SBML Model Report

Model name: "Montagne2011_Oligator_optimised"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by Lukas Endler[1] at February 17th 2011 at 1:23 a. m. and last time modified at April 20th 2012 at 9:59 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	20
events	0	constraints	0
reactions	27	function definitions	0
global parameters	47	unit definitions	5
rules	5	initial assignments	0

Model Notes

This is the model of the in vitro DNA oscillator called oligator with the optmized set of parameters described in the article:
Programming an in vitro DNA oscillator using a molecular networking strategy.
Montagne K, Plasson R, Sakai Y, Fujii T, Rondelez Y. Mol Syst Biol. 2011 Feb 1;7:466. PubmedID: 21283142 , Doi: 10.1038/msb.2010.120

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Abstract:
Living organisms perform and control complex behaviours by using webs of chemical reactions organized in precise networks. This powerful system concept, which is at the very core of biology, has recently become a new foundation for bioengineering. Remarkably, however, it is still extremely difficult to rationally create such network architectures in artificial, non-living and well-controlled settings. We introduce here a method for such a purpose, on the basis of standard DNA biochemistry. This approach is demonstrated by assembling de novo an efficient chemical oscillator: we encode the wiring of the corresponding network in the sequence of small DNA templates and obtain the predicted dynamics. Our results show that the rational cascading of standard elements opens the possibility to implement complex behaviours in vitro. Because of the simple and well-controlled environment, the corresponding chemical network is easily amenable to quantitative mathematical analysis. These synthetic systems may thus accelerate our understanding of the underlying principles of biological dynamic modules.

The model reproduces the time courses in fig 2B. The parameter identifiers of the reaction constants are not the same as in the supplemental material, but are just called kXd and kXr for the forward and backwards constant of reaction X respectively.

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To cite BioModels Database, please use: Li C, Donizelli M, Rodriguez N, Dharuri H, Endler L, Chelliah V, Li L, He E, Henry A, Stefan MI, Snoep JL, Hucka M, Le Novre N, Laibe C (2010) BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models. BMC Syst Biol., 4:92.

2 Unit Definitions

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

2.1 Unit `time`

Name min

Definition 60 s

2.2 Unit `substance`

Name nanomole

Definition nmol

2.3 Unit `nM`

Name nM

Definition $\mathrm{nmol} \cdot \mathrm{l}^{-1}$

2.4 Unit per_nM_per_min

Name nM_per_min

Definition $\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$

2.5 Unit per_min

Name per_min

Definition $(60\ \mathrm{s})^{-1}$

2.6 Unit volume

Notes Litre is the predefined SBML unit for `volume`.

Definition l

2.7 Unit area

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

Definition m^2

2.8 Unit length

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

Definition m

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
sample		0000290	3	1	litre	☑	

3.1 Compartment sample

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

SBO:0000290 physical compartment

4 Species

This model contains 20 species. The boundary condition of one of these species is set to `true` so that this species' amount cannot be changed by any reaction. Section 8 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
T1	T1	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha	alpha	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha_T1	alpha_T1	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha_T1_alpha	alpha_T1_alpha	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
T1_alpha	T1_alpha	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha_alpha_T1	alpha_alpha_T1	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
T2	T2	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha_T2	alpha_T2	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha_T2_beta	alpha_T2_beta	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
beta	beta	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
T2_beta	T2_beta	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
alpha_beta_T2	alpha_beta_T2	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
T3	T3	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
beta_T3	beta_T3	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
beta_T3_Inh	beta_T3_Inh	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Inh	Inh	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
T3_Inh	T3_Inh	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
beta_Inh_T3	beta_Inh_T3	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
Inh_T1	Inh_T1	sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
empty		sample	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	☑

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5 Parameters

This model contains 47 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k0d		0000339	0.029	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k0r		0000338	3.435	$(60\ \mathrm{s})^{-1}$	☑
k1d		0000338	3.435	$(60\ \mathrm{s})^{-1}$	☑
k1r		0000339	0.029	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k2d		0000338	3.435	$(60\ \mathrm{s})^{-1}$	☑
k2r		0000339	0.029	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k3d		0000338	3.435	$(60\ \mathrm{s})^{-1}$	☑
k3r		0000339	0.029	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k4d		0000035	15.200	$(60\ \mathrm{s})^{-1}$	☑
k5d		0000035	11.841	$(60\ \mathrm{s})^{-1}$	☑
k6d		0000035	3.340	$(60\ \mathrm{s})^{-1}$	☑
k7d		0000339	0.029	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k7r		0000338	3.435	$(60\ \mathrm{s})^{-1}$	☑
k8d		0000338	0.611	$(60\ \mathrm{s})^{-1}$	☑
k8r		0000339	0.017	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k9d		0000338	0.611	$(60\ \mathrm{s})^{-1}$	☑
k9r		0000339	0.017	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k10d		0000338	3.435	$(60\ \mathrm{s})^{-1}$	☑
k10r		0000339	0.029	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k11d		0000035	11.841	$(60\ \mathrm{s})^{-1}$	☑
k12d		0000035	9.224	$(60\ \mathrm{s})^{-1}$	☑
k13d		0000035	2.602	$(60\ \mathrm{s})^{-1}$	☑
k14d		0000339	0.017	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k14r		0000338	0.611	$(60\ \mathrm{s})^{-1}$	☑
k15d		0000338	0.002	$(60\ \mathrm{s})^{-1}$	☑
k15r		0000339	0.027	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k16d		0000339	0.027	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k16r		0000338	0.002	$(60\ \mathrm{s})^{-1}$	☑
k17d		0000339	0.017	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k17r		0000338	0.611	$(60\ \mathrm{s})^{-1}$	☑
k18d		0000035	17.024	$(60\ \mathrm{s})^{-1}$	☑
k19d		0000035	5.567	$(60\ \mathrm{s})^{-1}$	☑
k20d		0000035	3.206	$(60\ \mathrm{s})^{-1}$	☑
k21d		0000339	0.027	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑

