mathrm{MisP} \tag{108}$$

6.55 Reaction Aggregation17

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

Reaction equation

$$\mathrm{MisP\_Ub7} + \mathrm{MisP} \longrightarrow \mathrm{AggP} \tag{109}$$

Reactants

Table 114: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		
MisP		

Product

Table 115: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{55} = \mathrm{k72} \cdot \mathrm{MisP\_Ub7} \cdot \mathrm{MisP} \tag{110}$$

6.56 Reaction Aggregation18

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

Reaction equation

$$\mathrm{MisP\_Ub8} + \mathrm{MisP} \longrightarrow \mathrm{AggP} \tag{111}$$

Reactants

Table 116: Properties of each reactant.

Id	Name	SBO
MisP_Ub8		
MisP		

Product

Table 117: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{56} = \mathrm{k72} \cdot \mathrm{MisP\_Ub8} \cdot \mathrm{MisP} \tag{112}$$

6.57 Reaction Aggregation19

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

Reaction equation

$$\text{MisP\_Ub} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{113}$$

Reactants

Table 118: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
AggP		

Product

Table 119: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{57} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{AggP} \tag{114}$$

6.58 Reaction Aggregation20

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

Reaction equation

$$\text{MisP\_Ub2} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{115}$$

Reactants

Table 120: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
AggP		

Product

Table 121: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{58} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{AggP} \tag{116}$$

6.59 Reaction Aggregation21

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

Reaction equation

$$\text{MisP\_Ub3} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{117}$$

Reactants

Table 122: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
AggP		

Product

Table 123: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{59} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{AggP} \tag{118}$$

6.60 Reaction Aggregation22

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

Reaction equation

$$\text{MisP\_Ub4} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{119}$$

Reactants

Table 124: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
AggP		

Product

Table 125: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{60} = \text{k72} \cdot \text{MisP\_Ub4} \cdot \text{AggP} \tag{120}$$

6.61 Reaction Aggregation23

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

Reaction equation

$$\text{MisP\_Ub5} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{121}$$

Reactants

Table 126: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		

Id	Name	SBO
AggP		

Product

Table 127: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{61} = \text{k72} \cdot \text{MisP\_Ub5} \cdot \text{AggP} \tag{122}$$

6.62 Reaction Aggregation24

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

Reaction equation

$$\text{MisP\_Ub6} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{123}$$

Reactants

Table 128: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		
AggP		

Product

Table 129: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{62} = \text{k72} \cdot \text{MisP\_Ub6} \cdot \text{AggP} \tag{124}$$

6.63 Reaction Aggregation25

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

Reaction equation

$$\text{MisP\_Ub7} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{125}$$

Reactants

Table 130: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		
AggP		

Product

Table 131: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{63} = \text{k72} \cdot \text{MisP\_Ub7} \cdot \text{AggP} \tag{126}$$

6.64 Reaction Aggregation26

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

Reaction equation

$$\text{MisP\_Ub8} + \text{AggP} \longrightarrow 2\,\text{AggP} \tag{127}$$

Reactants

Table 132: Properties of each reactant.

Id	Name	SBO
MisP_Ub8		
AggP		

Product

Table 133: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{64} = \text{k72} \cdot \text{MisP\_Ub8} \cdot \text{AggP} \tag{128}$$

6.65 Reaction Aggregation27

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP\_Ub2} \longrightarrow \text{AggP} \tag{129}$$

Reactants

Table 134: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP_Ub2		

Product

Table 135: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{65} = \mathrm{k72} \cdot \mathrm{MisP\_Ub} \cdot \mathrm{MisP\_Ub2} \tag{130}$$

6.66 Reaction Aggregation28

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

Reaction equation

$$\mathrm{MisP\_Ub} + \mathrm{MisP\_Ub3} \longrightarrow \mathrm{AggP} \tag{131}$$

Reactants

Table 136: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP_Ub3		

Product

Table 137: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{66} = \mathrm{k72} \cdot \mathrm{MisP\_Ub} \cdot \mathrm{MisP\_Ub3} \tag{132}$$

