SBML Model Report

Model name: “Grlich2003_RanGTP_gradient”

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by the following three authors: Lukas Endler[1], Vijayalakshmi Chelliah[2] and Dirk Gorlich[3] at September nineth 2008 at 2:04 p. m. and last time modified at April eighth 2016 at 3:46 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	2
species types	0	species	13
events	0	constraints	0
reactions	9	function definitions	0
global parameters	0	unit definitions	5
rules	0	initial assignments	0

Model Notes

This model represents a concentration gradient of RanGTP across the nuclear envelope. This gradient is generated by distribution of regulators of RanGTPase. We have taken a log linear plot of graphs generated by GENESIS and compared with the experimental graphs.

[1]EMBL-EBI, lukas@ebi.ac.uk
[2]EMBL-EBI, viji@ebi.ac.uk
[3]ZMBH, INF 282, Heidelberg, dg@zmbh.uni-heidelberg.de

This model originates from BioModels Database: A Database of Annotated Published Models. It is copyright (c) 2005-2008 The BioModels Team.
For more information see the terms of use.

2 Unit Definitions

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

2.1 Unit `substance`

Definition μmol

2.2 Unit `microMpsec`

Name microMpsec

Definition $\mu mol \cdot s^{-1} \cdot l^{-1}$

2.3 Unit `pmicroMpsec`

Name pmicroMpsec

Definition $l \cdot \mu mol^{-1} \cdot s^{-1}$

2.4 Unit `psec`

Name psec

Definition s^{-1}

2.5 Unit `microM`

Name microM

Definition $\mu mol \cdot l^{-1}$

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

2.9 Unit `time`

Notes Second is the predefined SBML unit for `time`.

Definition s

3 Compartments

This model contains two compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`nucleus`			3	$1.2 \cdot 10^{-11}$	l	☑	
`cytoplasm`			3	$1.8 \cdot 10^{-11}$	l	☑	

3.1 Compartment `nucleus`

This is a three dimensional compartment with a constant size of $1.2 \cdot 10^{-11}$ litre.

3.2 Compartment `cytoplasm`

This is a three dimensional compartment with a constant size of $1.8 \cdot 10^{-11}$ litre.

4 Species

This model contains 13 species. The boundary condition of two of these species is set to `true` so that these species' amount cannot be changed by any reaction. Section 6 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
RanGDP_nuc		nucleus	$\mu mol \cdot l^{-1}$	☐	☐
RCC1_RanGDP		nucleus	$\mu mol \cdot l^{-1}$	☐	☐
GDP		nucleus	$\mu mol \cdot l^{-1}$	☐	☑
RCC1		nucleus	$\mu mol \cdot l^{-1}$	☐	☐
RCC1_RanGTP		nucleus	$\mu mol \cdot l^{-1}$	☐	☐
RCC1_Ran		nucleus	$\mu mol \cdot l^{-1}$	☐	☐
GTP		nucleus	$\mu mol \cdot l^{-1}$	☐	☑
RanGTP_nuc		nucleus	$\mu mol \cdot l^{-1}$	☐	☐
RanGAP		cytoplasm	$\mu mol \cdot l^{-1}$	☐	☐
RanBP1		cytoplasm	$\mu mol \cdot l^{-1}$	☐	☐
RanGTP_cy		cytoplasm	$\mu mol \cdot l^{-1}$	☐	☐
RanGTP_RanBP1		cytoplasm	$\mu mol \cdot l^{-1}$	☐	☐
RanGDP_cy		cytoplasm	$\mu mol \cdot l^{-1}$	☐	☐

