

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 Endler¹, Vijayalakshmi Chelliah² and Dirk Gorlich³ at September ninth 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.

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

2.3 Unit `pmicroMpsec`

Name `pmicroMpsec`

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

2.4 Unit `psec`

Name `psec`

Definition s^{-1}

2.5 Unit `microM`

Name `microM`

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

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 | <input checked="" type="checkbox"/> | |
| cytoplasm | | | 3 | $1.8 \cdot 10^{-11}$ | l | <input checked="" type="checkbox"/> | |

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 | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RCC1_RanGDP | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| GDP | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| RCC1 | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RCC1_RanGTP | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RCC1_Ran | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| GTP | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| RanGTP_nuc | | nucleus | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RanGAP | | cytoplasm | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RanBP1 | | cytoplasm | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RanGTP_cy | | cytoplasm | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RanGTP_RanBP1 | | cytoplasm | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |
| RanGDP_cy | | cytoplasm | $\mu\text{mol} \cdot \text{l}^{-1}$ | <input type="checkbox"/> | <input type="checkbox"/> |

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.

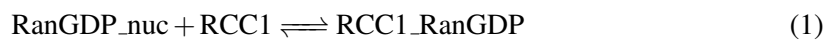
Table 4: Overview of all reactions

| Nº | Id | Name | Reaction Equation | SBO |
|----|-----------------------------|---------------|--|-----|
| 1 | RCC1.binding | | $\text{RanGDP}_{\text{nuc}} + \text{RCC1} \rightleftharpoons \text{RCC1_RanGDP}$ | |
| 2 | GDP- _dissociation | | $\text{RCC1_RanGDP} \rightleftharpoons \text{RCC1_Ran} + \text{GDP}$ | |
| 3 | GTP.binding | | $\text{RCC1_Ran} + \text{GTP} \rightleftharpoons \text{RCC1_RanGTP}$ | |
| 4 | RanGTP.release | | $\text{RCC1_RanGTP} \rightleftharpoons \text{RanGTP}_{\text{nuc}} + \text{RCC1}$ | |
| 5 | Cytoplasmic- _transfer | | $\text{RanGTP}_{\text{nuc}} \rightleftharpoons \text{RanGTP}_{\text{cy}}$ | |
| 6 | Nucleoplasmic- _transfer | | $\text{RanGDP}_{\text{nuc}} \rightleftharpoons \text{RanGDP}_{\text{cy}}$ | |
| 7 | RanGTP.binding | | $\text{RanGTP}_{\text{cy}} + \text{RanBP1} \rightleftharpoons \text{RanGTP_RanBP1}$ | |
| 8 | RanBP1_RanGDP | RanBP1_RanGDP | $\text{RanGTP_RanBP1} \xrightleftharpoons{\text{RanGAP}} \text{RanGDP}_{\text{cy}} + \text{RanBP1}$ | |
| 9 | RanGAP_RanGDP | RanGAP_RanGDP | $\text{RanGTP}_{\text{cy}} \xrightleftharpoons{\text{RanGAP}} \text{RanGDP}_{\text{cy}}$ | |

5.1 Reaction `RCC1_binding`

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

Reaction equation



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 $\text{s}^{-1} \cdot \mu\text{mol}$

$$v_1 = \text{vol}(\text{nucleus}) \cdot (r1 \cdot [\text{RanGDP_nuc}] \cdot [\text{RCC1}] - r8 \cdot [\text{RCC1_RanGDP}]) \quad (2)$$

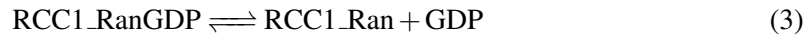
Table 7: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|----|------|-----|-------|--|-------------------------------------|
| r1 | r1 | | 74.0 | $1 \cdot \mu\text{mol}^{-1} \cdot \text{s}^{-1}$ | <input checked="" type="checkbox"/> |
| r8 | r8 | | 55.0 | s^{-1} | <input checked="" type="checkbox"/> |

5.2 Reaction `GDP_dissociation`

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

Reaction equation



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 $\text{s}^{-1} \cdot \mu\text{mol}$

$$v_2 = \text{vol}(\text{nucleus}) \cdot (r_2 \cdot [\text{RCC1_RanGDP}] - r_7 \cdot [\text{RCC1_Ran}] \cdot [\text{GDP}]) \quad (4)$$

Table 10: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|----|------|-----|-------|--|-------------------------------------|
| r2 | r2 | | 21.0 | s^{-1} | <input checked="" type="checkbox"/> |
| r7 | r7 | | 11.0 | $1 \cdot \mu\text{mol}^{-1} \cdot \text{s}^{-1}$ | <input checked="" type="checkbox"/> |