6.67 Reaction Aggregation29

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP\_Ub4} \longrightarrow \text{AggP} \tag{133}$$

Reactants

Table 138: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP_Ub4		

Product

Table 139: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{67} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{MisP\_Ub4} \tag{134}$$

6.68 Reaction Aggregation30

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP\_Ub5} \longrightarrow \text{AggP} \tag{135}$$

Reactants

Table 140: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP_Ub5		

Product

Table 141: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{68} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{MisP\_Ub5} \tag{136}$$

6.69 Reaction Aggregation31

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP\_Ub6} \longrightarrow \text{AggP} \tag{137}$$

Reactants

Table 142: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP_Ub6		

Product

Table 143: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{69} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{MisP\_Ub6} \tag{138}$$

6.70 Reaction Aggregation32

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP\_Ub7} \longrightarrow \text{AggP} \tag{139}$$

Reactants

Table 144: Properties of each reactant.

Id	Name	SBO
MisP_Ub		
MisP_Ub7		

Product

Table 145: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{70} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{MisP\_Ub7} \tag{140}$$

6.71 Reaction Aggregation33

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

Reaction equation

$$\text{MisP\_Ub} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{141}$$

Reactants

Table 146: Properties of each reactant.

Id	Name	SBO
MisP_Ub		

Id	Name	SBO
MisP_Ub8		

Product

Table 147: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{71} = \text{k72} \cdot \text{MisP\_Ub} \cdot \text{MisP\_Ub8} \tag{142}$$

6.72 Reaction Aggregation34

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP\_Ub3} \longrightarrow \text{AggP} \tag{143}$$

Reactants

Table 148: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP_Ub3		

Product

Table 149: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{72} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP\_Ub3} \tag{144}$$

6.73 Reaction Aggregation35

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP\_Ub4} \longrightarrow \text{AggP} \tag{145}$$

Reactants

Table 150: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP_Ub4		

Product

Table 151: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{73} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP\_Ub4} \tag{146}$$

6.74 Reaction Aggregation36

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP\_Ub5} \longrightarrow \text{AggP} \tag{147}$$

Reactants

Table 152: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP_Ub5		

Product

Table 153: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{74} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP\_Ub5} \tag{148}$$

6.75 Reaction Aggregation37

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP\_Ub6} \longrightarrow \text{AggP} \tag{149}$$

Reactants

Table 154: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP_Ub6		

Product

Table 155: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{75} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP\_Ub6} \tag{150}$$

6.76 Reaction Aggregation38

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP\_Ub7} \longrightarrow \text{AggP} \tag{151}$$

Reactants

Table 156: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP_Ub7		

Product

Table 157: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{76} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP\_Ub7} \tag{152}$$

6.77 Reaction Aggregation39

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

Reaction equation

$$\text{MisP\_Ub2} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{153}$$

Reactants

Table 158: Properties of each reactant.

Id	Name	SBO
MisP_Ub2		
MisP_Ub8		

Product

Table 159: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{77} = \text{k72} \cdot \text{MisP\_Ub2} \cdot \text{MisP\_Ub8} \tag{154}$$

6.78 Reaction Aggregation40

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

Reaction equation

$$\text{MisP\_Ub3} + \text{MisP\_Ub4} \longrightarrow \text{AggP} \tag{155}$$

Reactants

Table 160: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
MisP_Ub4		

Product

Table 161: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{78} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{MisP\_Ub4} \tag{156}$$

6.79 Reaction Aggregation41

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

Reaction equation

$$\text{MisP\_Ub3} + \text{MisP\_Ub5} \longrightarrow \text{AggP} \tag{157}$$

Reactants

Table 162: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
MisP_Ub5		

Product

Table 163: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{79} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{MisP\_Ub5} \tag{158}$$

6.80 Reaction Aggregation42

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

Reaction equation

$$\text{MisP\_Ub3} + \text{MisP\_Ub6} \longrightarrow \text{AggP} \tag{159}$$

Reactants

Table 164: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
MisP_Ub6		

Product

Table 165: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{80} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{MisP\_Ub6} \tag{160}$$