Produced by SBML2LaTeX

5 Reactions

This model contains nine 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 4: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	RCC1_binding		$\mathrm{RanGDP\_nuc} + \mathrm{RCC1} \rightleftharpoons \mathrm{RCC1\_RanGDP}$	
2	GDP-_dissociation		$\mathrm{RCC1\_RanGDP} \rightleftharpoons \mathrm{RCC1\_Ran} + \mathrm{GDP}$	
3	GTP_binding		$\mathrm{RCC1\_Ran} + \mathrm{GTP} \rightleftharpoons \mathrm{RCC1\_RanGTP}$	
4	RanGTP_release		$\mathrm{RCC1\_RanGTP} \rightleftharpoons \mathrm{RanGTP\_nuc} + \mathrm{RCC1}$	
5	Cytoplasmic-_transfer		$\mathrm{RanGTP\_nuc} \rightleftharpoons \mathrm{RanGTP\_cy}$	
6	Nucleoplasmic-_transfer		$\mathrm{RanGDP\_nuc} \rightleftharpoons \mathrm{RanGDP\_cy}$	
7	RanGTP_binding		$\mathrm{RanGTP\_cy} + \mathrm{RanBP1} \rightleftharpoons \mathrm{RanGTP\_RanBP1}$	
8	RanBP1_RanGDP	RanBP1_RanGDP	$\mathrm{RanGTP\_RanBP1} \overset{\mathrm{RanGAP}}{\rightleftharpoons} \mathrm{RanGDP\_cy} + \mathrm{RanBP1}$	
9	RanGAP_RanGDP	RanGAP_RanGDP	$\mathrm{RanGTP\_cy} \overset{\mathrm{RanGAP}}{\rightleftharpoons} \mathrm{RanGDP\_cy}$	

Produced by SBML2LaTeX

5.1 Reaction RCC1_binding

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

Reaction equation

$$\text{RanGDP\_nuc} + \text{RCC1} \rightleftharpoons \text{RCC1\_RanGDP} \tag{1}$$

Reactants

Table 5: Properties of each reactant.

Id	Name	SBO
RanGDP_nuc		
RCC1		

Product

Table 6: Properties of each product.

Id	Name	SBO
RCC1_RanGDP		

Kinetic Law

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

$$v_1 = \mathrm{vol}\,(\mathrm{nucleus}) \cdot (\mathrm{r1} \cdot [\mathrm{RanGDP\_nuc}] \cdot [\mathrm{RCC1}] - \mathrm{r8} \cdot [\mathrm{RCC1\_RanGDP}]) \tag{2}$$

Table 7: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
r1	r1		74.0	$1 \cdot \mu\mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑
r8	r8		55.0	s^{-1}	☑

5.2 Reaction GDP_dissociation

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

Reaction equation

$$\mathrm{RCC1\_RanGDP} \rightleftharpoons \mathrm{RCC1\_Ran} + \mathrm{GDP} \tag{3}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
RCC1_RanGDP		

Products

Table 9: Properties of each product.

Id	Name	SBO
RCC1_Ran		
GDP		

Kinetic Law

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

$$v_2 = \mathrm{vol}\,(\mathrm{nucleus}) \cdot (\mathrm{r2} \cdot [\mathrm{RCC1\_RanGDP}] - \mathrm{r7} \cdot [\mathrm{RCC1\_Ran}] \cdot [\mathrm{GDP}]) \tag{4}$$

Table 10: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
r2	r2		21.0	s^{-1}	☑
r7	r7		11.0	$1 \cdot \mu\mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑

5.3 Reaction GTP_binding

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

Reaction equation

$$\mathrm{RCC1\_Ran} + \mathrm{GTP} \rightleftharpoons \mathrm{RCC1\_RanGTP} \tag{5}$$

Reactants

Table 11: Properties of each reactant.

Id	Name	SBO
RCC1_Ran		
GTP		

Product

Table 12: Properties of each product.

Id	Name	SBO
RCC1_RanGTP		

Kinetic Law

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

$$v_3 = \mathrm{vol}\,(\mathrm{nucleus}) \cdot (\mathrm{r3} \cdot [\mathrm{RCC1\_Ran}] \cdot [\mathrm{GTP}] - \mathrm{r6} \cdot [\mathrm{RCC1\_RanGTP}]) \tag{6}$$

Table 13: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
r3	r3		0.6	$1 \cdot \mu\mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑
r6	r6		19.0	s^{-1}	☑

5.4 Reaction RanGTP_release

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

Reaction equation

$$\mathrm{RCC1\_RanGTP} \rightleftharpoons \mathrm{RanGTP\_nuc} + \mathrm{RCC1} \tag{7}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
RCC1_RanGTP		

Products

Table 15: Properties of each product.