Id	Name	SBO	Value	Unit	Constant
k21r		0000338	0.006	$(60\ \mathrm{s})^{-1}$	☑
k22d		0000036	0.022	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k22r		0000039	$4.15391351351 \cdot 10^{-5}$	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k23d		0000036	$4.15391351351 \cdot 10^{-5}$	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k23r		0000039	0.022	$\mathrm{nmol}^{-1} \cdot 1 \cdot (60\ \mathrm{s})^{-1}$	☑
k24d		0000356	0.411	$(60\ \mathrm{s})^{-1}$	☑
k25d		0000356	0.486	$(60\ \mathrm{s})^{-1}$	☑
k26d		0000356	1.726	$(60\ \mathrm{s})^{-1}$	☑
Bp- _concentration		0000196	0.000	$\mathrm{nmol} \cdot 1^{-1}$	⊟
fluorescence		0000002	0.000		⊟
Inh_total		0000196	0.000	$\mathrm{nmol} \cdot 1^{-1}$	⊟
beta_total		0000196	0.000	$\mathrm{nmol} \cdot 1^{-1}$	⊟
alpha_total		0000196	0.000	$\mathrm{nmol} \cdot 1^{-1}$	⊟

6 Rules

This is an overview of five rules.

6.1 Rule Bp_concentration

Rule Bp_concentration is an assignment rule for parameter Bp_concentration:

$$\begin{aligned}\mathrm{Bp\_concentration} = {} & 11 \cdot (\mathrm{[alpha\_T1]} + \mathrm{[T1\_alpha]} + \mathrm{[alpha\_T2]} + \mathrm{[T2\_beta]} + \mathrm{[beta\_T3]}) \\ & + 16 \cdot (\mathrm{[T3\_Inh]} + \mathrm{[Inh\_T1]}) + 22 \\ & \cdot (\mathrm{[alpha\_T1\_alpha]} + \mathrm{[alpha\_alpha\_T1]} + \mathrm{[alpha\_T2\_beta]} + \mathrm{[alpha\_beta\_T2]}) \\ & + 27 \cdot (\mathrm{[beta\_T3\_Inh]} + \mathrm{[beta\_Inh\_T3]})\end{aligned} \tag{1}$$

6.2 Rule fluorescence

Rule fluorescence is an assignment rule for parameter fluorescence:

$$\begin{aligned}\mathrm{fluorescence} = {} & -0.38 \\ & + 9.3 \cdot 10^{-4} \cdot (11 \cdot (\mathrm{[alpha\_T1]} + \mathrm{[T1\_alpha]} + \mathrm{[alpha\_T2]} + \mathrm{[T2\_beta]} + \mathrm{[beta\_T3]}) \\ & + 16 \cdot (\mathrm{[T3\_Inh]} + \mathrm{[Inh\_T1]}) + 22 \\ & \cdot (\mathrm{[alpha\_T1\_alpha]} + \mathrm{[alpha\_alpha\_T1]} + \mathrm{[alpha\_T2\_beta]} + \mathrm{[alpha\_beta\_T2]}) \\ & + 27 \cdot (\mathrm{[beta\_T3\_Inh]} + \mathrm{[beta\_Inh\_T3]}))\end{aligned} \tag{2}$$

6.3 Rule `Inh_total`

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

$$\text{Inh\_total} = [\text{Inh}] + [\text{T3\_Inh}] + [\text{beta\_T3\_Inh}] + [\text{Inh\_T1}] \tag{3}$$

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

6.4 Rule `beta_total`

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

$$\text{beta\_total} = [\text{beta}] + [\text{T2\_beta}] + [\text{alpha\_T2\_beta}] + [\text{beta\_T3}] + [\text{beta\_T3\_Inh}] \tag{4}$$