6.81 Reaction Aggregation43

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

Reaction equation

$$\text{MisP\_Ub3} + \text{MisP\_Ub7} \longrightarrow \text{AggP} \tag{161}$$

Reactants

Table 166: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		

Id	Name	SBO
MisP_Ub7		

Product

Table 167: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{81} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{MisP\_Ub7} \tag{162}$$

6.82 Reaction Aggregation44

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

Reaction equation

$$\text{MisP\_Ub3} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{163}$$

Reactants

Table 168: Properties of each reactant.

Id	Name	SBO
MisP_Ub3		
MisP_Ub8		

Product

Table 169: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{82} = \text{k72} \cdot \text{MisP\_Ub3} \cdot \text{MisP\_Ub8} \tag{164}$$

6.83 Reaction Aggregation45

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

Reaction equation

$$\text{MisP\_Ub4} + \text{MisP\_Ub5} \longrightarrow \text{AggP} \tag{165}$$

Reactants

Table 170: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
MisP_Ub5		

Product

Table 171: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{83} = \text{k72} \cdot \text{MisP\_Ub4} \cdot \text{MisP\_Ub5} \tag{166}$$

6.84 Reaction Aggregation46

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

Reaction equation

$$\text{MisP\_Ub4} + \text{MisP\_Ub6} \longrightarrow \text{AggP} \tag{167}$$

Reactants

Table 172: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
MisP_Ub6		

Product

Table 173: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{84} = \mathrm{k72} \cdot \mathrm{MisP\_Ub4} \cdot \mathrm{MisP\_Ub6} \tag{168}$$

6.85 Reaction Aggregation47

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

Reaction equation

$$\mathrm{MisP\_Ub4} + \mathrm{MisP\_Ub7} \longrightarrow \mathrm{AggP} \tag{169}$$

Reactants

Table 174: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
MisP_Ub7		

Product

Table 175: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{85} = \text{k72} \cdot \text{MisP\_Ub4} \cdot \text{MisP\_Ub7} \tag{170}$$

6.86 Reaction Aggregation48

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

Reaction equation

$$\text{MisP\_Ub4} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{171}$$

Reactants

Table 176: Properties of each reactant.

Id	Name	SBO
MisP_Ub4		
MisP_Ub8		

Product

Table 177: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{86} = \text{k72} \cdot \text{MisP\_Ub4} \cdot \text{MisP\_Ub8} \tag{172}$$

6.87 Reaction Aggregation49

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

Reaction equation

$$\text{MisP\_Ub5} + \text{MisP\_Ub6} \longrightarrow \text{AggP} \tag{173}$$

Reactants

Table 178: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		
MisP_Ub6		

Product

Table 179: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{87} = \text{k72} \cdot \text{MisP\_Ub5} \cdot \text{MisP\_Ub6} \tag{174}$$

6.88 Reaction Aggregation50

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

Reaction equation

$$\text{MisP\_Ub5} + \text{MisP\_Ub7} \longrightarrow \text{AggP} \tag{175}$$

Reactants

Table 180: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		
MisP_Ub7		

Product

Table 181: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{88} = \text{k72} \cdot \text{MisP\_Ub5} \cdot \text{MisP\_Ub7} \tag{176}$$

6.89 Reaction Aggregation51

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

Reaction equation

$$\text{MisP\_Ub5} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{177}$$

Reactants

Table 182: Properties of each reactant.

Id	Name	SBO
MisP_Ub5		
MisP_Ub8		

Product

Table 183: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{89} = \text{k72} \cdot \text{MisP\_Ub5} \cdot \text{MisP\_Ub8} \tag{178}$$

6.90 Reaction Aggregation52

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

Reaction equation

$$\text{MisP\_Ub6} + \text{MisP\_Ub7} \longrightarrow \text{AggP} \tag{179}$$

Reactants

Table 184: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		
MisP_Ub7		

Product

Table 185: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{90} = \text{k72} \cdot \text{MisP\_Ub6} \cdot \text{MisP\_Ub7} \tag{180}$$

6.91 Reaction Aggregation53

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

Reaction equation

$$\text{MisP\_Ub6} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{181}$$

Reactants

Table 186: Properties of each reactant.

