SBML Model Report

Model name: "Heldt2012 - Influenza Virus Replication"

May 6, 2016

1 General Overview

This is a document in SBML Level 3 Version 1 format. This model was created by the following three authors: Nick Juty[1], Vijayalakshmi Chelliah[2] and Frank Stefan Heldt[3] at August seventh 2013 at 1:32 p. m. and last time modified at April eighth 2016 at 5:34 p. m. Table 1 provides 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	50	function definitions	2
global parameters	48	unit definitions	5
rules	19	initial assignments	0

Model Notes

Heldt2012 - Influenza Virus Replication

---

[1]EMBL-EBI, juty@ebi.ac.uk

[2]EMBL-EBI, viji@ebi.ac.uk

[3]Bioprocess Engineering Group, Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany, heldt@mpi-magdeburg.mpg.de

The model describes the life cycle of influenza A virus in a mammalian cell including the following steps: attachment of parental virions to the cell membrane, receptor-mediated endocytosis, fusion of the virus envelope with the endosomal membrane, nuclear import of vRNPs, viral transcription and replication, translation of the structural viral proteins, nuclear export of progeny vRNPs and budding of new virions. It also explicitly accounts for the stabilization of cRNA by viral polymerases and NP and the inhibition of vRNP activity by M1 protein binding. In short, the model focuses on the molecular mechanism that controls viral transcription and replication.

This model is described in the article:Modeling the intracellular dynamics of influenza virus replication to understand the control of viral RNA synthesis.Heldt FS, Frensing T, Reichl U.J Virol.

Abstract:

Influenza viruses transcribe and replicate their negative-sense RNA genome inside the nucleus of host cells via three viral RNA species. In the course of an infection, these RNAs show distinct dynamics, suggesting that differential regulation takes place. To investigate this regulation in a systematic way, we developed a mathematical model of influenza virus infection at the level of a single mammalian cell. It accounts for key steps of the viral life cycle, from virus entry to progeny virion release, while focusing in particular on the molecular mechanisms that control viral transcription and replication. We therefore explicitly consider the nuclear export of viral genome copies (vRNPs) and a recent hypothesis proposing that replicative intermediates (cRNA) are stabilized by the viral polymerase complex and the nucleoprotein (NP). Together, both mechanisms allow the model to capture a variety of published data sets at an unprecedented level of detail. Our findings provide theoretical support for an early regulation of replication by cRNA stabilization. However, they also suggest that the matrix protein 1 (M1) controls viral RNA levels in the late phase of infection as part of its role during the nuclear export of viral genome copies. Moreover, simulations show an accumulation of viral proteins and RNA toward the end of infection, indicating that transport processes or budding limits virion release. Thus, our mathematical model provides an ideal platform for a systematic and quantitative evaluation of influenza virus replication and its complex regulation.

With the current parameter set, the model reproduces an infection at a multiplicity of infection (MOI) of 10. Figure 2A of the paper is reproduced here, with parameters kDegRnp and kSynP changed to zeros.

Initial conditions and parameter changes that were used to obtain specific figures in the article can be found in Table A2.

The model has the correct value for kAttLo as 4.55e-04. The value of this parameter mentioned as 4.55e-02 in Table 1 of the paper is incorrect. This is checked with the author.

This model is hosted on BioModels Database and identifiedby: MODEL1307270000 .

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

Produced by SBML2LATEX

2 Unit Definitions

This is an overview of five unit definitions.

2.1 Unit `length`

Name length

Definition m

2.2 Unit `area`

Name area

Definition m^2

2.3 Unit `volume`

Name volume

Definition dimensionless

2.4 Unit `time`

Name time

Definition 3600 s

2.5 Unit `substance`

Name substance

Definition dimensionless

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
compartment_1	cell		3	1		✓	

3.1 Compartment `compartment_1`

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

Name cell

Produced by SBML2LATEX

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 9 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
species_1	Bhi	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_2	VattHi	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_3	Vex	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_4	Blo	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_5	VattLo	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_6	Ven	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_7	Vfus	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_8	VpCyt	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_9	VpNuc	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_10	Rc	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_11	P_Rdrp	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_12	RcRdrp	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_13	P_Np	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_14	P_M1	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_15	VpNucM1	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_16	VpCytM1	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_17	Cp	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_18	Rv	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_19	RvRdrp	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_20	Rm1	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
species_21	Rm2	compartment_1	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
species_22	Rm3	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_23	Rm4	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_24	Rm5	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_25	Rm6	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_26	Rm7	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_27	Rm8	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_28	P_Pb1	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_29	P_Pb2	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_30	P_Pa	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_31	P_Nep	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_32	P_Ha	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_33	P_Na	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_34	P_M2	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_35	Vrel	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	⊟
species_36	total cRNA	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	☑
species_37	total cRNA of a segment	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	☑
species_38	total vRNA	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	☑
species_39	total vRNA of a segment	compartment_1	$\text{mol} \cdot \text{l}^{-1}$	⊟	☑

5 Parameters

This model contains 48 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
parameter_1	kAttHi		0.081		☑
parameter_2	kAttLo		$4.55 \cdot 10^{-4}$		☑
parameter_3	kDisHi		7.159		⊟
parameter_4	kDisLo		5.462		⊟
parameter_5	kEn		4.800		☑
parameter_6	kFus		3.210		☑
parameter_7	kDegVen		3.084		⊟
parameter_8	kImp		6.000		☑
parameter_9	kSynP		64800.000		☑
parameter_10	kSynV		13.860		☑
parameter_11	kSynC		1.380		☑
parameter_12	kBindRdrp		1.000		☑
parameter_13	kBindNp		$3.01 \cdot 10^{-4}$		☑
parameter_14	kBindM1		$1.39 \cdot 10^{-6}$		☑
parameter_15	kExp		10^{-6}		☑
parameter_16	kSynP_Drib		405.000		⊟
parameter_17	kRdrp		1.000		☑
parameter_18	kRel		0.004		☑
parameter_19	kDegR		36.360		☑
parameter_20	kDegRnp		0.090		☑
parameter_21	kDegM		0.330		☑
parameter_22	kDegRrdrp		4.250		☑
parameter_23	Ffus		0.510		☑
parameter_24	Drib		160.000		☑
parameter_25	Fspl7		0.020		☑
parameter_26	Fspl8		0.125		☑
parameter_27	kSynP_M1		396.900		⊟
parameter_28	kSynP_M2		8.100		⊟
parameter_29	kSynP_NEP		50.625		⊟
parameter_30	L1		2320.000		☑
parameter_31	L2		2320.000		☑
parameter_32	L3		2211.000		☑
parameter_33	L4		1757.000		☑
parameter_34	L5		1540.000		☑
parameter_35	L6		1392.000		☑
parameter_36	L7		1005.000		☑
parameter_37	L8		868.000		☑

Id	Name	SBO	Value	Unit	Constant
parameter_38	kSynM		250000.000		☑
parameter_39	kSynM1		13.470		⊟
parameter_40	kSynM2		13.470		⊟
parameter_41	kSynM3		14.134		⊟
parameter_42	kSynM4		17.786		⊟
parameter_43	kSynM5		20.292		⊟
parameter_44	kSynM6		22.450		⊟
parameter_45	kSynM7		31.095		⊟
parameter_46	kSynM8		36.002		⊟
parameter_47	kEqHi		0.011		☑
parameter_48	kEqLo		$8.33 \cdot 10^{-5}$		☑

6 Function definitions

This is an overview of two function definitions.

6.1 Function definition `function_2`

Name Virus release kinetic

Arguments k, substrateA, substrateB, KmB, substrateC, KmC, substrateD, KmD, substrateE, KmE, substrateF, KmF, substrateG, KmG, substrateH, KmH

Mathematical Expression

$$\frac{k \cdot \text{substrateA} \cdot \text{substrateB} \cdot \text{substrateC} \cdot \text{substrateD} \cdot \text{substrateE} \cdot \text{substrateF} \cdot \text{substrate}}{(\text{substrateB} + \text{KmB}) \cdot (\text{substrateC} + \text{KmC}) \cdot (\text{substrateD} + \text{KmD}) \cdot (\text{substrateE} + \text{KmE}) \cdot (\text{substrateF} + \text{KmF}) \cdot (\text{s}} \quad (1)$$

6.2 Function definition `function_1`

Name Protein binding

Arguments k, substratea, substrateb

Mathematical Expression

$$k \cdot \text{substratea} \cdot \text{substrateb} \quad (2)$$

7 Rules

This is an overview of 19 rules.