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

6.5 Rule `alpha_total`

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

$$\begin{aligned}\text{alpha\_total} = {} & [\text{alpha}] + [\text{alpha\_T1}] + [\text{T1\_alpha}] + 2 \cdot [\text{alpha\_T1\_alpha}] \\ & + [\text{alpha\_T2}] + [\text{alpha\_T2\_beta}] + [\text{alpha\_T2}]\end{aligned} \tag{5}$$

7 Reactions

This model contains 27 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	ass_aa_l		T1 + alpha $\rightleftharpoons$ alpha_T1	0000177
2	m_ass_aa_lr		alpha_T1_alpha $\rightleftharpoons$ alpha + alpha_T1	0000180
3	m_ass_aa_r		T1_alpha $\rightleftharpoons$ T1 + alpha	0000180
4	m_ass_aa_rl		alpha_T1_alpha $\rightleftharpoons$ alpha + T1_alpha	0000180
5	pol_aa		alpha_T1 $\longrightarrow$ alpha_alpha_T1	0000205
6	dis_aa		alpha_T1_alpha $\longrightarrow$ alpha + alpha_alpha_T1	0000180
7	nick_aa		alpha_alpha_T1 $\longrightarrow$ alpha_T1_alpha	0000178
8	ass_ab_l		alpha + T2 $\rightleftharpoons$ alpha_T2	0000177
9	m_ass_ab_lr		alpha_T2_beta $\rightleftharpoons$ alpha_T2 + beta	0000180
10	m_ass_ab_r		T2_beta $\rightleftharpoons$ T2 + beta	0000180
11	m_ass_ab_rl		alpha_T2_beta $\rightleftharpoons$ alpha + T2_beta	0000180
12	pol_ab		alpha_T2 $\longrightarrow$ alpha_beta_T2	0000205
13	dis_ab		alpha_T2_beta $\longrightarrow$ beta + alpha_beta_T2	0000205
14	nick_ab		alpha_beta_T2 $\longrightarrow$ alpha_T2_beta	0000178
15	ass_bc_l		beta + T3 $\rightleftharpoons$ beta_T3	0000177
16	m_ass_bc_lr		beta_T3_Inh $\rightleftharpoons$ beta_T3 + Inh	0000180
17	ass_bc_r		T3 + Inh $\rightleftharpoons$ T3_Inh	0000177
18	ass_bc_rl		beta + T3_Inh $\rightleftharpoons$ beta_T3_Inh	0000177
19	pol_bc		beta_T3 $\longrightarrow$ beta_Inh_T3	0000205
20	dis_bc		beta_T3_Inh $\longrightarrow$ Inh + beta_Inh_T3	0000205
21	nick_bc		beta_Inh_T3 $\longrightarrow$ beta_T3_Inh	0000178
22	inh_ac		T1 + Inh $\rightleftharpoons$ Inh_T1	0000177
23	inh_displ_ac		T1_alpha + Inh $\rightleftharpoons$ alpha + Inh_T1	0000177

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№	Id	Name	Reaction Equation	SBO
24	m_inh_displ_ca		alpha + Inh_T1 $\rightleftharpoons$ alpha_T1 + Inh	0000177
25	exo_a		alpha $\rightleftharpoons$ empty	0000179
26	exo_b		beta $\rightleftharpoons$ empty	0000179
27	exo_c		Inh $\rightleftharpoons$ empty	0000179

Produced by SBML2LaTeX

7.1 Reaction ass_aa_l

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

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{T1} + \mathrm{alpha} \rightleftharpoons \mathrm{alpha\_T1} \tag{6}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
T1	T1	
alpha	alpha	

Product

Table 7: Properties of each product.

Id	Name	SBO
alpha_T1	alpha_T1	

Kinetic Law

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_1 = \mathrm{vol}\,(\mathrm{sample}) \cdot (\mathrm{k0d} \cdot [\mathrm{T1}] \cdot [\mathrm{alpha}] - \mathrm{k0r} \cdot [\mathrm{alpha\_T1}]) \tag{7}$$

7.2 Reaction m_ass_aa_lr

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

SBO:0000180 dissociation

Reaction equation

$$\mathrm{alpha\_T1\_alpha} \rightleftharpoons \mathrm{alpha} + \mathrm{alpha\_T1} \tag{8}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
alpha_T1_alpha	alpha_T1_alpha	

Products

Table 9: Properties of each product.

Id	Name	SBO
alpha	alpha	
alpha_T1	alpha_T1	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\,\mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_2 = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k1d} \cdot [\mathrm{alpha\_T1\_alpha}] - \mathrm{k1r} \cdot [\mathrm{alpha}] \cdot [\mathrm{alpha\_T1}]) \tag{9}$$

7.3 Reaction m_ass_aa_r

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

SBO:0000180 dissociation

Reaction equation

$$\mathrm{T1\_alpha} \rightleftharpoons \mathrm{T1} + \mathrm{alpha} \tag{10}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
T1_alpha	T1_alpha	

Products

Table 11: Properties of each product.