Id	Name	SBO
MisP_Ub6		

Id	Name	SBO
MisP_Ub8		

Product

Table 187: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{91} = \text{k72} \cdot \text{MisP\_Ub6} \cdot \text{MisP\_Ub8} \tag{182}$$

6.92 Reaction Aggregation54

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

Reaction equation

$$\text{MisP\_Ub7} + \text{MisP\_Ub8} \longrightarrow \text{AggP} \tag{183}$$

Reactants

Table 188: Properties of each reactant.

Id	Name	SBO
MisP_Ub7		
MisP_Ub8		

Product

Table 189: Properties of each product.

Id	Name	SBO
AggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{92} = \text{k72} \cdot \text{MisP\_Ub7} \cdot \text{MisP\_Ub8} \tag{184}$$

6.93 Reaction SequesteringOfAggregates

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

Reaction equation

$$\text{AggP} \longrightarrow \text{SeqAggP} \tag{185}$$

Reactant

Table 190: Properties of each reactant.

Id	Name	SBO
AggP		

Product

Table 191: Properties of each product.

Id	Name	SBO
SeqAggP		

Kinetic Law

Derived unit contains undeclared units

$$v_{93} = \text{k73} \cdot \text{AggP} \tag{186}$$

6.94 Reaction ProteasomeInhibtion

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

Reaction equation

$$\text{AggP} + \text{Proteasome} \longrightarrow \text{AggP\_Proteasome} \tag{187}$$

Reactants

Table 192: Properties of each reactant.

Id	Name	SBO
AggP		
Proteasome		

Product

Table 193: Properties of each product.

Id	Name	SBO
AggP_Proteasome		

Kinetic Law

Derived unit contains undeclared units

$$v_{94} = \mathrm{k74} \cdot \mathrm{AggP} \cdot \mathrm{Proteasome} \tag{188}$$

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 NatP

Initial amount 500 item

This species takes part in three reactions (as a reactant in Misfolding and as a product in ProteinSynthesis, Refolding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{NatP} = v_1 + v_3 - v_2 \tag{189}$$

7.2 Species MisP

Initial amount 0 item

This species takes part in 15 reactions (as a reactant in Refolding, MisPE3Binding, Aggregation1, Aggregation2, Aggregation11, Aggregation12, Aggregation13, Aggregation14, Aggregation15, Aggregation16, Aggregation17, Aggregation18 and as a product in Misfolding, MisPE3Release, Deubiqutination8).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP} = v_2 + v_5 + v_{23} - v_3 - v_4 - 2\,v_{39} - v_{40} - v_{49} - v_{50} - v_{51} - v_{52} - v_{53} - v_{54} - v_{55} - v_{56} \tag{190}$$

7.3 Species Ub

Initial amount 500 item

This species takes part in 19 reactions (as a reactant in E1UbBinding and as a product in Deubiqutination1, Deubiqutination2, Deubiqutination3, Deubiqutination4, Deubiqutination5, Deubiqutination6, Deubiqutination7, Deubiqutination8, DeubiquitinationBoundMisP5, DeubiquitinationBoundMisP4, DeubiquitinationBoundMisP3, DeubiquitinationBoundMisP2, DeubiquitinationBoundMisP1, ProteasomeActivity1, ProteasomeActivity2, ProteasomeActivity3, ProteasomeActivity4, ProteasomeActivity5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ub} = v_{16} + v_{17} + v_{18} + v_{19} + v_{20} + v_{21} + v_{22} + v_{23} + v_{29} + v_{30} + v_{31} + v_{32} + v_{33} + 4\,v_{34} + 5\,v_{35} + 6\,v_{36} + 7\,v_{37} + 8\,v_{38} - v_6 \tag{191}$$

