SBML Model Report

Model name: “Franois2005 - Mixed Feedback Loop (two-gene network)”

May 6, 2016

1 General Overview

This is a document in SBML Level 3 Version 1 format. This model was created by Nicolas Le Novre[1] at August 14th 2014 at 10:59 a. m. and last time modified at September eleventh 2014 at 3:48 p. m. Table 1 gives an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	6
events	0	constraints	0
reactions	11	function definitions	2
global parameters	11	unit definitions	5
rules	0	initial assignments	0

2 Unit Definitions

This is an overview of five unit definitions.

2.1 Unit `length`

Name length

[1] Babraham Institute, n.lenovere@gmail.com

Definition m

2.2 Unit `area`

Name area

Definition m^2

2.3 Unit `volume`

Name volume

Definition pl

2.4 Unit `time`

Name time

Definition 60 s

2.5 Unit `substance`

Name substance

Definition item

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`cell`	cell		3	1		☑	

3.1 Compartment `cell`

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

Name cell

4 Species

This model contains six species. 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
A	A	cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AgB	AgB	cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
gB	gB	cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
rB	rB	cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
B	B	cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
AB	AB	cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains eleven global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
theta	theta		0.040		☑
alpha	alpha		0.001		☑
rhob	rhob		5.000		☑
rhof	rhof		0.100		☑
deltar	deltar		0.030		☑
rhoA	rhoA		100.000		☑
gamma	gamma		1.000		☑
deltaA	deltaA		0.010		☑
deltaB	deltaB		0.010		☑
beta	beta		3.000		☑
deltaAB	deltaAB		0.010		☑

6 Function definitions

This is an overview of two function definitions.

6.1 Function definition Constant_flux__irreversible

Name Constant flux (irreversible)

Argument v

Mathematical Expression

$$v \tag{1}$$

6.2 Function definition transcription_and_translation

Name transcription and translation

Arguments k, X

Mathematical Expression

$$k \cdot X \tag{2}$$

7 Reactions

This model contains eleven 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	A_binds_gB	A binds gB	$A + gB \xrightarrow{A,\ gB} AgB$	
2	gB_releases_A	gB releases A	$AgB \xrightarrow{AgB} A + gB$	
3	basal_transcription_B	basal transcription B	$\emptyset \xrightarrow{gB,\ gB} rB$	
4	stim_transcription_B	stim transcription B	$\emptyset \xrightarrow{AgB,\ AgB} rB$	
5	degradation_mRNA_B	degradation mRNA B	$rB \xrightarrow{rB} \emptyset$	
6	production_A	production A	$\emptyset \longrightarrow A$	
7	degradation_A	degradation A	$A \xrightarrow{A} \emptyset$	
8	translation_B	translation B	$\emptyset \xrightarrow{rB,\ rB} B$	
9	degradation_B	degradation B	$B \xrightarrow{B} \emptyset$	
10	formation_dimer	formation dimer	$A + B \xrightarrow{A,\ B} AB$	
11	degradation_dimer	degradation dimer	$AB \xrightarrow{AB} \emptyset$	

7.1 Reaction A_binds_gB

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

Name A binds gB

Reaction equation

$$\mathrm{A} + \mathrm{gB} \xrightarrow{\mathrm{A},\ \mathrm{gB}} \mathrm{AgB} \tag{3}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
A	A	
gB	gB	

Modifiers

Table 7: Properties of each modifier.

Id	Name	SBO
A	A	
gB	gB	

Product

Table 8: Properties of each product.

Id	Name	SBO
AgB	AgB	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{alpha} \cdot [\mathrm{A}] \cdot [\mathrm{gB}] \tag{4}$$

7.2 Reaction gB_releases_A

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

Name gB releases A

Reaction equation

$$\mathrm{AgB} \xrightarrow{\mathrm{AgB}} \mathrm{A} + \mathrm{gB} \tag{5}$$

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
AgB	AgB	

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
AgB	AgB	

Products

Table 11: Properties of each product.