Id	Name	SBO
T1	T1	
alpha	alpha	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_3 = \mathrm{vol}\,(\mathrm{sample}) \cdot (\mathrm{k2d} \cdot [\mathrm{T1\_alpha}] - \mathrm{k2r} \cdot [\mathrm{T1}] \cdot [\mathrm{alpha}]) \tag{11}$$

7.4 Reaction m_ass_aa_rl

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

SBO:0000180 dissociation

Reaction equation

$$\mathrm{alpha\_T1\_alpha} \rightleftharpoons \mathrm{alpha} + \mathrm{T1\_alpha} \tag{12}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
alpha_T1_alpha	alpha_T1_alpha	

Products

Table 13: Properties of each product.

Id	Name	SBO
alpha	alpha	
T1_alpha	T1_alpha	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_4 = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k3d} \cdot [\mathrm{alpha\_T1\_alpha}] - \mathrm{k3r} \cdot [\mathrm{alpha}] \cdot [\mathrm{T1\_alpha}]) \tag{13}$$

7.5 Reaction `pol_aa`

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

SBO:0000205 composite biochemical process

Reaction equation

$$\mathrm{alpha\_T1} \longrightarrow \mathrm{alpha\_alpha\_T1} \tag{14}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
`alpha_T1`	alpha_T1	

Product

Table 15: Properties of each product.

Id	Name	SBO
`alpha_alpha_T1`	alpha_alpha_T1	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_5 = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k4d} \cdot [\mathrm{alpha\_T1}] \tag{15}$$

7.6 Reaction `dis_aa`

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

SBO:0000180 dissociation

Reaction equation

$$\text{alpha\_T1\_alpha} \longrightarrow \text{alpha} + \text{alpha\_alpha\_T1} \tag{16}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
alpha_T1_alpha	alpha_T1_alpha	

Products

Table 17: Properties of each product.

Id	Name	SBO
alpha	alpha	
alpha_alpha_T1	alpha_alpha_T1	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_6 = \mathrm{vol}\,(\mathrm{sample}) \cdot \mathrm{k5d} \cdot [\mathrm{alpha\_T1\_alpha}] \tag{17}$$

7.7 Reaction nick_aa

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

SBO:0000178 cleavage

Reaction equation

$$\text{alpha\_alpha\_T1} \longrightarrow \text{alpha\_T1\_alpha} \tag{18}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
alpha_alpha_T1	alpha_alpha_T1	

Product

Table 19: Properties of each product.

Id	Name	SBO
alpha_T1_alpha	alpha_T1_alpha	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_7 = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k6d} \cdot [\mathrm{alpha\_alpha\_T1}] \tag{19}$$

7.8 Reaction ass_ab_1

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

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{alpha} + \mathrm{T2} \rightleftharpoons \mathrm{alpha\_T2} \tag{20}$$

Reactants

Table 20: Properties of each reactant.

Id	Name	SBO
alpha	alpha	
T2	T2	

Product

Table 21: Properties of each product.

Id	Name	SBO
alpha_T2	alpha_T2	

Kinetic Law

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_8 = \mathrm{vol}\,(\mathrm{sample}) \cdot (\mathrm{k7d} \cdot [\mathrm{alpha}] \cdot [\mathrm{T2}] - \mathrm{k7r} \cdot [\mathrm{alpha\_T2}]) \tag{21}$$

7.9 Reaction m_ass_ab_lr

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

SBO:0000180 dissociation

Reaction equation

$$\mathrm{alpha\_T2\_beta} \rightleftharpoons \mathrm{alpha\_T2} + \mathrm{beta} \tag{22}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
alpha_T2_beta	alpha_T2_beta	

Products

Table 23: Properties of each product.

Id	Name	SBO
alpha_T2	alpha_T2	
beta	beta	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_9 = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k8d} \cdot [\mathrm{alpha\_T2\_beta}] - \mathrm{k8r} \cdot [\mathrm{alpha\_T2}] \cdot [\mathrm{beta}]) \tag{23}$$

7.10 Reaction m_ass_ab_r

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

SBO:0000180 dissociation

Reaction equation

$$\mathrm{T2\_beta} \rightleftharpoons \mathrm{T2} + \mathrm{beta} \tag{24}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
T2_beta	T2_beta	

Products

Table 25: Properties of each product.

Id	Name	SBO
T2	T2	
beta	beta	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{10} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k9d} \cdot [\mathrm{T2\_beta}] - \mathrm{k9r} \cdot [\mathrm{T2}] \cdot [\mathrm{beta}]) \tag{25}$$

7.11 Reaction m_ass_ab_rl

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

SBO:0000180 dissociation

Reaction equation

$$\text{alpha\_T2\_beta} \rightleftharpoons \text{alpha} + \text{T2\_beta} \tag{26}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
alpha_T2_beta	alpha_T2_beta	

Products

Table 27: Properties of each product.