7.4 Species E1

Initial amount 100 item

This species takes part in two reactions (as a reactant in E1UbBinding and as a product in E2UbBinding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E1} = v_7 - v_6 \tag{192}$$

7.5 Species E2

Initial amount 100 item

This species takes part in nine reactions (as a reactant in E2UbBinding and as a product in Monoubiquitination, Polyubiquitination1, Polyubiquitination2, Polyubiquitination3, Polyubiquitination4, Polyubiquitination5, Polyubiquitination6, Polyubiquitination7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E2} = v_8 + v_9 + v_{10} + v_{11} + v_{12} + v_{13} + v_{14} + v_{15} - v_7 \tag{193}$$

7.6 Species E3

Initial amount 100 item

This species takes part in three reactions (as a reactant in MisPE3Binding and as a product in MisPE3Release, Monoubiquitination).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E3} = v_5 + v_8 - v_4 \tag{194}$$

7.7 Species DUB

Initial amount 200 item

This species takes part in 26 reactions (as a reactant in Deubiqutination1, Deubiqutination2, Deubiqutination3, Deubiqutination4, Deubiqutination5, Deubiqutination6, Deubiqutination7, Deubiqutination8, DeubiquitinationBoundMisP5, DeubiquitinationBoundMisP4, DeubiquitinationBo DeubiquitinationBoundMisP2, DeubiquitinationBoundMisP1 and as a product in Deubiqutination1, Deubiqutination2, Deubiqutination3, Deubiqutination4, Deubiqutination5, Deubiqutination6, Deubiqutination7, Deubiqutination8, DeubiquitinationBoundMisP5, DeubiquitinationBoundMisP4, DeubiquitinationBoundMisP3, DeubiquitinationBoundMisP2, DeubiquitinationBoundMisP1).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{DUB} = {} & v_{16} + v_{17} + v_{18} + v_{19} + v_{20} + v_{21} + v_{22} + v_{23} + v_{29} \\ & + v_{30} + v_{31} + v_{32} + v_{33} - v_{16} - v_{17} - v_{18} - v_{19} - v_{20} \\ & - v_{21} - v_{22} - v_{23} - v_{29} - v_{30} - v_{31} - v_{32} - v_{33}\end{aligned} \tag{195}$$

7.8 Species Proteasome

Initial amount 100 item

This species takes part in twelve reactions (as a reactant in ProteasomeBinding1, ProteasomeBinding2, ProteasomeBinding3, ProteasomeBinding4, ProteasomeBinding5, ProteasomeInhibtion and as a product in DeubiquitinationBoundMisP1, ProteasomeActivity1, ProteasomeActivity2, ProteasomeActivity3, ProteasomeActivity4, ProteasomeActivity5).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Proteasome} = {} & v_{33} + v_{34} + v_{35} + v_{36} + v_{37} + v_{38} \\ & - v_{24} - v_{25} - v_{26} - v_{27} - v_{28} - v_{94}\end{aligned} \tag{196}$$

7.9 Species ROS

Initial amount 10 item

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ROS} = v_2 - v_2 \tag{197}$$

7.10 Species E1_Ub

Initial amount 0 item

This species takes part in two reactions (as a reactant in E2UbBinding and as a product in E1UbBinding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E1\_Ub} = v_6 - v_7 \tag{198}$$

7.11 Species E2_Ub

Initial amount 0 item

This species takes part in nine reactions (as a reactant in Monoubiquitination, Polyubiquitination1, Polyubiquitination2, Polyubiquitination3, Polyubiquitination4, Polyubiquitination5, Polyubiquitination6, Polyubiquitination7 and as a product in E2UbBinding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E2\_Ub} = v_7 - v_8 - v_9 - v_{10} - v_{11} - v_{12} - v_{13} - v_{14} - v_{15} \tag{199}$$

7.12 Species E3_MisP

Initial amount 0 item

This species takes part in three reactions (as a reactant in MisPE3Release, Monoubiquitination and as a product in MisPE3Binding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E3\_MisP} = v_4 - v_5 - v_8 \tag{200}$$