Id	Name	SBO
A	A	
gB	gB	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{theta} \cdot [\mathrm{AgB}] \tag{6}$$

7.3 Reaction basal_transcription_B

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

Name basal transcription B

Reaction equation

$$\emptyset \xrightarrow{\text{gB, gB}} \text{rB} \tag{7}$$

Modifiers

Table 12: Properties of each modifier.

Id	Name	SBO
gB	gB	
gB	gB	

Product

Table 13: Properties of each product.

Id	Name	SBO
rB	rB	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \text{vol}\left(\text{cell}\right) \cdot \text{transcription\_and\_translation}\left(\text{rhof}, [\text{gB}]\right) \tag{8}$$

$$\text{transcription\_and\_translation}\left(\text{k}, \text{X}\right) = \text{k} \cdot \text{X} \tag{9}$$

$$\text{transcription\_and\_translation}\left(\text{k}, \text{X}\right) = \text{k} \cdot \text{X} \tag{10}$$

7.4 Reaction stim_transcription_B

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

Name stim transcription B

Reaction equation

$$\emptyset \xrightarrow{\text{AgB, AgB}} \text{rB} \tag{11}$$

Modifiers

Table 14: Properties of each modifier.

Id	Name	SBO
AgB	AgB	
AgB	AgB	

Product

Table 15: Properties of each product.

Id	Name	SBO
rB	rB	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{transcription\_and\_translation}\,(\mathrm{rhob}, [\mathrm{AgB}]) \tag{12}$$

$$\mathrm{transcription\_and\_translation}\,(\mathrm{k}, \mathrm{X}) = \mathrm{k} \cdot \mathrm{X} \tag{13}$$

$$\mathrm{transcription\_and\_translation}\,(\mathrm{k}, \mathrm{X}) = \mathrm{k} \cdot \mathrm{X} \tag{14}$$

7.5 Reaction degradation_mRNA_B

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

Name degradation mRNA B

Reaction equation

$$\mathrm{rB} \xrightarrow{\mathrm{rB}} \emptyset \tag{15}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
rB	rB	

Modifier

Table 17: Properties of each modifier.

Id	Name	SBO
rB	rB	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{deltar} \cdot [\mathrm{rB}] \tag{16}$$

7.6 Reaction production_A

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

Name production A

Reaction equation

$$\emptyset \longrightarrow \mathrm{A} \tag{17}$$

Product

Table 18: Properties of each product.

Id	Name	SBO
A	A	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{Constant\_flux\_\_irreversible}\,(\mathrm{rhoA}) \tag{18}$$

$$\mathrm{Constant\_flux\_\_irreversible}\,(\mathrm{v}) = \mathrm{v} \tag{19}$$

$$\mathrm{Constant\_flux\_\_irreversible}\,(\mathrm{v}) = \mathrm{v} \tag{20}$$

7.7 Reaction degradation_A

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

Name degradation A

Reaction equation

$$\mathrm{A} \xrightarrow{\mathrm{A}} \emptyset \tag{21}$$

Reactant

Table 19: Properties of each reactant.

Id	Name	SBO
A	A	

Modifier

Table 20: Properties of each modifier.

Id	Name	SBO
A	A	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{deltaA} \cdot [\mathrm{A}] \tag{22}$$

7.8 Reaction translation_B

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

Name translation B

Reaction equation

$$\emptyset \xrightarrow{\mathrm{rB},\ \mathrm{rB}} \mathrm{B} \tag{23}$$

Modifiers

Table 21: Properties of each modifier.

Id	Name	SBO
rB	rB	
rB	rB	

Product

Table 22: Properties of each product.