Id	Name	SBO
alpha	alpha	
T2_beta	T2_beta	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{11} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k10d} \cdot [\mathrm{alpha\_T2\_beta}] - \mathrm{k10r} \cdot [\mathrm{alpha}] \cdot [\mathrm{T2\_beta}]) \tag{27}$$

7.12 Reaction pol_ab

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

SBO:0000205 composite biochemical process

Reaction equation

$$\text{alpha\_T2} \longrightarrow \text{alpha\_beta\_T2} \tag{28}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
alpha_T2	alpha_T2	

Product

Table 29: Properties of each product.

Id	Name	SBO
alpha_beta_T2	alpha_beta_T2	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{12} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k11d} \cdot [\mathrm{alpha\_T2}] \tag{29}$$

7.13 Reaction dis_ab

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

SBO:0000205 composite biochemical process

Reaction equation

$$\mathrm{alpha\_T2\_beta} \longrightarrow \mathrm{beta} + \mathrm{alpha\_beta\_T2} \tag{30}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
alpha_T2_beta	alpha_T2_beta	

Products

Table 31: Properties of each product.

Id	Name	SBO
beta	beta	
alpha_beta_T2	alpha_beta_T2	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{13} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k12d} \cdot [\mathrm{alpha\_T2\_beta}] \tag{31}$$

7.14 Reaction nick_ab

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

SBO:0000178 cleavage

Reaction equation

$$\mathrm{alpha\_beta\_T2} \longrightarrow \mathrm{alpha\_T2\_beta} \tag{32}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
alpha_beta_T2	alpha_beta_T2	

Product

Table 33: Properties of each product.

Id	Name	SBO
alpha_T2_beta	alpha_T2_beta	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{14} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k13d} \cdot [\mathrm{alpha\_beta\_T2}] \tag{33}$$

7.15 Reaction ass_bc_l

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

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{beta} + \mathrm{T3} \rightleftharpoons \mathrm{beta\_T3} \tag{34}$$

Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
beta	beta	
T3	T3	

Product

Table 35: Properties of each product.

Id	Name	SBO
beta_T3	beta_T3	

Kinetic Law

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{15} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k14d} \cdot [\mathrm{beta}] \cdot [\mathrm{T3}] - \mathrm{k14r} \cdot [\mathrm{beta\_T3}]) \tag{35}$$

7.16 Reaction m_ass_bc_lr

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

SBO:0000180 dissociation

Reaction equation

$$\mathrm{beta\_T3\_Inh} \rightleftharpoons \mathrm{beta\_T3} + \mathrm{Inh} \tag{36}$$

Reactant

Table 36: Properties of each reactant.

Id	Name	SBO
beta_T3_Inh	beta_T3_Inh	

Products

Table 37: Properties of each product.

Id	Name	SBO
beta_T3_Inh	beta_T3_Inh	

Kinetic Law

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{16} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k15d} \cdot [\mathrm{beta\_T3\_Inh}] - \mathrm{k15r} \cdot [\mathrm{beta\_T3}] \cdot [\mathrm{Inh}]) \tag{37}$$

7.17 Reaction ass_bc_r

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

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{T3} + \mathrm{Inh} \rightleftharpoons \mathrm{T3\_Inh} \tag{38}$$

Reactants

Table 38: Properties of each reactant.

Id	Name	SBO
T3	T3	
Inh	Inh	

Product

Table 39: Properties of each product.

Id	Name	SBO
T3_Inh	T3_Inh	

Kinetic Law

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{17} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k16d} \cdot [\mathrm{T3}] \cdot [\mathrm{Inh}] - \mathrm{k16r} \cdot [\mathrm{T3\_Inh}]) \tag{39}$$

7.18 Reaction ass_bc_rl

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

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{beta} + \mathrm{T3\_Inh} \rightleftharpoons \mathrm{beta\_T3\_Inh} \tag{40}$$

Reactants

Table 40: Properties of each reactant.

Id	Name	SBO
beta	beta	
T3_Inh	T3_Inh	

Product

Table 41: Properties of each product.

Id	Name	SBO
beta_T3_Inh	beta_T3_Inh	

Kinetic Law

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{18} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k17d} \cdot [\mathrm{beta}] \cdot [\mathrm{T3\_Inh}] - \mathrm{k17r} \cdot [\mathrm{beta\_T3\_Inh}]) \tag{41}$$

7.19 Reaction `pol_bc`

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

SBO:0000205 composite biochemical process

Reaction equation

$$\mathrm{beta\_T3} \longrightarrow \mathrm{beta\_Inh\_T3} \tag{42}$$

Reactant

Table 42: Properties of each reactant.

Id	Name	SBO
`beta_T3`	beta_T3	

Product

Table 43: Properties of each product.

Id	Name	SBO
`beta_Inh_T3`	beta_Inh_T3	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{19} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k18d} \cdot [\mathrm{beta\_T3}] \tag{43}$$

7.20 Reaction `dis_bc`

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

SBO:0000205 composite biochemical process

Reaction equation

$$\text{beta\_T3\_Inh} \longrightarrow \text{Inh} + \text{beta\_Inh\_T3} \tag{44}$$

Reactant

Table 44: Properties of each reactant.