7.13 Species MisP_Ub

Initial amount 0 item

This species takes part in 14 reactions (as a reactant in Polyubiquitination1, Deubiqutination8, Aggregation3, Aggregation11, Aggregation19, Aggregation27, Aggregation28, Aggregation29, Aggregation30, Aggregation31, Aggregation32, Aggregation33 and as a product in Monoubiquitination, Deubiqutination7).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub} = {} & v_8 + v_{22} - v_9 - v_{23} - 2\,v_{41} - v_{49} - v_{57} \\ & - v_{65} - v_{66} - v_{67} - v_{68} - v_{69} - v_{70} - v_{71}\end{aligned} \tag{201}$$

7.14 Species MisP_Ub2

Initial amount 0 item

This species takes part in 14 reactions (as a reactant in Polyubiquitination2, Deubiqutination7, Aggregation4, Aggregation12, Aggregation20, Aggregation27, Aggregation34, Aggregation35, Aggregation36, Aggregation37, Aggregation38, Aggregation39 and as a product in Polyubiquitination1, Deubiqutination6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub2} = v_9 + v_{21} - v_{10} - v_{22} - 2\,v_{42} - v_{50} - v_{58} - v_{65} - v_{72} - v_{73} - v_{74} - v_{75} - v_{76} - v_{77} \tag{202}$$

7.15 Species MisP_Ub3

Initial amount 0 item

This species takes part in 15 reactions (as a reactant in Polyubiquitination3, Deubiqutination6, Aggregation5, Aggregation13, Aggregation21, Aggregation28, Aggregation34, Aggregation40, Aggregation41, Aggregation42, Aggregation43, Aggregation44 and as a product in Polyubiquitination2, Deubiqutination5, DeubiquitinationBoundMisP1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub3} = v_{10} + v_{20} + v_{33} - v_{11} - v_{21} - 2\,v_{43} - v_{51} - v_{59} - v_{66} - v_{72} - v_{78} - v_{79} - v_{80} - v_{81} - v_{82} \tag{203}$$

7.16 Species MisP_Ub4

Initial amount 0 item

This species takes part in 15 reactions (as a reactant in Polyubiquitination4, Deubiqutination5, ProteasomeBinding1, Aggregation6, Aggregation14, Aggregation22, Aggregation29, Aggregation35, Aggregation40, Aggregation45, Aggregation46, Aggregation47, Aggregation48 and as a product in Polyubiquitination3, Deubiqutination4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub4} = v_{11} + v_{19} - v_{12} - v_{20} - v_{24} - 2\,v_{44} - v_{52} - v_{60} - v_{67} - v_{73} - v_{78} - v_{83} - v_{84} - v_{85} - v_{86} \tag{204}$$

7.17 Species MisP_Ub5

Initial amount 0 item

This species takes part in 15 reactions (as a reactant in Polyubiquitination5, Deubiqutination4, ProteasomeBinding2, Aggregation7, Aggregation15, Aggregation23, Aggregation30,

Aggregation36, Aggregation41, Aggregation45, Aggregation49, Aggregation50, Aggregation51 and as a product in Polyubiquitination4, Deubiqutination3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub5} = v_{12} + v_{18} - v_{13} - v_{19} - v_{25} - 2\,v_{45} - v_{53} - v_{61} - v_{68} - v_{74} - v_{79} - v_{83} - v_{87} - v_{88} - v_{89} \tag{205}$$

7.18 Species MisP_Ub6

Initial amount 0 item

This species takes part in 15 reactions (as a reactant in Polyubiquitination6, Deubiqutination3, ProteasomeBinding3, Aggregation8, Aggregation16, Aggregation24, Aggregation31, Aggregation37, Aggregation42, Aggregation46, Aggregation49, Aggregation52, Aggregation53 and as a product in Polyubiquitination5, Deubiqutination2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub6} = v_{13} + v_{17} - v_{14} - v_{18} - v_{26} - 2\,v_{46} - v_{54} - v_{62} - v_{69} - v_{75} - v_{80} - v_{84} - v_{87} - v_{90} - v_{91} \tag{206}$$