7.1 Rule `parameter_16`

Rule `parameter_16` is an assignment rule for parameter `parameter_16`:

$$\text{parameter\_16} = \frac{\text{parameter\_9}}{\text{parameter\_24}} \tag{3}$$

7.2 Rule `parameter_3`

Rule `parameter_3` is an assignment rule for parameter `parameter_3`:

$$\text{parameter\_3} = \frac{\text{parameter\_1}}{\text{parameter\_47}} \tag{4}$$

7.3 Rule `parameter_4`

Rule `parameter_4` is an assignment rule for parameter `parameter_4`:

$$\text{parameter\_4} = \frac{\text{parameter\_2}}{\text{parameter\_48}} \tag{5}$$

7.4 Rule `parameter_7`

Rule `parameter_7` is an assignment rule for parameter `parameter_7`:

$$\text{parameter\_7} = \frac{1 - \text{parameter\_23}}{\text{parameter\_23}} \cdot \text{parameter\_6} \tag{6}$$

7.5 Rule `parameter_43`

Rule `parameter_43` is an assignment rule for parameter `parameter_43`:

$$\text{parameter\_43} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_34}}}{8} \tag{7}$$

7.6 Rule `parameter_44`

Rule `parameter_44` is an assignment rule for parameter `parameter_44`:

$$\text{parameter\_44} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_35}}}{8} \tag{8}$$

7.7 Rule `parameter_27`

Rule `parameter_27` is an assignment rule for parameter `parameter_27`:

$$\text{parameter\_27} = \frac{\text{parameter\_9}}{\text{parameter\_24}} \cdot (1 - \text{parameter\_25}) \tag{9}$$

7.8 Rule `parameter_46`

Rule `parameter_46` is an assignment rule for parameter `parameter_46`:

$$\text{parameter\_46} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_37}}}{8} \qquad (10)$$

7.9 Rule `parameter_40`

Rule `parameter_40` is an assignment rule for parameter `parameter_40`:

$$\text{parameter\_40} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_31}}}{8} \qquad (11)$$

7.10 Rule `parameter_41`

Rule `parameter_41` is an assignment rule for parameter `parameter_41`:

$$\text{parameter\_41} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_32}}}{8} \qquad (12)$$

7.11 Rule `parameter_39`

Rule `parameter_39` is an assignment rule for parameter `parameter_39`:

$$\text{parameter\_39} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_30}}}{8} \qquad (13)$$

7.12 Rule `parameter_42`

Rule `parameter_42` is an assignment rule for parameter `parameter_42`:

$$\text{parameter\_42} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_33}}}{8} \qquad (14)$$

7.13 Rule `parameter_28`

Rule `parameter_28` is an assignment rule for parameter `parameter_28`:

$$\text{parameter\_28} = \frac{\text{parameter\_9}}{\text{parameter\_24}} \cdot \text{parameter\_25} \qquad (15)$$

7.14 Rule `parameter_29`

Rule `parameter_29` is an assignment rule for parameter `parameter_29`:

$$\text{parameter\_29} = \frac{\text{parameter\_9}}{\text{parameter\_24}} \cdot \text{parameter\_26} \qquad (16)$$

7.15 Rule `parameter_45`

Rule `parameter_45` is an assignment rule for parameter `parameter_45`:

$$\text{parameter\_45} = \frac{\frac{\text{parameter\_38}}{\text{parameter\_36}}}{8} \tag{17}$$

7.16 Rule `species_38`

Rule `species_38` is an assignment rule for species `species_38`:

$$\text{species\_38} = 8 \cdot ([\text{species\_2}] + [\text{species\_5}] + [\text{species\_6}]) + [\text{species\_8}] + [\text{species\_9}] + [\text{species\_18}] + [\text{species\_19}] + [\text{species\_15}] + [\text{species\_16}] \tag{18}$$

7.17 Rule `species_36`

Rule `species_36` is an assignment rule for species `species_36`:

$$\text{species\_36} = [\text{species\_10}] + [\text{species\_12}] + [\text{species\_17}] \tag{19}$$

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

7.18 Rule `species_39`

Rule `species_39` is an assignment rule for species `species_39`:

$$\text{species\_39} = \frac{[\text{species\_38}]}{8} \tag{20}$$

7.19 Rule `species_37`

Rule `species_37` is an assignment rule for species `species_37`:

$$\text{species\_37} = \frac{[\text{species\_36}]}{8} \tag{21}$$

8 Reactions

This model contains 50 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	reaction_1	Binding of virions to high-affinity sites	$\text{species\_3} + \text{species\_1} \xrightarrow{\text{species\_3, species\_1, species\_2}} \text{species\_2}$	
2	reaction_2	Binding of virions to low-affinity sites	$\text{species\_3} + \text{species\_4} \xrightarrow{\text{species\_3, species\_4, species\_5}} \text{species\_5}$	
3	reaction_3	Endocytosis of virions bound to high-affinity sites	$\text{species\_2} \xrightarrow{\text{species\_2}} \text{species\_6} + \text{species\_1}$	
4	reaction_4	Endocytosis of virions bound to low-affinity sites	$\text{species\_5} \xrightarrow{\text{species\_5}} \text{species\_6} + \text{species\_4}$	
5	reaction_5	Fusion of virions with endosomes	$\text{species\_6} \xrightarrow{\text{species\_6}} \text{species\_7} + 8\,\text{species\_8}$	
6	reaction_6	Degradation of virions in endosomes	$\text{species\_6} \xrightarrow{\text{species\_6}} \emptyset$	
7	reaction_7	Nuclear import of vRNPs	$\text{species\_8} \xrightarrow{\text{species\_8}} \text{species\_9}$	
8	reaction_8	Synthesis of cRNA	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_10}$	
9	reaction_9	Binding of polymerase to nascent cRNA	$\text{species\_10} + \text{species\_11} \xrightarrow{\text{species\_10, species\_11}} \text{species\_12}$	
10	reaction_10	Binding of NP to RdRp-cRNA complexes	$\text{species\_12} + 71\,\text{species\_13} \xrightarrow{\text{species\_12, species\_13}} \text{species\_17}$	
11	reaction_11	Binding of M1 to vRNPs in the nucleus	$\text{species\_9} + 8 \cdot 5\,\text{species\_14} \xrightarrow{\text{species\_9, species\_14}} \text{species\_15}$	
12	reaction_12	Nuclear export of vRNPs	$\text{species\_15} + \text{species\_31} \xrightarrow{\text{species\_15, species\_31}} \text{species\_16}$	
13	reaction_13	Synthesis of vRNA	$\text{species\_17} \xrightarrow{\text{species\_17}} \text{species\_17} + \text{species\_18}$	
14	reaction_14	Binding of polymerase to nascent vRNA	$\text{species\_18} + \text{species\_11} \xrightarrow{\text{species\_18, species\_11}} \text{species\_19}$	

№	Id	Name	Reaction Equation	SBO
15	reaction_15	Binding of NP to RdRp-vRNA complexes	$\text{species\_19} + 71\,\text{species\_13} \xrightarrow{\text{species\_19, species\_13}} \text{species\_9}$	
16	reaction_16	Synthesis of mRNA of segment 1	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_20}$	
17	reaction_17	Synthesis of mRNA of segment 2	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_21}$	
18	reaction_18	Synthesis of mRNA of segment 3	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_22}$	
19	reaction_19	Synthesis of mRNA of segment 4	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_23}$	
20	reaction_20	Synthesis of mRNA of segment 5	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_24}$	
21	reaction_21	Synthesis of mRNA of segment 6	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_25}$	
22	reaction_22	Synthesis of mRNA of segment 7	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_26}$	
23	reaction_23	Synthesis of mRNA of segment 8	$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_27}$	
24	reaction_24	Synthesis of PB1	$\text{species\_21} \xrightarrow{\text{species\_21}} \text{species\_21} + \text{species\_28}$	
25	reaction_25	Synthesis of PB2	$\text{species\_20} \xrightarrow{\text{species\_20}} \text{species\_20} + \text{species\_29}$	
26	reaction_26	Synthesis of PA	$\text{species\_22} \xrightarrow{\text{species\_22}} \text{species\_22} + \text{species\_30}$	
27	reaction_27	Formation of polymerases	$\text{species\_28} + \text{species\_29} + \text{species\_30} \xrightarrow{\text{species\_28, species\_29, species\_30}} \text{species\_11}$	
28	reaction_28	Synthesis of NP	$\text{species\_24} \xrightarrow{\text{species\_24}} \text{species\_24} + \text{species\_13}$	
29	reaction_29	Synthesis of M1	$\text{species\_26} \xrightarrow{\text{species\_26}} \text{species\_26} + \text{species\_14}$	
30	reaction_30	Synthesis of NEP	$\text{species\_27} \xrightarrow{\text{species\_27}} \text{species\_27} + \text{species\_31}$	
31	reaction_31	Synthesis of HA	$\text{species\_23} \xrightarrow{\text{species\_23}} \text{species\_23} + \text{species\_32}$	
32	reaction_32	Synthesis of NA	$\text{species\_25} \xrightarrow{\text{species\_25}} \text{species\_25} + \text{species\_33}$	
33	reaction_33	Synthesis of M2	$\text{species\_26} \xrightarrow{\text{species\_26}} \text{species\_26} + \text{species\_34}$	

№	Id	Name	Reaction Equation	SBO
34	reaction_34	Virus release	$8\,\text{species\_16} + 37\,\text{species\_11} + 433\,\text{species\_13} + 2932\,\text{species\_14} + 157\,\text{species\_31} + 500\,\text{species\_32} + 100\,\text{species\_33} + 40\,\text{species\_34} \xrightarrow{\text{species\_16, species\_11, species\_32, species\_13, species\_33, species\_14, s}}$	
35	reaction_35	Degradation of vRNPs in the nucleus	$\text{species\_9} \xrightarrow{\text{species\_9}} \emptyset$	
36	reaction_36	Degradation of nascent cRNA	$\text{species\_10} \xrightarrow{\text{species\_10}} \emptyset$	
37	reaction_37	Degradation of nascent vRNA	$\text{species\_18} \xrightarrow{\text{species\_18}} \emptyset$	
38	reaction_38	Degradation of RdRp-cRNA	$\text{species\_12} \xrightarrow{\text{species\_12}} \emptyset$	
39	reaction_39	Degradation of RdRp-vRNA	$\text{species\_19} \xrightarrow{\text{species\_19}} \emptyset$	
40	reaction_40	Degradation of cRNPs	$\text{species\_17} \xrightarrow{\text{species\_17}} \emptyset$	
41	reaction_41	Degradation of M1-vRNP complexes in the nucleus	$\text{species\_15} \xrightarrow{\text{species\_15}} \emptyset$	
42	reaction_42	Degradation of M1-vRNP complexes in the cytoplasm	$\text{species\_16} \xrightarrow{\text{species\_16}} \emptyset$	
43	reaction_43	Degradation of mRNA of segment 1	$\text{species\_20} \xrightarrow{\text{species\_20}} \emptyset$	
44	reaction_44	Degradation of mRNA of segment 2	$\text{species\_21} \xrightarrow{\text{species\_21}} \emptyset$	
45	reaction_45	Degradation of mRNA of segment 3	$\text{species\_22} \xrightarrow{\text{species\_22}} \emptyset$	
46	reaction_46	Degradation of mRNA of segment 4	$\text{species\_23} \xrightarrow{\text{species\_23}} \emptyset$	
47	reaction_47	Degradation of mRNA of segment 5	$\text{species\_24} \xrightarrow{\text{species\_24}} \emptyset$	
48	reaction_48	Degradation of mRNA of segment 6	$\text{species\_25} \xrightarrow{\text{species\_25}} \emptyset$	
49	reaction_49	Degradation of mRNA of segment 7	$\text{species\_26} \xrightarrow{\text{species\_26}} \emptyset$	