Id	Name	SBO
beta_T3_Inh	beta_T3_Inh	

Products

Table 45: Properties of each product.

Id	Name	SBO
Inh	Inh	
beta_Inh_T3	beta_Inh_T3	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{20} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k19d} \cdot [\mathrm{beta\_T3\_Inh}] \tag{45}$$

7.21 Reaction nick_bc

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

SBO:0000178 cleavage

Reaction equation

$$\text{beta\_Inh\_T3} \longrightarrow \text{beta\_T3\_Inh} \tag{46}$$

Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
beta_Inh_T3	beta_Inh_T3	

Product

Table 47: Properties of each product.

Id	Name	SBO
beta_T3_Inh	beta_T3_Inh	

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{21} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k20d} \cdot [\mathrm{beta\_Inh\_T3}] \tag{47}$$

7.22 Reaction inh_ac

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

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{T1} + \mathrm{Inh} \rightleftharpoons \mathrm{Inh\_T1} \tag{48}$$

Reactants

Table 48: Properties of each reactant.

Id	Name	SBO
T1	T1	
Inh	Inh	

Product

Table 49: Properties of each product.

Id	Name	SBO
Inh_T1	Inh_T1	

Kinetic Law

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{22} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k21d} \cdot [\mathrm{T1}] \cdot [\mathrm{Inh}] - \mathrm{k21r} \cdot [\mathrm{Inh\_T1}]) \tag{49}$$

7.23 Reaction inh_displ_ac

This is a reversible reaction of two reactants forming two products.

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{T1\_alpha} + \mathrm{Inh} \rightleftharpoons \mathrm{alpha} + \mathrm{Inh\_T1} \tag{50}$$

Reactants

Table 50: Properties of each reactant.

Id	Name	SBO
T1_alpha	T1_alpha	
Inh	Inh	

Products

Table 51: Properties of each product.

Id	Name	SBO
alpha	alpha	
Inh_T1	Inh_T1	

Kinetic Law

SBO:0000103 mass action rate law for second order forward, second order reverse, reversible reactions, two reactants, one product, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{23} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k22d} \cdot [\mathrm{T1\_alpha}] \cdot [\mathrm{Inh}] - \mathrm{k22r} \cdot [\mathrm{alpha}] \cdot [\mathrm{Inh\_T1}]) \tag{51}$$

7.24 Reaction `m_inh_displ_ca`

This is a reversible reaction of two reactants forming two products.

SBO:0000177 non-covalent binding

Reaction equation

$$\mathrm{alpha} + \mathrm{Inh\_T1} \rightleftharpoons \mathrm{alpha\_T1} + \mathrm{Inh} \tag{52}$$

Reactants

Table 52: Properties of each reactant.

Id	Name	SBO
`alpha`	alpha	
`Inh_T1`	Inh_T1	

Products

Table 53: Properties of each product.

Id	Name	SBO
`alpha_T1`	alpha_T1	
`Inh`	Inh	

Kinetic Law

SBO:0000103 mass action rate law for second order forward, second order reverse, reversible reactions, two reactants, one product, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{24} = \mathrm{vol}(\mathrm{sample}) \cdot (\mathrm{k23d} \cdot [\mathrm{alpha}] \cdot [\mathrm{Inh\_T1}] - \mathrm{k23r} \cdot [\mathrm{alpha\_T1}] \cdot [\mathrm{Inh}]) \tag{53}$$

7.25 Reaction exo_a

This is a reversible reaction of one reactant forming one product.

SBO:0000179 degradation

Reaction equation

$$\text{alpha} \rightleftharpoons \text{empty} \tag{54}$$

Reactant

Table 54: Properties of each reactant.

Id	Name	SBO
alpha	alpha	

Product

Table 55: Properties of each product.

Id	Name	SBO
empty		

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{25} = \mathrm{vol}\,(\mathrm{sample}) \cdot \mathrm{k24d} \cdot [\mathrm{alpha}] \tag{55}$$

7.26 Reaction exo_b

This is a reversible reaction of one reactant forming one product.

SBO:0000179 degradation

Reaction equation

$$\text{beta} \rightleftharpoons \text{empty} \tag{56}$$

Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
beta	beta	

Product

Table 57: Properties of each product.

Id	Name	SBO
empty		

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{26} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k25d} \cdot [\mathrm{beta}] \tag{57}$$

7.27 Reaction exo_c

This is a reversible reaction of one reactant forming one product.

SBO:0000179 degradation

Reaction equation

$$\mathrm{Inh} \rightleftharpoons \mathrm{empty} \tag{58}$$

Reactant

Table 58: Properties of each reactant.

Id	Name	SBO
Inh	Inh	

Product

Table 59: Properties of each product.