Id	Name	SBO
B	B	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{transcription\_and\_translation}\left(\mathrm{beta}, [\mathrm{rB}]\right) \tag{24}$$

$$\mathrm{transcription\_and\_translation}\left(\mathrm{k}, \mathrm{X}\right) = \mathrm{k} \cdot \mathrm{X} \tag{25}$$

$$\mathrm{transcription\_and\_translation}\left(\mathrm{k}, \mathrm{X}\right) = \mathrm{k} \cdot \mathrm{X} \tag{26}$$

7.9 Reaction degradation_B

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

Name degradation B

Reaction equation

$$\mathrm{B} \xrightarrow{\mathrm{B}} \emptyset \tag{27}$$

Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
B	B	

Modifier

Table 24: Properties of each modifier.

Id	Name	SBO
B	B	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{deltaB} \cdot [\mathrm{B}] \tag{28}$$

7.10 Reaction `formation_dimer`

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

Name formation dimer

Reaction equation

$$\mathrm{A} + \mathrm{B} \xrightarrow{\mathrm{A,\ B}} \mathrm{AB} \tag{29}$$

Reactants

Table 25: Properties of each reactant.

Id	Name	SBO
`A`	A	
`B`	B	

Modifiers

Table 26: Properties of each modifier.

Id	Name	SBO
`A`	A	
`B`	B	

Product

Table 27: Properties of each product.

Id	Name	SBO
`AB`	AB	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{gamma} \cdot [\mathrm{A}] \cdot [\mathrm{B}] \tag{30}$$

7.11 Reaction degradation_dimer

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

Name degradation dimer

Reaction equation

$$\mathrm{AB} \xrightarrow{\mathrm{AB}} \emptyset \tag{31}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
AB	AB	

Modifier

Table 29: Properties of each modifier.

Id	Name	SBO
AB	AB	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{deltaAB} \cdot [\mathrm{AB}] \tag{32}$$

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.

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.

8.1 Species A

Name A

Initial concentration $40\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in A_binds_gB, degradation_A, formation_dimer and as a product in gB_releases_A, production_A and as a modifier in A_binds_gB, degradation_A, formation_dimer).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{A} = v_2 + v_6 - v_1 - v_7 - v_{10} \tag{33}$$

8.2 Species AgB

Name AgB

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

This species takes part in five reactions (as a reactant in gB_releases_A and as a product in A_binds_gB and as a modifier in gB_releases_A, stim_transcription_B, stim_transcription_B).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AgB} = v_1 - v_2 \tag{34}$$

8.3 Species gB

Name gB

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

This species takes part in five reactions (as a reactant in A_binds_gB and as a product in gB_releases_A and as a modifier in A_binds_gB, basal_transcription_B, basal_transcription_B).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{gB} = v_2 - v_1 \tag{35}$$

8.4 Species rB

Name rB

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

This species takes part in six reactions (as a reactant in degradation_mRNA_B and as a product in basal_transcription_B, stim_transcription_B and as a modifier in degradation_mRNA_B, translation_B, translation_B).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{rB} = v_3 + v_4 - v_5 \tag{36}$$

8.5 Species B

Name B

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

This species takes part in five reactions (as a reactant in degradation_B, formation_dimer and as a product in translation_B and as a modifier in degradation_B, formation_dimer).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{B} = v_8 - v_9 - v_{10} \tag{37}$$

8.6 Species AB

Name AB

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

This species takes part in three reactions (as a reactant in degradation_dimer and as a product in formation_dimer and as a modifier in degradation_dimer).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AB} = v_{10} - v_{11} \tag{38}$$

SBML2LaTeX was developed by Andreas Dräger[a], Hannes Planatscher[a], Dieudonné M Wouamba[a], Adrian Schröder[a], Michael Hucka[b], Lukas Endler[c], Martin Golebiewski[d] and Andreas Zell[a]. Please see http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX for more information.

[a]Center for Bioinformatics Tübingen (ZBIT), Germany
[b]California Institute of Technology, Beckman Institute BNMC, Pasadena, United States
[c]European Bioinformatics Institute, Wellcome Trust Genome Campus, Hinxton, United Kingdom
[d]EML Research gGmbH, Heidelberg, Germany