№	Id	Name	Reaction Equation	SBO
50	reaction_50	Degradation of mRNA of segment 8	$\text{species\_27} \xrightarrow{\text{species\_27}} \emptyset$	

8.1 Reaction `reaction_1`

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

Name Binding of virions to high-affinity sites

Reaction equation

$$\text{species\_3} + \text{species\_1} \xrightleftharpoons{\text{species\_3, species\_1, species\_2}} \text{species\_2} \qquad (22)$$
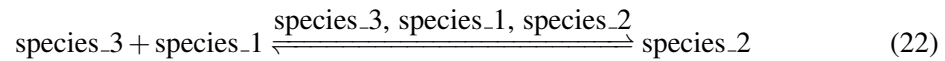
Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
species_3	Vex	
species_1	Bhi	

Modifiers

Table 7: Properties of each modifier.

Id	Name	SBO
species_3	Vex	
species_1	Bhi	
species_2	VattHi	

Product

Table 8: Properties of each product.

Id	Name	SBO
species_2	VattHi	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{vol}\,(\text{compartment\_1}) \cdot (\text{parameter\_1} \cdot [\text{species\_3}] \cdot [\text{species\_1}] - \text{parameter\_3} \cdot [\text{species\_2}])$$
$$(23)$$

8.2 Reaction `reaction_2`

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

Name Binding of virions to low-affinity sites

Reaction equation

$$\text{species\_3} + \text{species\_4} \xrightleftharpoons{\text{species\_3, species\_4, species\_5}} \text{species\_5} \qquad (24)$$

Reactants

Table 9: Properties of each reactant.

Id	Name	SBO
species_3	Vex	
species_4	Blo	

Modifiers

Table 10: Properties of each modifier.

Id	Name	SBO
species_3	Vex	
species_4	Blo	
species_5	VattLo	

Product

Table 11: Properties of each product.

Id	Name	SBO
species_5	VattLo	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\left(\text{compartment\_1}\right) \cdot \left(\text{parameter\_2} \cdot [\text{species\_3}] \cdot [\text{species\_4}] - \text{parameter\_4} \cdot [\text{species\_5}]\right) \qquad (25)$$

8.3 Reaction `reaction_3`

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

Name Endocytosis of virions bound to high-affinity sites

Reaction equation

$$\text{species\_2} \xrightarrow{\text{species\_2}} \text{species\_6} + \text{species\_1} \tag{26}$$
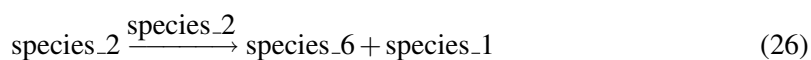
Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
species_2	VattHi	

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
species_2	VattHi	

Products

Table 14: Properties of each product.

Id	Name	SBO
species_6	Ven	
species_1	Bhi	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_5} \cdot [\text{species\_2}] \tag{27}$$

8.4 Reaction `reaction_4`

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

Name Endocytosis of virions bound to low-affinity sites

Reaction equation

$$\text{species\_5} \xrightarrow{\text{species\_5}} \text{species\_6} + \text{species\_4} \tag{28}$$

Reactant

Table 15: Properties of each reactant.

Id	Name	SBO
species_5	VattLo	

Modifier

Table 16: Properties of each modifier.

Id	Name	SBO
species_5	VattLo	

Products

Table 17: Properties of each product.

Id	Name	SBO
species_6	Ven	
species_4	Blo	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_5} \cdot [\text{species\_5}] \tag{29}$$

8.5 Reaction `reaction_5`

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

Name Fusion of virions with endosomes

Reaction equation

$$\text{species\_6} \xrightarrow{\text{species\_6}} \text{species\_7} + 8\,\text{species\_8} \tag{30}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
species_6	Ven	

Modifier

Table 19: Properties of each modifier.

Id	Name	SBO
species_6	Ven	

Products

Table 20: Properties of each product.

Id	Name	SBO
species_7	Vfus	
species_8	VpCyt	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \text{vol}(\text{compartment\_1}) \cdot \text{parameter\_6} \cdot [\text{species\_6}] \tag{31}$$

8.6 Reaction `reaction_6`

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

Name Degradation of virions in endosomes

Reaction equation

$$\text{species\_6} \xrightarrow{\text{species\_6}} \emptyset \tag{32}$$

Reactant

Produced by SBML2LATEX

Table 21: Properties of each reactant.

Id	Name	SBO
species_6	Ven	

Modifier

Table 22: Properties of each modifier.

Id	Name	SBO
species_6	Ven	

Kinetic Law

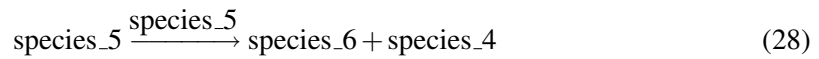**Derived unit** contains undeclared units

$$v_6 = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_7} \cdot [\text{species\_6}] \tag{33}$$

8.7 Reaction `reaction_7`

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

Name Nuclear import of vRNPs

Reaction equation

$$\text{species\_8} \xrightarrow{\text{species\_8}} \text{species\_9} \tag{34}$$

Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
species_8	VpCyt	

Modifier

Table 24: Properties of each modifier.

Id	Name	SBO
species_8	VpCyt	

Product

<p align="center">Table 25: Properties of each product.</p>

Id	Name	SBO
species_9	VpNuc	

Kinetic Law

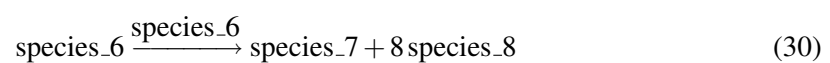**Derived unit** contains undeclared units

$$v_7 = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_8} \cdot [\text{species\_8}] \tag{35}$$

8.8 Reaction `reaction_8`

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

Name Synthesis of cRNA

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_10} \tag{36}$$
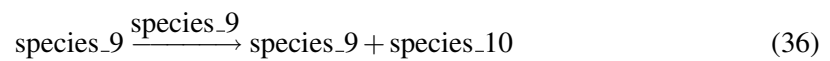
Reactant

<p align="center">Table 26: Properties of each reactant.</p>

Id	Name	SBO
species_9	VpNuc	

Modifier

<p align="center">Table 27: Properties of each modifier.</p>

Id	Name	SBO
species_9	VpNuc	

Products

Table 28: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_10	Rc	

Kinetic Law

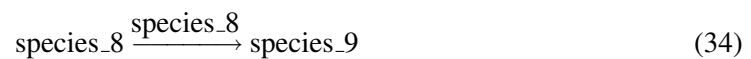**Derived unit** contains undeclared units

$$v_8 = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_11} \cdot [\text{species\_9}] \tag{37}$$

8.9 Reaction reaction_9

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

Name Binding of polymerase to nascent cRNA

Reaction equation

$$\text{species\_10} + \text{species\_11} \xrightarrow{\text{species\_10, species\_11}} \text{species\_12} \tag{38}$$
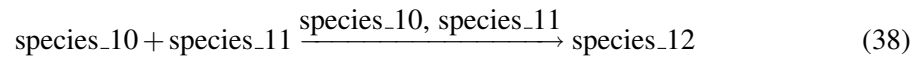
Reactants

Table 29: Properties of each reactant.

Id	Name	SBO
species_10	Rc	
species_11	P_Rdrp	

Modifiers

Table 30: Properties of each modifier.

Id	Name	SBO
species_10	Rc	
species_11	P_Rdrp	

Product

Table 31: Properties of each product.

Id	Name	SBO
species_12	RcRdrp	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_12} \cdot [\text{species\_10}] \cdot [\text{species\_11}] \tag{39}$$

8.10 Reaction `reaction_10`

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

Name Binding of NP to RdRp-cRNA complexes

Reaction equation

$$\text{species\_12} + 71\,\text{species\_13} \xrightarrow{\text{species\_12, species\_13}} \text{species\_17} \tag{40}$$
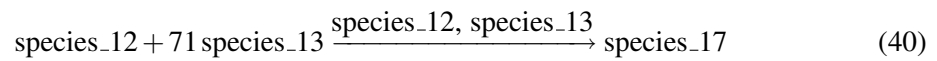
Reactants

Table 32: Properties of each reactant.

Id	Name	SBO
species_12	RcRdrp	
species_13	P_Np	

Modifiers

Table 33: Properties of each modifier.