Id	Name	SBO
RanGTP_nuc		
RCC1		

Kinetic Law

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

$$v_4 = \mathrm{vol}\,(\mathrm{nucleus}) \cdot (\mathrm{r4} \cdot [\mathrm{RCC1\_RanGTP}] - \mathrm{r5} \cdot [\mathrm{RanGTP\_nuc}] \cdot [\mathrm{RCC1}]) \tag{8}$$

Table 16: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
r4	r4		55.0	s^{-1}	☑
r5	r5		100.0	$1 \cdot \mu\mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑

5.5 Reaction Cytoplasmic_transfer

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

Reaction equation

$$\mathrm{RanGTP\_nuc} \rightleftharpoons \mathrm{RanGTP\_cy} \tag{9}$$

Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
RanGTP_nuc		

Product

Table 18: Properties of each product.

Id	Name	SBO
RanGTP_cy		

Kinetic Law

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

$$v_5 = \mathrm{kpermRanGTP} \cdot \mathrm{vol}\,(\mathrm{nucleus}) \cdot ([\mathrm{RanGTP\_nuc}] - [\mathrm{RanGTP\_cy}]) \tag{10}$$

Table 19: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kpermRanGTP	kpermRanGTP		0.03	s^{-1}	☑

5.6 Reaction Nucleoplasmic_transfer

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

Reaction equation

$$\mathrm{RanGDP\_nuc} \rightleftharpoons \mathrm{RanGDP\_cy} \tag{11}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
RanGDP_nuc		

Product

Table 21: Properties of each product.

Id	Name	SBO
RanGDP_cy		

Kinetic Law

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

$$v_6 = \text{kpermRanGDP} \cdot \text{vol}(\text{nucleus}) \cdot ([\text{RanGDP\_nuc}] - [\text{RanGDP\_cy}]) \quad (12)$$

Table 22: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kpermRanGDP	kpermRanGDP		0.12	s^{-1}	☑

5.7 Reaction RanGTP_binding

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

Reaction equation

$$\text{RanGTP\_cy} + \text{RanBP1} \rightleftharpoons \text{RanGTP\_RanBP1} \quad (13)$$

Reactants

Table 23: Properties of each reactant.

Id	Name	SBO
RanGTP_cy		
RanBP1		

Product

Table 24: Properties of each product.

Id	Name	SBO
RanGTP_RanBP1		

Kinetic Law

Derived unit $s^{-1} \cdot \mu mol$

$$v_7 = (\text{kon} \cdot [\text{RanGTP\_cy}] \cdot [\text{RanBP1}] - \text{koff} \cdot [\text{RanGTP\_RanBP1}]) \cdot \text{vol}(\text{cytoplasm}) \quad (14)$$

Table 25: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kon	kon		0.300	$l \cdot \mu mol^{-1} \cdot s^{-1}$	☑
koff	koff		$4 \cdot 10^{-4}$	s^{-1}	☑

5.8 Reaction RanBP1_RanGDP

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

Name RanBP1_RanGDP

Reaction equation

$$\text{RanGTP\_RanBP1} \overset{\text{RanGAP}}{\rightleftharpoons} \text{RanGDP\_cy} + \text{RanBP1} \tag{15}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
RanGTP_RanBP1		

Modifier

Table 27: Properties of each modifier.

Id	Name	SBO
RanGAP		

Products

Table 28: Properties of each product.

Id	Name	SBO
RanGDP_cy		
RanBP1		

Kinetic Law

Derived unit $\mathrm{s}^{-1} \cdot 10^{-6}\,\mathrm{mol}$

$$v_8 = \frac{\mathrm{vol}\,(\text{cytoplasm}) \cdot \text{kcat} \cdot [\text{RanGTP\_RanBP1}] \cdot [\text{RanGAP}]}{[\text{RanGTP\_RanBP1}] + \text{Km}} \tag{16}$$

Table 29: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kcat	kcat		10.8	s^{-1}	☑
Km	Km		0.1	$\mu mol \cdot l^{-1}$	☑

5.9 Reaction RanGAP_RanGDP

This is a reversible reaction of one reactant forming one product influenced by one modifier.

Name RanGAP_RanGDP

Reaction equation

$$\text{RanGTP\_cy} \overset{\text{RanGAP}}{\rightleftharpoons} \text{RanGDP\_cy} \tag{17}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
RanGTP_cy		

Modifier

Table 31: Properties of each modifier.