Id	Name	SBO
empty		

Kinetic Law

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme

Derived unit $(60\ \mathrm{s})^{-1} \cdot \mathrm{nmol}$

$$v_{27} = \mathrm{vol}(\mathrm{sample}) \cdot \mathrm{k26d} \cdot [\mathrm{Inh}] \tag{59}$$

8 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.

8.1 Species T1

Name T1

SBO:0000250 ribonucleic acid

Initial concentration $38.5\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in ass_aa_l, inh_ac and as a product in m_ass_aa_r).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T1} = v_3 - v_1 - v_{22} \tag{60}$$

8.2 Species alpha

Name alpha

SBO:0000250 ribonucleic acid

Initial concentration $10\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in ten reactions (as a reactant in ass_aa_l, ass_ab_l, m_inh_displ_ca, exo_a and as a product in m_ass_aa_lr, m_ass_aa_r, m_ass_aa_rl, dis_aa, m_ass_ab_rl, inh_displ_ac).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha} = v_2 + v_3 + v_4 + v_6 + v_{11} + v_{23} - v_1 - v_8 - v_{24} - v_{25} \tag{61}$$

8.3 Species alpha_T1

Name alpha_T1

SBO:0000250 ribonucleic acid

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

This species takes part in four reactions (as a reactant in pol_aa and as a product in ass_aa_l, m_ass_aa_lr, m_inh_displ_ca).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha\_T1} = v_1 + v_2 + v_{24} - v_5 \tag{62}$$

8.4 Species alpha_T1_alpha

Name alpha_T1_alpha

SBO:0000250 ribonucleic acid

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

This species takes part in four reactions (as a reactant in m_ass_aa_lr, m_ass_aa_rl, dis_aa and as a product in nick_aa).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha\_T1\_alpha} = v_7 - v_2 - v_4 - v_6 \tag{63}$$

8.5 Species T1_alpha

Name T1_alpha

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in m_ass_aa_r, inh_displ_ac and as a product in m_ass_aa_rl).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T1\_alpha} = v_4 - v_3 - v_{23} \tag{64}$$

8.6 Species alpha_alpha_T1

Name alpha_alpha_T1

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in nick_aa and as a product in pol_aa, dis_aa).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha\_alpha\_T1} = v_5 + v_6 - v_7 \tag{65}$$

8.7 Species T2

Name T2

SBO:0000250 ribonucleic acid

Initial concentration $3.89\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T2} = v_{10} - v_8 \tag{66}$$

8.8 Species alpha_T2

Name alpha_T2

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in pol_ab and as a product in ass_ab_l, m_ass_ab_lr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha\_T2} = v_8 + v_9 - v_{12} \tag{67}$$

8.9 Species alpha_T2_beta

Name alpha_T2_beta

SBO:0000250 ribonucleic acid

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

This species takes part in four reactions (as a reactant in m_ass_ab_lr, m_ass_ab_rl, dis_ab and as a product in nick_ab).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha\_T2\_beta} = v_{14} - v_9 - v_{11} - v_{13} \tag{68}$$

8.10 Species beta

Name beta

SBO:0000250 ribonucleic acid

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

This species takes part in six reactions (as a reactant in ass_bc_l, ass_bc_rl, exo_b and as a product in m_ass_ab_lr, m_ass_ab_r, dis_ab).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{beta} = v_9 + v_{10} + v_{13} - v_{15} - v_{18} - v_{26} \tag{69}$$

8.11 Species T2_beta

Name T2_beta

SBO:0000250 ribonucleic acid

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T2\_beta} = v_{11} - v_{10} \tag{70}$$

8.12 Species alpha_beta_T2

Name alpha_beta_T2

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in nick_ab and as a product in pol_ab, dis_ab).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{alpha\_beta\_T2} = v_{12} + v_{13} - v_{14} \tag{71}$$

8.13 Species T3

Name T3

SBO:0000250 ribonucleic acid

Initial concentration $38.5\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in ass_bc_l, ass_bc_r).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T3} = -v_{15} - v_{17} \tag{72}$$

8.14 Species beta_T3

Name beta_T3

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in pol_bc and as a product in ass_bc_l, m_ass_bc_lr).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{beta\_T3} = v_{15} + v_{16} - v_{19} \tag{73}$$

8.15 Species beta_T3_Inh

Name beta_T3_Inh

SBO:0000250 ribonucleic acid

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

This species takes part in four reactions (as a reactant in m_ass_bc_lr, dis_bc and as a product in ass_bc_rl, nick_bc).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{beta\_T3\_Inh} = v_{18} + v_{21} - v_{16} - v_{20} \tag{74}$$

8.16 Species Inh

Name Inh

SBO:0000250 ribonucleic acid

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

This species takes part in seven reactions (as a reactant in ass_bc_r, inh_ac, inh_displ_ac, exo_c and as a product in m_ass_bc_lr, dis_bc, m_inh_displ_ca).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Inh} = v_{16} + v_{20} + v_{24} - v_{17} - v_{22} - v_{23} - v_{27} \tag{75}$$