Id	Name	SBO
species_12	RcRdrp	
species_13	P_Np	

Product

Table 34: Properties of each product.

Id	Name	SBO
species_17	Cp	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \text{vol}\,(\text{compartment\_1}) \cdot \text{function\_1}\,(\text{parameter\_13}, [\text{species\_12}], [\text{species\_13}]) \quad (41)$$

$$\text{function\_1}\,(\text{k}, \text{substratea}, \text{substrateb}) = \text{k} \cdot \text{substratea} \cdot \text{substrateb} \quad (42)$$

$$\text{function\_1}\,(\text{k}, \text{substratea}, \text{substrateb}) = \text{k} \cdot \text{substratea} \cdot \text{substrateb} \quad (43)$$

8.11 Reaction `reaction_11`

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

Name Binding of M1 to vRNPs in the nucleus

Reaction equation

$$\text{species\_9} + 8 \cdot 5\,\text{species\_14} \xrightarrow{\text{species\_9, species\_14}} \text{species\_15} \quad (44)$$
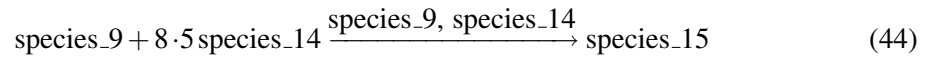
Reactants

Table 35: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	
species_14	P_M1	

Modifiers

Table 36: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	
species_14	P_M1	

Product

Table 37: Properties of each product.

Id	Name	SBO
species_15	VpNucM1	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \text{vol}\,(\text{compartment\_1}) \cdot \text{function\_1}\,(\text{parameter\_14}, [\text{species\_9}], [\text{species\_14}]) \quad (45)$$

$$\text{function\_1}\,(\text{k}, \text{substratea}, \text{substrateb}) = \text{k} \cdot \text{substratea} \cdot \text{substrateb} \quad (46)$$

$$\text{function\_1}\,(\text{k}, \text{substratea}, \text{substrateb}) = \text{k} \cdot \text{substratea} \cdot \text{substrateb} \quad (47)$$

8.12 Reaction `reaction_12`

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

Name Nuclear export of vRNPs

Reaction equation

$$\text{species\_15} + \text{species\_31} \xrightarrow{\text{species\_15, species\_31}} \text{species\_16} \quad (48)$$
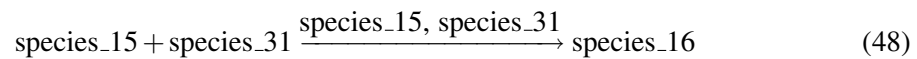
Reactants

Table 38: Properties of each reactant.

Id	Name	SBO
species_15	VpNucM1	
species_31	P_Nep	

Modifiers

Table 39: Properties of each modifier.

Id	Name	SBO
species_15	VpNucM1	

Produced by SBML2LATEX

Id	Name	SBO
species_31	P_Nep	

Product

Table 40: Properties of each product.

Id	Name	SBO
species_16	VpCytM1	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_15} \cdot [\text{species\_15}] \cdot [\text{species\_31}] \qquad (49)$$

8.13 Reaction `reaction_13`

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

Name Synthesis of vRNA

Reaction equation

$$\text{species\_17} \xrightarrow{\text{species\_17}} \text{species\_17} + \text{species\_18} \qquad (50)$$

Reactant

Table 41: Properties of each reactant.

Id	Name	SBO
species_17	Cp	

Modifier

Table 42: Properties of each modifier.

Id	Name	SBO
species_17	Cp	

Products

Table 43: Properties of each product.

Id	Name	SBO
species_17	Cp	
species_18	Rv	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_10} \cdot [\text{species\_17}] \tag{51}$$

8.14 Reaction `reaction_14`

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

Name Binding of polymerase to nascent vRNA

Reaction equation

$$\text{species\_18} + \text{species\_11} \xrightarrow{\text{species\_18, species\_11}} \text{species\_19} \tag{52}$$

Reactants

Table 44: Properties of each reactant.

Id	Name	SBO
species_18	Rv	
species_11	P_Rdrp	

Modifiers

Table 45: Properties of each modifier.

Id	Name	SBO
species_18	Rv	
species_11	P_Rdrp	

Product

Table 46: Properties of each product.

Id	Name	SBO
species_19	RvRdrp	

Kinetic Law
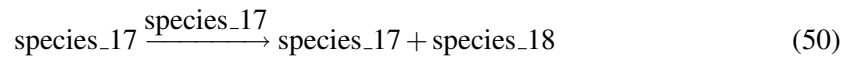
Derived unit contains undeclared units

$$v_{14} = \text{vol}(\text{compartment\_1}) \cdot \text{parameter\_12} \cdot [\text{species\_18}] \cdot [\text{species\_11}] \quad (53)$$

8.15 Reaction `reaction_15`

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

Name Binding of NP to RdRp-vRNA complexes

Reaction equation

$$\text{species\_19} + 71\,\text{species\_13} \xrightarrow{\text{species\_19, species\_13}} \text{species\_9} \quad (54)$$
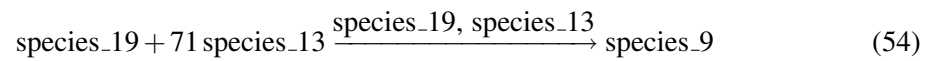
Reactants

Table 47: Properties of each reactant.

Id	Name	SBO
species_19	RvRdrp	
species_13	P_Np	

Modifiers

Table 48: Properties of each modifier.

Id	Name	SBO
species_19	RvRdrp	
species_13	P_Np	

Product

Table 49: Properties of each product.

Id	Name	SBO
species_9	VpNuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \text{vol} \left(\text{compartment\_1} \right) \cdot \text{function\_1} \left(\text{parameter\_13}, [\text{species\_19}], [\text{species\_13}] \right) \quad (55)$$

$$\text{function\_1} \left(\text{k}, \text{substratea}, \text{substrateb} \right) = \text{k} \cdot \text{substratea} \cdot \text{substrateb} \quad (56)$$

$$\text{function\_1} \left(\text{k}, \text{substratea}, \text{substrateb} \right) = \text{k} \cdot \text{substratea} \cdot \text{substrateb} \quad (57)$$

8.16 Reaction `reaction_16`

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

Name Synthesis of mRNA of segment 1

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_20} \quad (58)$$
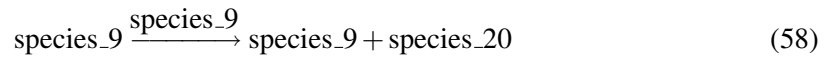
Reactant

Table 50: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 51: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Produced by SBML2LATEX

Table 52: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_20	Rm1	

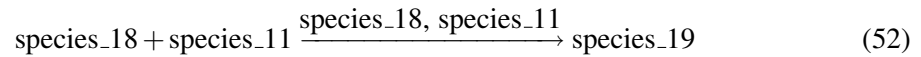**Kinetic Law**

Derived unit contains undeclared units

$$v_{16} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_39} \cdot [\text{species\_9}] \tag{59}$$

8.17 Reaction reaction_17

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

Name Synthesis of mRNA of segment 2

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_21} \tag{60}$$

Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 54: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 55: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_21	Rm2	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_40} \cdot [\mathrm{species\_9}] \qquad (61)$$

8.18 Reaction `reaction_18`

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

Name Synthesis of mRNA of segment 3

Reaction equation

$$\mathrm{species\_9} \xrightarrow{\mathrm{species\_9}} \mathrm{species\_9} + \mathrm{species\_22} \qquad (62)$$

Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 57: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 58: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_22	Rm3	

Kinetic Law

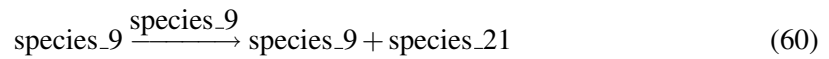**Derived unit** contains undeclared units

$$v_{18} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_41} \cdot [\text{species\_9}] \qquad (63)$$

8.19 Reaction reaction_19

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

Name Synthesis of mRNA of segment 4

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_23} \qquad (64)$$

Reactant

Table 59: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 60: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 61: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_23	Rm4	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_42} \cdot [\mathrm{species\_9}] \tag{65}$$

8.20 Reaction `reaction_20`

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

Name Synthesis of mRNA of segment 5

Reaction equation

$$\mathrm{species\_9} \xrightarrow{\mathrm{species\_9}} \mathrm{species\_9} + \mathrm{species\_24} \tag{66}$$

Reactant

Table 62: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 63: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 64: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_24	Rm5	

Kinetic Law
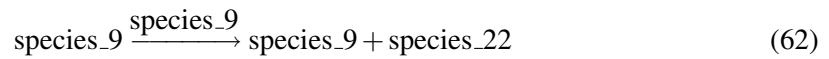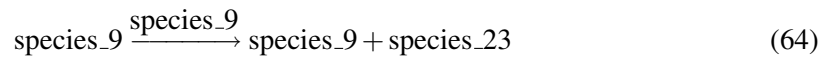
Derived unit contains undeclared units

$$v_{20} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_43} \cdot [\text{species\_9}] \tag{67}$$

8.21 Reaction `reaction_21`

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

Name Synthesis of mRNA of segment 6

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_25} \tag{68}$$

Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 66: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 67: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_25	Rm6	

Kinetic Law

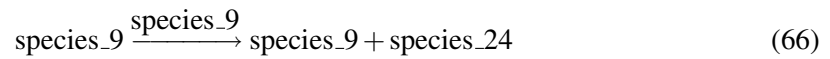**Derived unit** contains undeclared units

$$v_{21} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_44} \cdot [\text{species\_9}] \tag{69}$$

8.22 Reaction `reaction_22`

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

Name Synthesis of mRNA of segment 7

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_26} \tag{70}$$
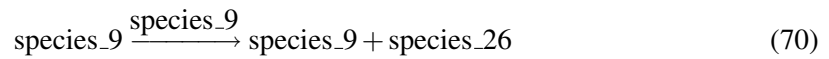
Reactant

Table 68: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 69: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 70: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_26	Rm7	

Kinetic Law

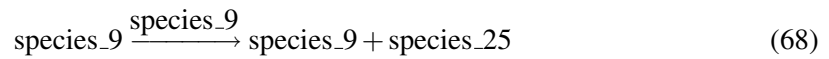**Derived unit** contains undeclared units

$$v_{22} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_45} \cdot [\text{species\_9}] \tag{71}$$

8.23 Reaction `reaction_23`

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

Name Synthesis of mRNA of segment 8

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_9} + \text{species\_27} \tag{72}$$

Reactant

Table 71: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 72: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Products

Table 73: Properties of each product.