7.19 Species MisP_Ub7

Initial amount 0 item

This species takes part in 15 reactions (as a reactant in Polyubiquitination7, Deubiqutination2, ProteasomeBinding4, Aggregation9, Aggregation17, Aggregation25, Aggregation32, Aggregation38, Aggregation43, Aggregation47, Aggregation50, Aggregation52, Aggregation54 and as a product in Polyubiquitination6, Deubiqutination1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub7} = v_{14} + v_{16} - v_{15} - v_{17} - v_{27} - 2\,v_{47} - v_{55} - v_{63} - v_{70} - v_{76} - v_{81} - v_{85} - v_{88} - v_{90} - v_{92} \tag{207}$$

7.20 Species MisP_Ub8

Initial amount 0 item

This species takes part in 13 reactions (as a reactant in Deubiqutination1, ProteasomeBinding5, Aggregation10, Aggregation18, Aggregation26, Aggregation33, Aggregation39, Aggregation44, Aggregation48, Aggregation51, Aggregation53, Aggregation54 and as a product in Polyubiquitination7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub8} = v_{15} - v_{16} - v_{28} - 2\,v_{48} - v_{56} - v_{64} - v_{71} - v_{77} - v_{82} - v_{86} - v_{89} - v_{91} - v_{92} \tag{208}$$

7.21 Species MisP_Ub4_Proteasome

Initial amount 0 item

This species takes part in four reactions (as a reactant in DeubiquitinationBoundMisP1, ProteasomeActivity1 and as a product in ProteasomeBinding1, DeubiquitinationBoundMisP2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub4\_Proteasome} = v_{24} + v_{32} - v_{33} - v_{34} \tag{209}$$

7.22 Species MisP_Ub5_Proteasome

Initial amount 0 item

This species takes part in four reactions (as a reactant in DeubiquitinationBoundMisP2, ProteasomeActivity2 and as a product in ProteasomeBinding2, DeubiquitinationBoundMisP3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub5\_Proteasome} = v_{25} + v_{31} - v_{32} - v_{35} \tag{210}$$

7.23 Species MisP_Ub6_Proteasome

Initial amount 0 item

This species takes part in four reactions (as a reactant in DeubiquitinationBoundMisP3, ProteasomeActivity3 and as a product in ProteasomeBinding3, DeubiquitinationBoundMisP4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub6\_Proteasome} = v_{26} + v_{30} - v_{31} - v_{36} \tag{211}$$

7.24 Species MisP_Ub7_Proteasome

Initial amount 0 item

This species takes part in four reactions (as a reactant in DeubiquitinationBoundMisP4, ProteasomeActivity4 and as a product in ProteasomeBinding4, DeubiquitinationBoundMisP5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub7\_Proteasome} = v_{27} + v_{29} - v_{30} - v_{37} \tag{212}$$

7.25 Species MisP_Ub8_Proteasome

Initial amount 0 item

This species takes part in three reactions (as a reactant in DeubiquitinationBoundMisP5, ProteasomeActivity5 and as a product in ProteasomeBinding5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MisP\_Ub8\_Proteasome} = v_{28} - v_{29} - v_{38} \tag{213}$$

7.26 Species ATP

Initial amount 10000 item

This species takes part in six reactions (as a reactant in E1UbBinding, ProteasomeActivity1, ProteasomeActivity2, ProteasomeActivity3, ProteasomeActivity4, ProteasomeActivity5), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ATP} = 0 \tag{214}$$

7.27 Species ADP

Initial amount 1000 item

This species takes part in five reactions (as a product in ProteasomeActivity1, ProteasomeActivity2, ProteasomeActivity3, ProteasomeActivity4, ProteasomeActivity5), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ADP} = 0 \tag{215}$$

7.28 Species AMP

Initial amount 1000 item

This species takes part in one reaction (as a product in E1UbBinding), which does not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AMP} = 0 \tag{216}$$