8.17 Species T3_Inh

Name T3_Inh

SBO:0000250 ribonucleic acid

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T3\_Inh} = v_{17} - v_{18} \tag{76}$$

8.18 Species beta_Inh_T3

Name beta_Inh_T3

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in nick_bc and as a product in pol_bc, dis_bc).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{beta\_Inh\_T3} = v_{19} + v_{20} - v_{21} \tag{77}$$

8.19 Species Inh_T1

Name Inh_T1

SBO:0000250 ribonucleic acid

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

This species takes part in three reactions (as a reactant in m_inh_displ_ca and as a product in inh_ac, inh_displ_ac).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Inh\_T1} = v_{22} + v_{23} - v_{24} \tag{78}$$

8.20 Species empty

SBO:0000291 empty set

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

This species takes part in three reactions (as a product in exo_a, exo_b, exo_c), which do not influence its rate of change because this species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{empty} = 0 \tag{79}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000002 quantitative systems description parameter: A numerical value that defines certain characteristics of systems or system functions. It may be part of a calculation, but its value is not determined by the form of the equation itself, and may be arbitrarily assigned

SBO:0000035 forward unimolecular rate constant, continuous case: Numerical parameter that quantifies the forward velocity of a chemical reaction involving only one reactant. This parameter encompasses all the contributions to the velocity except the quantity of the reactant. It is to be used in a reaction modelled using a continuous framework

SBO:0000036 forward bimolecular rate constant, continuous case: Numerical parameter that quantifies the forward velocity of a chemical reaction involving two reactants. This parameter encompasses all the contributions to the velocity except the quantity of the reactants. It is to be used in a reaction modelled using a continuous framework

SBO:0000039 reverse bimolecular rate constant, continuous case: Numerical parameter that quantifies the reverse velocity of a chemical reaction involving only one product. This parameter encompasses all the contributions to the velocity except the quantity of the product. It is to be used in a reaction modelled using a continuous framework

SBO:0000049 mass action rate law for first order irreversible reactions, continuous scheme: Reaction scheme where the products are created from the reactants and the change of a product quantity is proportional to the product of reactant activities. The reaction scheme does not include any reverse process that creates the reactants from the products. The change of a product quantity is proportional to the quantity of one reactant. It is to be used in a reaction modelled using a continuous framework.

SBO:0000083 mass action rate law for first order forward, second order reverse, reversible reactions, two products, continuous scheme: Reaction scheme where the products are created from the reactants and the change of a product quantity is proportional to the product of reactant activities. The reaction scheme does include a reverse process that creates the reactants from the products. The rate of the forward process is proportional to the quantity of one reactant. The rate of the reverse process is proportional to the product of two product quantities. It is to be used in a reaction modelled using a continuous framework.

SBO:0000101 mass action rate law for second order forward, first order reverse, reversible reactions, two reactants, continuous scheme: Reaction scheme where the products are created from the reactants and the change of a product quantity is proportional to the product of reactant activities. The reaction scheme does include a reverse process that creates the reactants from the products. The rate of the forward process is proportional to the product of two reactant quantities. The rate of the reverse process is proportional to the quantity of one product. It is to be used in a reaction modelled using a continuous framework.

SBO:0000103 mass action rate law for second order forward, second order reverse, reversible reactions, two reactants, one product, continuous scheme: Reaction scheme where the products are created from the reactants and the change of a product quantity is proportional to the product of reactant activities. The reaction scheme does include a reverse process that creates the reactants from the products. The rate of the forward process is proportional to the product of two reactant quantities. The rate of the reverse process is proportional to the square of one product quantity. It is to be used in a reaction modelled using a continuous framework.

SBO:0000177 non-covalent binding: Interaction between several biochemical entities that results in the formation of a non-covalent comple

SBO:0000178 cleavage: Rupture of a covalent bond resulting in the conversion of one physical entity into several physical entities

SBO:0000179 degradation: Complete disappearance of a physical entity

SBO:0000180 dissociation: Transformation of a non-covalent complex that results in the formation of several independent biochemical entitie

SBO:0000196 concentration of an entity pool: The amount of an entity per unit of volume.

SBO:0000205 composite biochemical process: Process that involves the participation of chemical or biological entities and is composed of several elementary steps or reactions.

SBO:0000250 ribonucleic acid: Macromolecule formed by a repetition of ribonucleosides linked by phosphodiester bonds. CHEBI:3369

SBO:0000290 physical compartment: Specific location of space, that can be bounded or not. A physical compartment can have 1, 2 or 3 dimensions

SBO:0000291 empty set: Entity defined by the absence of any actual object. An empty set is often used to represent the source of a creation process or the result of a degradation process.

SBO:0000338 dissociation rate constant: Rate with which a complex dissociates into its components

SBO:0000339 bimolecular association rate constant: Rate with which two components associate into a complex

SBO:0000356 decay constant: Kinetic constant characterising a mono-exponential decay. It is the inverse of the mean lifetime of the continuant being decayed. Its unit is"per tim".

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