Id	Name	SBO
species_9	VpNuc	
species_27	Rm8	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_46} \cdot [\mathrm{species\_9}] \tag{73}$$

8.24 Reaction `reaction_24`

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

Name Synthesis of PB1

Reaction equation

$$\mathrm{species\_21} \xrightarrow{\mathrm{species\_21}} \mathrm{species\_21} + \mathrm{species\_28} \tag{74}$$

Reactant

Table 74: Properties of each reactant.

Id	Name	SBO
species_21	Rm2	

Modifier

Table 75: Properties of each modifier.

Id	Name	SBO
species_21	Rm2	

Products

Produced by SBML2LATEX

Table 76: Properties of each product.

Id	Name	SBO
species_21	Rm2	
species_28	P_Pb1	

Kinetic Law

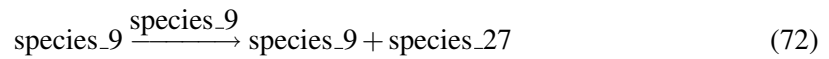**Derived unit** contains undeclared units

$$v_{24} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_16} \cdot [\text{species\_21}] \tag{75}$$

8.25 Reaction `reaction_25`

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

Name Synthesis of PB2

Reaction equation

$$\text{species\_20} \xrightarrow{\text{species\_20}} \text{species\_20} + \text{species\_29} \tag{76}$$

Reactant

Table 77: Properties of each reactant.

Id	Name	SBO
species_20	Rm1	

Modifier

Table 78: Properties of each modifier.

Id	Name	SBO
species_20	Rm1	

Products

Table 79: Properties of each product.

Id	Name	SBO
species_20	Rm1	
species_29	P_Pb2	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_16} \cdot [\mathrm{species\_20}] \qquad (77)$$

8.26 Reaction `reaction_26`

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

Name Synthesis of PA

Reaction equation

$$\mathrm{species\_22} \xrightarrow{\mathrm{species\_22}} \mathrm{species\_22} + \mathrm{species\_30} \qquad (78)$$
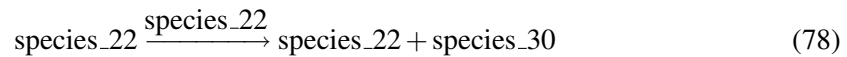
Reactant

Table 80: Properties of each reactant.

Id	Name	SBO
species_22	Rm3	

Modifier

Table 81: Properties of each modifier.

Id	Name	SBO
species_22	Rm3	

Products

Table 82: Properties of each product.

Id	Name	SBO
species_22	Rm3	
species_30	P_Pa	

Kinetic Law

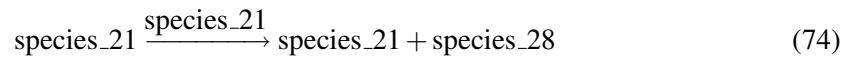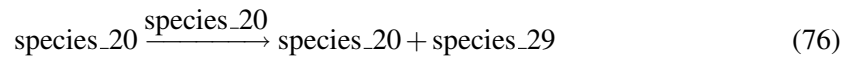**Derived unit** contains undeclared units

$$v_{26} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_16} \cdot [\text{species\_22}] \qquad (79)$$

8.27 Reaction `reaction_27`

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

Name Formation of polymerases

Reaction equation

$$\text{species\_28} + \text{species\_29} + \text{species\_30} \xrightarrow{\text{species\_28, species\_29, species\_30}} \text{species\_11} \qquad (80)$$
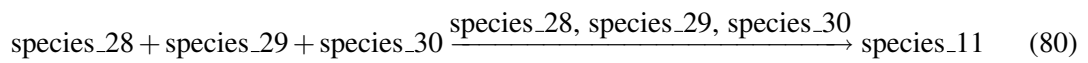
Reactants

Table 83: Properties of each reactant.

Id	Name	SBO
species_28	P_Pb1	
species_29	P_Pb2	
species_30	P_Pa	

Modifiers

Table 84: Properties of each modifier.

Id	Name	SBO
species_28	P_Pb1	
species_29	P_Pb2	
species_30	P_Pa	

Product

Table 85: Properties of each product.

Id	Name	SBO
species_11	P_Rdrp	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_17} \cdot [\text{species\_28}] \cdot [\text{species\_29}] \cdot [\text{species\_30}] \quad (81)$$

8.28 Reaction reaction_28

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

Name Synthesis of NP

Reaction equation

$$\text{species\_24} \xrightarrow{\text{species\_24}} \text{species\_24} + \text{species\_13} \quad (82)$$
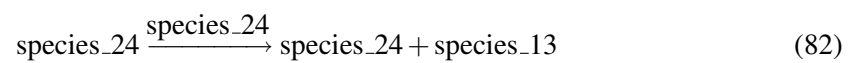
Reactant

Table 86: Properties of each reactant.

Id	Name	SBO
species_24	Rm5	

Modifier

Table 87: Properties of each modifier.

Id	Name	SBO
species_24	Rm5	

Products

Produced by SBML2LATEX

Table 88: Properties of each product.

Id	Name	SBO
species_24	Rm5	
species_13	P_Np	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_16} \cdot [\mathrm{species\_24}] \tag{83}$$

8.29 Reaction `reaction_29`

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

Name Synthesis of M1

Reaction equation

$$\mathrm{species\_26} \xrightarrow{\mathrm{species\_26}} \mathrm{species\_26} + \mathrm{species\_14} \tag{84}$$

Reactant

Table 89: Properties of each reactant.

Id	Name	SBO
species_26	Rm7	

Modifier

Table 90: Properties of each modifier.

Id	Name	SBO
species_26	Rm7	

Products

Table 91: Properties of each product.

Id	Name	SBO
species_26	Rm7	
species_14	P_M1	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_27} \cdot [\text{species\_26}] \tag{85}$$

8.30 Reaction `reaction_30`

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

Name Synthesis of NEP

Reaction equation

$$\text{species\_27} \xrightarrow{\text{species\_27}} \text{species\_27} + \text{species\_31} \tag{86}$$

Reactant

Table 92: Properties of each reactant.

Id	Name	SBO
species_27	Rm8	

Modifier

Table 93: Properties of each modifier.

Id	Name	SBO
species_27	Rm8	

Products

Table 94: Properties of each product.

Id	Name	SBO
species_27	Rm8	
species_31	P_Nep	

Kinetic Law

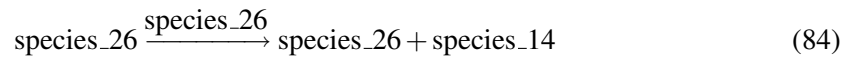**Derived unit** contains undeclared units

$$v_{30} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_29} \cdot [\text{species\_27}] \qquad (87)$$

8.31 Reaction `reaction_31`

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

Name Synthesis of HA

Reaction equation

$$\text{species\_23} \xrightarrow{\text{species\_23}} \text{species\_23} + \text{species\_32} \qquad (88)$$

Reactant

Table 95: Properties of each reactant.

Id	Name	SBO
species_23	Rm4	

Modifier

Table 96: Properties of each modifier.

Id	Name	SBO
species_23	Rm4	

Products

Table 97: Properties of each product.

Id	Name	SBO
species_23	Rm4	
species_32	P_Ha	

Kinetic Law
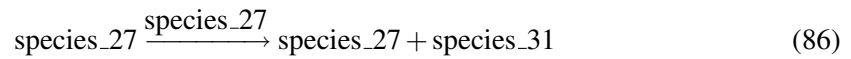
Derived unit contains undeclared units

$$v_{31} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_16} \cdot [\text{species\_23}] \tag{89}$$

8.32 Reaction reaction_32

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

Name Synthesis of NA

Reaction equation

$$\text{species\_25} \xrightarrow{\text{species\_25}} \text{species\_25} + \text{species\_33} \tag{90}$$
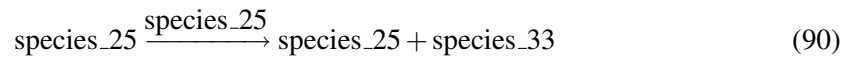
Reactant

Table 98: Properties of each reactant.

Id	Name	SBO
species_25	Rm6	

Modifier

Table 99: Properties of each modifier.

Id	Name	SBO
species_25	Rm6	

Products

Table 100: Properties of each product.