Id	Name	SBO
RanGAP		

Product

Table 32: Properties of each product.

Id	Name	SBO
RanGDP_cy		

Kinetic Law

Derived unit $s^{-1} \cdot 10^{-6}$ mol

$$v_9 = \frac{\mathrm{vol}\,(\mathrm{cytoplasm}) \cdot \mathrm{kcat\_GAP} \cdot [\mathrm{RanGTP\_cy}] \cdot [\mathrm{RanGAP}]}{\mathrm{Km\_GAP} + [\mathrm{RanGTP\_cy}]} \tag{18}$$

Table 33: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kcat_GAP	kcat		10.6	s^{-1}	☑
Km_GAP	Km		0.7	$\mu mol \cdot l^{-1}$	☑

6 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.

6.1 Species RanGDP_nuc

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

This species takes part in two reactions (as a reactant in RCC1_binding, Nucleoplasmic_transfer).

$$\frac{d}{dt}\mathrm{RanGDP\_nuc} = -v_1 - v_6 \tag{19}$$

6.2 Species RCC1_RanGDP

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

This species takes part in two reactions (as a reactant in GDP_dissociation and as a product in RCC1_binding).

$$\frac{d}{dt}\mathrm{RCC1\_RanGDP} = v_1 - v_2 \tag{20}$$

6.3 Species GDP

Initial concentration $1.6\ \mu mol \cdot l^{-1}$

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

$$\frac{d}{dt}\mathrm{GDP} = 0 \tag{21}$$

6.4 Species RCC1

Initial concentration $0.7\ \mu\text{mol} \cdot \text{l}^{-1}$

This species takes part in two reactions (as a reactant in RCC1_binding and as a product in RanGTP_release).

$$\frac{\text{d}}{\text{d}t}\text{RCC1} = v_4 - v_1 \tag{22}$$

6.5 Species RCC1_RanGTP

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

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

$$\frac{\text{d}}{\text{d}t}\text{RCC1\_RanGTP} = v_3 - v_4 \tag{23}$$

6.6 Species RCC1_Ran

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

This species takes part in two reactions (as a reactant in GTP_binding and as a product in GDP-_dissociation).

$$\frac{\text{d}}{\text{d}t}\text{RCC1\_Ran} = v_2 - v_3 \tag{24}$$

6.7 Species GTP

Initial concentration $500\ \mu\text{mol} \cdot \text{l}^{-1}$

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

$$\frac{\text{d}}{\text{d}t}\text{GTP} = 0 \tag{25}$$

6.8 Species RanGTP_nuc

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

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

$$\frac{\text{d}}{\text{d}t}\text{RanGTP\_nuc} = v_4 - v_5 \tag{26}$$

6.9 Species RanGAP

Initial concentration $0.7\ \mu\text{mol}\cdot\text{l}^{-1}$

This species takes part in two reactions (as a modifier in RanBP1_RanGDP, RanGAP_RanGDP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RanGAP} = 0 \tag{27}$$

6.10 Species RanBP1

Initial concentration $2\ \mu\text{mol}\cdot\text{l}^{-1}$

This species takes part in two reactions (as a reactant in RanGTP_binding and as a product in RanBP1_RanGDP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RanBP1} = v_8 - v_7 \tag{28}$$

6.11 Species RanGTP_cy

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

This species takes part in three reactions (as a reactant in RanGTP_binding, RanGAP_RanGDP and as a product in Cytoplasmic_transfer).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RanGTP\_cy} = v_5 - v_7 - v_9 \tag{29}$$

6.12 Species RanGTP_RanBP1

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

This species takes part in two reactions (as a reactant in RanBP1_RanGDP and as a product in RanGTP_binding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RanGTP\_RanBP1} = v_7 - v_8 \tag{30}$$

6.13 Species RanGDP_cy

Initial concentration $5\ \mu\text{mol}\cdot\text{l}^{-1}$

This species takes part in three reactions (as a product in Nucleoplasmic_transfer, RanBP1-_RanGDP, RanGAP_RanGDP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RanGDP\_cy} = v_6 + v_8 + v_9 \tag{31}$$

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