7.29 Species Source

Initial amount 1 item

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Source} = 0 \tag{217}$$

7.30 Species degUb4

Initial amount 0 item

This species takes part in one reaction (as a product in ProteasomeActivity1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{degUb4} = v_{34} \tag{218}$$

7.31 Species degUb5

Initial amount 0 item

This species takes part in one reaction (as a product in ProteasomeActivity2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{degUb5} = v_{35} \tag{219}$$

7.32 Species degUb6

Initial amount 0 item

This species takes part in one reaction (as a product in ProteasomeActivity3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{degUb6} = v_{36} \tag{220}$$

7.33 Species degUb7

Initial amount 0 item

This species takes part in one reaction (as a product in ProteasomeActivity4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{degUb7} = v_{37} \tag{221}$$

7.34 Species degUb8

Initial amount 0 item

This species takes part in one reaction (as a product in ProteasomeActivity5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{degUb8} = v_{38} \tag{222}$$

7.35 Species totMisP

Initial amount 0 item

This species takes part in one reaction (as a product in Misfolding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{totMisP} = v_{2} \tag{223}$$

7.36 Species refNatP

Initial amount 0 item

This species takes part in one reaction (as a product in Refolding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{refNatP} = v_{3} \tag{224}$$

7.37 Species AggP

Initial amount 0 item

This species takes part in 65 reactions (as a reactant in Aggregation2, Aggregation19, Aggregation20, Aggregation21, Aggregation22, Aggregation23, Aggregation24, Aggregation25, Aggregation26, SequesteringOfAggregates, ProteasomeInhibtion and as a product in Aggregation1, Aggregation2, Aggregation3, Aggregation4, Aggregation5, Aggregation6, Aggregation7, Aggregation8, Aggregation9, Aggregation10, Aggregation11, Aggregation12, Aggregation13, Aggregation14, Aggregation15, Aggregation16, Aggregation17, Aggregation18, Aggregation19, Aggregation20, Aggregation21, Aggregation22, Aggregation23, Aggregation24, Aggregation25, Aggregation26, Aggregation27, Aggregation28, Aggregation29, Aggregation30, Aggregation31, Aggregation32, Aggregation33, Aggregation34, Aggregation35, Aggregation36, Aggregation37, Aggregation38, Aggregation39, Aggregation40, Aggregation41, Aggregation42, Aggregation43, Aggregation44, Aggregation45, Aggregation46, Aggregation47, Aggregation48, Aggregation49, Aggregation50, Aggregation51, Aggregation52, Aggregation53, Aggregation54).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AggP} = {} & v_{39} + 2\,v_{40} + v_{41} + v_{42} + v_{43} + v_{44} + v_{45} + v_{46} + v_{47} + v_{48} + v_{49} \\ & + v_{50} + v_{51} + v_{52} + v_{53} + v_{54} + v_{55} + v_{56} + 2\,v_{57} + 2\,v_{58} + 2\,v_{59} + 2\,v_{60} \\ & + 2\,v_{61} + 2\,v_{62} + 2\,v_{63} + 2\,v_{64} + v_{65} + v_{66} + v_{67} + v_{68} + v_{69} + v_{70} \\ & + v_{71} + v_{72} + v_{73} + v_{74} + v_{75} + v_{76} + v_{77} + v_{78} + v_{79} + v_{80} + v_{81} \\ & + v_{82} + v_{83} + v_{84} + v_{85} + v_{86} + v_{87} + v_{88} + v_{89} + v_{90} + v_{91} + v_{92} \\ & - v_{40} - v_{57} - v_{58} - v_{59} - v_{60} - v_{61} - v_{62} - v_{63} - v_{64} - v_{93} - v_{94}\end{aligned} \tag{225}$$

7.38 Species SeqAggP

Initial amount 0 item

This species takes part in one reaction (as a product in SequesteringOfAggregates).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{SeqAggP} = v_{93} \tag{226}$$

7.39 Species AggP_Proteasome

Initial amount 0 item

This species takes part in one reaction (as a product in ProteasomeInhibtion).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AggP\_Proteasome} = v_{94} \tag{227}$$

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