Id	Name	SBO
species_25	Rm6	
species_33	P_Na	

Kinetic Law

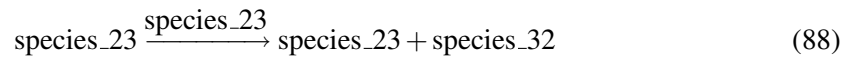**Derived unit** contains undeclared units

$$v_{32} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_16} \cdot [\text{species\_25}] \tag{91}$$

8.33 Reaction reaction_33

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

Name Synthesis of M2

Reaction equation

$$\text{species\_26} \xrightarrow{\text{species\_26}} \text{species\_26} + \text{species\_34} \tag{92}$$
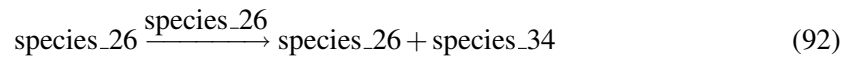
Reactant

Table 101: Properties of each reactant.

Id	Name	SBO
species_26	Rm7	

Modifier

Table 102: Properties of each modifier.

Id	Name	SBO
species_26	Rm7	

Products

Table 103: Properties of each product.

Id	Name	SBO
species_26	Rm7	
species_34	P_M2	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_28} \cdot [\text{species\_26}] \tag{93}$$

8.34 Reaction `reaction_34`

This is an irreversible reaction of eight reactants forming one product influenced by eight modifiers.

Name Virus release

Reaction equation

$$8\,\text{species\_16} + 37\,\text{species\_11} + 433\,\text{species\_13} + 2932\,\text{species\_14} + 157\,\text{species\_31} + 500\,\text{species\_32} + 100\,\text{species\_33} \tag{94}$$

Reactants

Table 104: Properties of each reactant.

Id	Name	SBO
species_16	VpCytM1	
species_11	P_Rdrp	
species_13	P_Np	
species_14	P_M1	
species_31	P_Nep	
species_32	P_Ha	
species_33	P_Na	
species_34	P_M2	

Modifiers

Table 105: Properties of each modifier.

Id	Name	SBO
species_16	VpCytM1	
species_11	P_Rdrp	
species_32	P_Ha	
species_13	P_Np	
species_33	P_Na	
species_14	P_M1	
species_34	P_M2	
species_31	P_Nep	

Product

Table 106: Properties of each product.

Id	Name	SBO
species_35	Vrel	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \text{vol}\,(\text{compartment\_1}) \cdot \text{function\_2}\,(\text{parameter\_18}, [\text{species\_16}], [\text{species\_11}], \text{KmB},$$
$$[\text{species\_32}], \text{KmC}, [\text{species\_13}], \text{KmD}, [\text{species\_33}], \text{KmE}, [\text{species\_14}], \text{KmF}, \quad (95)$$
$$[\text{species\_34}], \text{KmG}, [\text{species\_31}], \text{KmH})$$

$$\text{function\_2}\,(k, \text{substrateA}, \text{substrateB}, \text{KmB}, \text{substrateC}, \text{KmC}, \text{substrateD}, \quad (96)$$
$$\text{KmD}, \text{substrateE}, \text{KmE}, \text{substrateF}, \text{KmF}, \text{substrateG}, \text{KmG}, \text{substrateH}, \text{KmH})$$
$$= \frac{k \cdot \text{substrateA} \cdot \text{substrateB} \cdot \text{substrateC} \cdot \text{substrateD} \cdot \text{substrateE} \cdot \text{substrateF} \cdot \text{substrat}}{(\text{substrateB} + \text{KmB}) \cdot (\text{substrateC} + \text{KmC}) \cdot (\text{substrateD} + \text{KmD}) \cdot (\text{substrateE} + \text{KmE}) \cdot (\text{substrateF} + \text{KmF}) \cdot}$$

$$\text{function\_2}\,(k, \text{substrateA}, \text{substrateB}, \text{KmB}, \text{substrateC}, \text{KmC}, \text{substrateD}, \quad (97)$$
$$\text{KmD}, \text{substrateE}, \text{KmE}, \text{substrateF}, \text{KmF}, \text{substrateG}, \text{KmG}, \text{substrateH}, \text{KmH})$$
$$= \frac{k \cdot \text{substrateA} \cdot \text{substrateB} \cdot \text{substrateC} \cdot \text{substrateD} \cdot \text{substrateE} \cdot \text{substrateF} \cdot \text{substrat}}{(\text{substrateB} + \text{KmB}) \cdot (\text{substrateC} + \text{KmC}) \cdot (\text{substrateD} + \text{KmD}) \cdot (\text{substrateE} + \text{KmE}) \cdot (\text{substrateF} + \text{KmF}) \cdot}$$

8.35 Reaction `reaction_35`

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

Name Degradation of vRNPs in the nucleus

Reaction equation

$$\text{species\_9} \xrightarrow{\text{species\_9}} \emptyset \tag{98}$$

Reactant

Table 107: Properties of each reactant.

Id	Name	SBO
species_9	VpNuc	

Modifier

Table 108: Properties of each modifier.

Id	Name	SBO
species_9	VpNuc	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_20} \cdot [\text{species\_9}] \tag{99}$$

8.36 Reaction `reaction_36`

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

Name Degradation of nascent cRNA

Reaction equation

$$\text{species\_10} \xrightarrow{\text{species\_10}} \emptyset \tag{100}$$

Reactant

Table 109: Properties of each reactant.

Id	Name	SBO
species_10	Rc	

Modifier

Table 110: Properties of each modifier.

Id	Name	SBO
species_10	Rc	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_19} \cdot [\mathrm{species\_10}] \qquad (101)$$

8.37 Reaction reaction_37

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

Name Degradation of nascent vRNA

Reaction equation

$$\mathrm{species\_18} \xrightarrow{\mathrm{species\_18}} \emptyset \qquad (102)$$

Reactant

Table 111: Properties of each reactant.

Id	Name	SBO
species_18	Rv	

Modifier

Table 112: Properties of each modifier.

Id	Name	SBO
species_18	Rv	

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \mathrm{vol}\,(\mathrm{compartment\_1}) \cdot \mathrm{parameter\_19} \cdot [\mathrm{species\_18}] \qquad (103)$$

8.38 Reaction `reaction_38`

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

Name Degradation of RdRp-cRNA

Reaction equation

$$\text{species\_12} \xrightarrow{\text{species\_12}} \emptyset \tag{104}$$

Reactant

Table 113: Properties of each reactant.

Id	Name	SBO
species_12	RcRdrp	

Modifier

Table 114: Properties of each modifier.

Id	Name	SBO
species_12	RcRdrp	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_22} \cdot [\text{species\_12}] \tag{105}$$

8.39 Reaction `reaction_39`

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

Name Degradation of RdRp-vRNA

Reaction equation

$$\text{species\_19} \xrightarrow{\text{species\_19}} \emptyset \tag{106}$$

Reactant

Produced by SBML2LATEX

Table 115: Properties of each reactant.

Id	Name	SBO
species_19	RvRdrp	

Modifier

Table 116: Properties of each modifier.

Id	Name	SBO
species_19	RvRdrp	

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \text{vol} \left(\text{compartment\_1} \right) \cdot \text{parameter\_22} \cdot [\text{species\_19}] \qquad (107)$$

8.40 Reaction reaction_40

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

Name Degradation of cRNPs

Reaction equation

$$\text{species\_17} \xrightarrow{\text{species\_17}} \emptyset \qquad (108)$$

Reactant

Table 117: Properties of each reactant.

Id	Name	SBO
species_17	Cp	

Modifier

Table 118: Properties of each modifier.

Id	Name	SBO
species_17	Cp	

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_20} \cdot [\text{species\_17}] \tag{109}$$

8.41 Reaction `reaction_41`

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

Name Degradation of M1-vRNP complexes in the nucleus

Reaction equation

$$\text{species\_15} \xrightarrow{\text{species\_15}} \emptyset \tag{110}$$

Reactant

Table 119: Properties of each reactant.

Id	Name	SBO
species_15	VpNucM1	

Modifier

Table 120: Properties of each modifier.

Id	Name	SBO
species_15	VpNucM1	

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_20} \cdot [\text{species\_15}] \tag{111}$$

8.42 Reaction `reaction_42`

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

Name Degradation of M1-vRNP complexes in the cytoplasm

Reaction equation

$$\text{species\_16} \xrightarrow{\text{species\_16}} \emptyset \tag{112}$$

Reactant

Table 121: Properties of each reactant.

Id	Name	SBO
species_16	VpCytM1	

Modifier

Table 122: Properties of each modifier.

Id	Name	SBO
species_16	VpCytM1	

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_20} \cdot \left[\text{species\_16}\right] \tag{113}$$

8.43 Reaction `reaction_43`

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

Name Degradation of mRNA of segment 1

Reaction equation

$$\text{species\_20} \xrightarrow{\text{species\_20}} \emptyset \tag{114}$$

Reactant

Table 123: Properties of each reactant.

Id	Name	SBO
species_20	Rm1	

Modifier

Table 124: Properties of each modifier.

Id	Name	SBO
species_20	Rm1	

Kinetic Law

Derived unit contains undeclared units

$$v_{43} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_21} \cdot [\text{species\_20}] \tag{115}$$

8.44 Reaction reaction_44

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

Name Degradation of mRNA of segment 2

Reaction equation

$$\text{species\_21} \xrightarrow{\text{species\_21}} \emptyset \tag{116}$$

Reactant

Table 125: Properties of each reactant.

Id	Name	SBO
species_21	Rm2	

Modifier

Table 126: Properties of each modifier.

Id	Name	SBO
species_21	Rm2	

Kinetic Law

Derived unit contains undeclared units

$$v_{44} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_21} \cdot [\text{species\_21}] \tag{117}$$

Produced by SBML2LATEX

8.45 Reaction `reaction_45`

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

Name Degradation of mRNA of segment 3

Reaction equation

$$\text{species\_22} \xrightarrow{\text{species\_22}} \emptyset \tag{118}$$

Reactant

Table 127: Properties of each reactant.

Id	Name	SBO
species_22	Rm3	

Modifier

Table 128: Properties of each modifier.

Id	Name	SBO
species_22	Rm3	

Kinetic Law

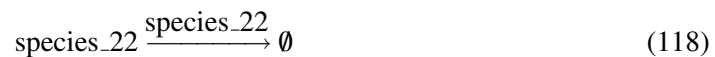**Derived unit** contains undeclared units

$$v_{45} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_21} \cdot [\text{species\_22}] \tag{119}$$

8.46 Reaction `reaction_46`

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

Name Degradation of mRNA of segment 4

Reaction equation

$$\text{species\_23} \xrightarrow{\text{species\_23}} \emptyset \tag{120}$$

Reactant

Table 129: Properties of each reactant.

Id	Name	SBO
species_23	Rm4	

Modifier

Table 130: Properties of each modifier.

Id	Name	SBO
species_23	Rm4	

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_21} \cdot [\text{species\_23}] \tag{121}$$

8.47 Reaction reaction_47

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

Name Degradation of mRNA of segment 5

Reaction equation

$$\text{species\_24} \xrightarrow{\text{species\_24}} \emptyset \tag{122}$$

Reactant

Table 131: Properties of each reactant.

Id	Name	SBO
species_24	Rm5	

Modifier

Table 132: Properties of each modifier.

Id	Name	SBO
species_24	Rm5	

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_21} \cdot [\text{species\_24}] \tag{123}$$

8.48 Reaction `reaction_48`

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

Name Degradation of mRNA of segment 6

Reaction equation

$$\text{species\_25} \xrightarrow{\text{species\_25}} \emptyset \tag{124}$$

Reactant

Table 133: Properties of each reactant.

Id	Name	SBO
species_25	Rm6	

Modifier

Table 134: Properties of each modifier.

Id	Name	SBO
species_25	Rm6	

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_21} \cdot [\text{species\_25}] \tag{125}$$

8.49 Reaction `reaction_49`

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

Name Degradation of mRNA of segment 7

Reaction equation

$$\text{species\_26} \xrightarrow{\text{species\_26}} \emptyset \tag{126}$$

Reactant

Table 135: Properties of each reactant.

Id	Name	SBO
species_26	Rm7	

Modifier

Table 136: Properties of each modifier.

Id	Name	SBO
species_26	Rm7	

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = \text{vol}\left(\text{compartment\_1}\right) \cdot \text{parameter\_21} \cdot [\text{species\_26}] \tag{127}$$

8.50 Reaction `reaction_50`

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

Name Degradation of mRNA of segment 8

Reaction equation

$$\text{species\_27} \xrightarrow{\text{species\_27}} \emptyset \tag{128}$$

Reactant

Table 137: Properties of each reactant.

Id	Name	SBO
species_27	Rm8	

Modifier

Table 138: Properties of each modifier.

Id	Name	SBO
species_27	Rm8	

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = \text{vol}\,(\text{compartment\_1}) \cdot \text{parameter\_21} \cdot [\text{species\_27}] \tag{129}$$

9 Derived Rate Equations

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

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

- parameters without an unit definition are involved or

- volume correction is necessary because the `hasOnlySubstanceUnits` flag may be set to `false` and `spacialDimensions` > 0 for certain species.

9.1 Species species_1

Name Bhi

SBO:0000605 high affinity receptor

Notes free high-affinity binding sites (sites)

Initial concentration $150\,\text{mol}\cdot\text{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_1` and as a product in `reaction_3` and as a modifier in `reaction_1`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_1} = v_3 - v_1 \tag{130}$$

9.2 Species `species_2`

Name VattHi

SBO:0000605 high affinity receptor

Notes `virions attached to high-affinity binding sites (virions)`

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

This species takes part in four reactions (as a reactant in `reaction_3` and as a product in `reaction_1` and as a modifier in `reaction_1`, `reaction_3`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_2} = v_1 - v_3 \tag{131}$$

9.3 Species `species_3`

Name Vex

Notes `virions in the extracellular medium (virions)`

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

This species takes part in four reactions (as a reactant in `reaction_1`, `reaction_2` and as a modifier in `reaction_1`, `reaction_2`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_3} = -v_1 - v_2 \tag{132}$$

9.4 Species `species_4`

Name Blo

SBO:0000606 low affinity receptor

Notes `free low-affinity binding sites (sites)`

Initial concentration $1000\,\text{mol}\cdot\text{l}^{-1}$

This species takes part in three reactions (as a reactant in `reaction_2` and as a product in `reaction_4` and as a modifier in `reaction_2`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_4} = v_4 - v_2 \tag{133}$$

9.5 Species `species_5`

Name VattLo

SBO:0000606 low affinity receptor

Notes `virions attached to low-affinity binding sites (virions)`

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

This species takes part in four reactions (as a reactant in `reaction_4` and as a product in `reaction_2` and as a modifier in `reaction_2`, `reaction_4`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species}\_5 = v_2 - v_4 \tag{134}$$

9.6 Species `species_6`

Name Ven

Notes `virions in endosomes (virions)`

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

This species takes part in six reactions (as a reactant in `reaction_5`, `reaction_6` and as a product in `reaction_3`, `reaction_4` and as a modifier in `reaction_5`, `reaction_6`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species}\_6 = v_3 + v_4 - v_5 - v_6 \tag{135}$$

9.7 Species `species_7`

Name Vfus

Notes `total amount of virions fused with endosomes (virions)`

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

This species takes part in one reaction (as a product in `reaction_5`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species}\_7 = v_5 \tag{136}$$

9.8 Species `species_8`

Name VpCyt

Notes `parental vRNPs in the cytoplasm (virions)`

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

This species takes part in three reactions (as a reactant in `reaction_7` and as a product in `reaction_5` and as a modifier in `reaction_7`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_8} = 8\,v_5 \;-\; v_7 \tag{137}$$

9.9 Species `species_9`

Name VpNuc

Notes `vRNPs in the nucleus (virions)`

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

This species takes part in 33 reactions (as a reactant in `reaction_8`, `reaction_11`, `reaction_16`, `reaction_17`, `reaction_18`, `reaction_19`, `reaction_20`, `reaction_21`, `reaction_22`, `reaction_23`, `reaction_35` and as a product in `reaction_7`, `reaction_8`, `reaction_15`, `reaction_16`, `reaction_17`, `reaction_18`, `reaction_19`, `reaction_20`, `reaction_21`, `reaction_22`, `reaction_23` and as a modifier in `reaction_8`, `reaction_11`, `reaction_16`, `reaction_17`, `reaction_18`, `reaction_19`, `reaction_20`, `reaction_21`, `reaction_22`, `reaction_23`, `reaction_35`).

$$\begin{aligned}
\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_9} = {}& v_7 + v_8 + v_{15} + v_{16} + v_{17} + v_{18} + v_{19} + v_{20} + v_{21} + v_{22} + v_{23} \\
& - v_8 - v_{11} - v_{16} - v_{17} - v_{18} - v_{19} - v_{20} - v_{21} - v_{22} - v_{23} - v_{35}
\end{aligned} \tag{138}$$

9.10 Species `species_10`

Name Rc

Notes `nascent cRNA (molecules)`

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

This species takes part in five reactions (as a reactant in `reaction_9`, `reaction_36` and as a product in `reaction_8` and as a modifier in `reaction_9`, `reaction_36`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_10} = v_8 \;-\; v_9 \;-\; v_{36} \tag{139}$$

9.11 Species `species_11`

Name P_Rdrp

SBO:0000297 protein complex

Notes `viral polymerase complex (molecules)`

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

This species takes part in seven reactions (as a reactant in `reaction_9`, `reaction_14`, `reaction-_34` and as a product in `reaction_27` and as a modifier in `reaction_9`, `reaction_14`, `reaction-_34`).

$$\frac{\text{d}}{\text{d}t}\text{species\_11} = v_{27} - v_9 - v_{14} - 37 \, v_{34} \tag{140}$$

9.12 Species `species_12`

Name RcRdrp

SBO:0000296 macromolecular complex

Notes `complex of viral polymerase and cRNA (molecules)`

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

This species takes part in five reactions (as a reactant in `reaction_10`, `reaction_38` and as a product in `reaction_9` and as a modifier in `reaction_10`, `reaction_38`).

$$\frac{\text{d}}{\text{d}t}\text{species\_12} = v_9 - v_{10} - v_{38} \tag{141}$$

9.13 Species `species_13`

Name P_Np

Notes `NP proteins (molecules)`

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

This species takes part in seven reactions (as a reactant in `reaction_10`, `reaction_15`, `reaction-_34` and as a product in `reaction_28` and as a modifier in `reaction_10`, `reaction_15`, `reaction-_34`).

$$\frac{\text{d}}{\text{d}t}\text{species\_13} = v_{28} - 71 \, v_{10} - 71 \, v_{15} - 433 \, v_{34} \tag{142}$$

9.14 Species `species_14`

Name P_M1

Notes M1 proteins (molecules)

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

This species takes part in five reactions (as a reactant in `reaction_11`, `reaction_34` and as a product in `reaction_29` and as a modifier in `reaction_11`, `reaction_34`).

$$\frac{\text{d}}{\text{d}t}\text{species\_14} = v_{29} - 8.5 \, v_{11} - 2932 \, v_{34} \tag{143}$$

9.15 Species `species_15`

Name VpNucM1

Notes M1-vRNP complexes in the nucleus (virions)

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

This species takes part in five reactions (as a reactant in `reaction_12`, `reaction_41` and as a product in `reaction_11` and as a modifier in `reaction_12`, `reaction_41`).

$$\frac{\text{d}}{\text{d}t}\text{species\_15} = v_{11} - v_{12} - v_{41} \tag{144}$$

9.16 Species `species_16`

Name VpCytM1

Notes M1-vRNP complexes in the cytoplasm (virions)

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

This species takes part in five reactions (as a reactant in `reaction_34`, `reaction_42` and as a product in `reaction_12` and as a modifier in `reaction_34`, `reaction_42`).

$$\frac{\text{d}}{\text{d}t}\text{species\_16} = v_{12} - 8 \, v_{34} - v_{42} \tag{145}$$

9.17 Species `species_17`

Name Cp

Notes cRNPs (molecules)

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

This species takes part in six reactions (as a reactant in `reaction_13`, `reaction_40` and as a product in `reaction_10`, `reaction_13` and as a modifier in `reaction_13`, `reaction_40`).

$$\frac{\text{d}}{\text{d}t}\text{species\_17} = v_{10} + v_{13} - v_{13} - v_{40} \tag{146}$$

9.18 Species `species_18`

Name Rv

Notes `nascent vRNA (molecules)`

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

This species takes part in five reactions (as a reactant in `reaction_14`, `reaction_37` and as a product in `reaction_13` and as a modifier in `reaction_14`, `reaction_37`).

$$\frac{\mathrm{d}}{\mathrm{d}t} \text{species\_18} = v_{13} - v_{14} - v_{37} \tag{147}$$

9.19 Species `species_19`

Name RvRdrp

Notes `complex of viral polymerase and vRNA (molecules)`

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

This species takes part in five reactions (as a reactant in `reaction_15`, `reaction_39` and as a product in `reaction_14` and as a modifier in `reaction_15`, `reaction_39`).

$$\frac{\mathrm{d}}{\mathrm{d}t} \text{species\_19} = v_{14} - v_{15} - v_{39} \tag{148}$$

9.20 Species `species_20`

Name Rm1

SBO:0000278 messenger RNA

Notes `mRNA of segment 1 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_25`, `reaction_43` and as a product in `reaction_16`, `reaction_25` and as a modifier in `reaction_25`, `reaction_43`).

$$\frac{\mathrm{d}}{\mathrm{d}t} \text{species\_20} = v_{16} + v_{25} - v_{25} - v_{43} \tag{149}$$

9.21 Species `species_21`

Name Rm2

SBO:0000278 messenger RNA

Notes `mRNA of segment 2 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_24`, `reaction_44` and as a product in `reaction_17`, `reaction_24` and as a modifier in `reaction_24`, `reaction_44`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_21} = v_{17} + v_{24} - v_{24} - v_{44} \tag{150}$$

9.22 Species `species_22`

Name Rm3

SBO:0000278 messenger RNA

Notes `mRNA of segment 3 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_26`, `reaction_45` and as a product in `reaction_18`, `reaction_26` and as a modifier in `reaction_26`, `reaction_45`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_22} = v_{18} + v_{26} - v_{26} - v_{45} \tag{151}$$

9.23 Species `species_23`

Name Rm4

SBO:0000278 messenger RNA

Notes `mRNA of segment 4 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_31`, `reaction_46` and as a product in `reaction_19`, `reaction_31` and as a modifier in `reaction_31`, `reaction_46`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species\_23} = v_{19} + v_{31} - v_{31} - v_{46} \tag{152}$$

9.24 Species `species_24`

Name Rm5

SBO:0000278 messenger RNA

Notes `mRNA of segment 5 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_28`, `reaction_47` and as a product in `reaction_20`, `reaction_28` and as a modifier in `reaction_28`, `reaction_47`).

$$\frac{\text{d}}{\text{d}t}\text{species\_24} = v_{20} + v_{28} - v_{28} - v_{47} \tag{153}$$

9.25 Species `species_25`

Name Rm6

SBO:0000278 messenger RNA

Notes `mRNA of segment 6 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_32`, `reaction_48` and as a product in `reaction_21`, `reaction_32` and as a modifier in `reaction_32`, `reaction_48`).

$$\frac{\text{d}}{\text{d}t}\text{species\_25} = v_{21} + v_{32} - v_{32} - v_{48} \tag{154}$$

9.26 Species `species_26`

Name Rm7

SBO:0000278 messenger RNA

Notes `unspliced mRNA of segment 7 (molecules)`

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

This species takes part in nine reactions (as a reactant in `reaction_29`, `reaction_33`, `reaction_49` and as a product in `reaction_22`, `reaction_29`, `reaction_33` and as a modifier in `reaction_29`, `reaction_33`, `reaction_49`).

$$\frac{\text{d}}{\text{d}t}\text{species\_26} = v_{22} + v_{29} + v_{33} - v_{29} - v_{33} - v_{49} \tag{155}$$

9.27 Species `species_27`

Name Rm8

SBO:0000278 messenger RNA

Notes `unspliced mRNA of segment 8 (molecules)`

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

This species takes part in six reactions (as a reactant in `reaction_30`, `reaction_50` and as a product in `reaction_23`, `reaction_30` and as a modifier in `reaction_30`, `reaction_50`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_27} = v_{23} + v_{30} - v_{30} - v_{50} \tag{156}$$

9.28 Species `species_28`

Name P_Pb1

Notes `PB1 proteins (molecules)`

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

This species takes part in three reactions (as a reactant in `reaction_27` and as a product in `reaction_24` and as a modifier in `reaction_27`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_28} = v_{24} - v_{27} \tag{157}$$

9.29 Species `species_29`

Name P_Pb2

Notes `PB2 proteins (molecules)`

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

This species takes part in three reactions (as a reactant in `reaction_27` and as a product in `reaction_25` and as a modifier in `reaction_27`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{species\_29} = v_{25} - v_{27} \tag{158}$$

Produced by SBML₂L̸ATEX

9.30 Species `species_30`

Name P_Pa

Notes `PA proteins (molecules)`

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

This species takes part in three reactions (as a reactant in `reaction_27` and as a product in `reaction_26` and as a modifier in `reaction_27`).

$$\frac{d}{dt}\text{species\_30} = v_{26} - v_{27} \tag{159}$$

9.31 Species `species_31`

Name P_Nep

Notes `NEP proteins (molecules)`

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

This species takes part in five reactions (as a reactant in `reaction_12`, `reaction_34` and as a product in `reaction_30` and as a modifier in `reaction_12`, `reaction_34`).

$$\frac{d}{dt}\text{species\_31} = v_{30} - v_{12} - 157 \, v_{34} \tag{160}$$

9.32 Species `species_32`

Name P_Ha

Notes `HA proteins (molecules)`

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

This species takes part in three reactions (as a reactant in `reaction_34` and as a product in `reaction_31` and as a modifier in `reaction_34`).

$$\frac{d}{dt}\text{species\_32} = v_{31} - 500 \, v_{34} \tag{161}$$

9.33 Species `species_33`

Name P_Na

Notes `NA proteins (molecules)`

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

This species takes part in three reactions (as a reactant in `reaction_34` and as a product in `reaction_32` and as a modifier in `reaction_34`).

$$\frac{d}{dt}\text{species\_33} = v_{32} - 100 \, v_{34} \tag{162}$$

9.34 Species `species_34`

Name P_M2

Notes `M2 proteins (molecules)`

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

This species takes part in three reactions (as a reactant in `reaction_34` and as a product in `reaction_33` and as a modifier in `reaction_34`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species}\_34 = v_{33} - 40 \, v_{34} \qquad (163)$$

9.35 Species `species_35`

Name Vrel

Notes `total amount of released virions (virions)`

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

This species takes part in one reaction (as a product in `reaction_34`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{species}\_35 = v_{34} \qquad (164)$$

9.36 Species `species_36`

Name total cRNA

Notes `total amount of cRNA in the cell considering all segments (molecules)`

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

Involved in rule `species_36`

One rule determines the species' quantity.

9.37 Species `species_37`

Name total cRNA of a segment

Notes `total amount of cRNA in the cell considering an arbitrary segment (molecules)`

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

Involved in rule `species_37`

One rule determines the species' quantity.

Produced by SBML2LATEX

9.38 Species `species_38`

Name total vRNA

Notes `total amount of vRNA in the cell considering all segments (molecules)`

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

Involved in rule `species_38`

One rule determines the species' quantity.

9.39 Species `species_39`

Name total vRNA of a segment

Notes `total amount of vRNA in the cell considering an arbitrary segments (molecules)`

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

Involved in rule `species_39`

One rule determines the species' quantity.

A Glossary of Systems Biology Ontology Terms

SBO:0000278 messenger RNA: A messenger RNA is a ribonucleic acid synthesized during the transcription of a gene, and that carries the information to encode one or several proteins

SBO:0000296 macromolecular complex: Non-covalent complex of one or more macromolecules and zero or more simple chemicals

SBO:0000297 protein complex: Macromolecular complex containing one or more polypeptide chains possibly associated with simple chemicals. CHEBI:3608

SBO:0000605 high affinity receptor: A receptor where binding occurs through strong intermolecular forces such as Van der Waals, hydrogen bonds or ionic bonds

SBO:0000606 low affinity receptor: A receptor where binding occurs through weak intermolecular forces