5.3 Reaction GTP_binding

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

Reaction equation



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 $\text{s}^{-1} \cdot \mu\text{mol}$

$$v_3 = \text{vol}(\text{nucleus}) \cdot (r_3 \cdot [\text{RCC1_Ran}] \cdot [\text{GTP}] - r_6 \cdot [\text{RCC1_RanGTP}]) \quad (6)$$

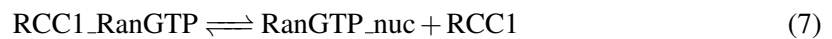
Table 13: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|----|------|-----|-------|--|-------------------------------------|
| r3 | r3 | | 0.6 | $1 \cdot \mu\text{mol}^{-1} \cdot \text{s}^{-1}$ | <input checked="" type="checkbox"/> |
| r6 | r6 | | 19.0 | s^{-1} | <input checked="" type="checkbox"/> |

5.4 Reaction RanGTP_release

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

Reaction equation



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 $\text{s}^{-1} \cdot \mu\text{mol}$

$$v_4 = \text{vol}(\text{nucleus}) \cdot (r_4 \cdot [\text{RCC1_RanGTP}] - r_5 \cdot [\text{RanGTP_nuc}] \cdot [\text{RCC1}]) \quad (8)$$

Table 16: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|----|------|-----|-------|--|-------------------------------------|
| r4 | r4 | | 55.0 | s^{-1} | <input checked="" type="checkbox"/> |
| r5 | r5 | | 100.0 | $1 \cdot \mu\text{mol}^{-1} \cdot \text{s}^{-1}$ | <input checked="" type="checkbox"/> |

5.5 Reaction [Cytoplasmic_transfer](#)

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

Reaction equation



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** $\text{s}^{-1} \cdot \mu\text{mol}$

$$v_5 = \text{kpermRanGTP} \cdot \text{vol}(\text{nucleus}) \cdot ([\text{RanGTP_nuc}] - [\text{RanGTP_cy}]) \quad (10)$$

Table 19: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|-------------|-------------|-----|-------|-----------------|-------------------------------------|
| kpermRanGTP | kpermRanGTP | | 0.03 | s^{-1} | <input checked="" type="checkbox"/> |

5.6 Reaction `Nucleoplasmic_transfer`

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

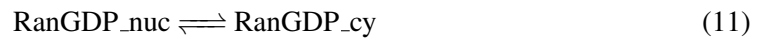
Reaction equation**Reactant**

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** $\text{s}^{-1} \cdot \mu\text{mol}$

$$v_6 = kpermRanGDP \cdot vol(nucleus) \cdot ([RanGDP_nuc] - [RanGDP_cy]) \quad (12)$$

Table 22: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|-------------|-------------|-----|-------|-----------------|-------------------------------------|
| kpermRanGDP | kpermRanGDP | | 0.12 | s ⁻¹ | <input checked="" type="checkbox"/> |

5.7 Reaction [RanGTP_binding](#)

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

Reaction equation



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 · μmol

$$v_7 = (kon \cdot [RanGTP_cy] \cdot [RanBP1] - koff \cdot [RanGTP_RanBP1]) \cdot vol(cytoplasm) \quad (14)$$

Table 25: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|------|------|-----|----------------------|--|-------------------------------------|
| kon | kon | | 0.300 | 1 · μmol ⁻¹ · s ⁻¹ | <input checked="" type="checkbox"/> |
| koff | koff | | 4 · 10 ⁻⁴ | s ⁻¹ | <input checked="" type="checkbox"/> |

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



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

$$v_8 = \frac{\text{vol}(\text{cytoplasm}) \cdot \text{kcat} \cdot [\text{RanGTP_RanBP1}] \cdot [\text{RanGAP}]}{[\text{RanGTP_RanBP1}] + \text{Km}} \quad (16)$$

Table 29: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|------|------|-----|-------|------------------------|-------------------------------------|
| kcat | kcat | | 10.8 | s ⁻¹ | <input checked="" type="checkbox"/> |
| Km | Km | | 0.1 | μmol · l ⁻¹ | <input checked="" type="checkbox"/> |

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



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 · 10⁻⁶ mol

$$v_9 = \frac{\text{vol}(\text{cytoplasm}) \cdot \text{kcat_GAP} \cdot [\text{RanGTP_cy}] \cdot [\text{RanGAP}]}{\text{Km_GAP} + [\text{RanGTP_cy}]} \quad (18)$$

Table 33: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|----------|------|-----|-------|------------------------|-------------------------------------|
| kcat_GAP | kcat | | 10.6 | s ⁻¹ | <input checked="" type="checkbox"/> |
| Km_GAP | Km | | 0.7 | μmol · l ⁻¹ | <input checked="" type="checkbox"/> |

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 μmol · l⁻¹

This species takes part in two reactions (as a reactant in [RCC1_binding](#), [Nucleoplasmic-transfer](#)).

$$\frac{d}{dt}\text{RanGDP_nuc} = -v_1 - v_6 \quad (19)$$

6.2 Species [RCC1_RanGDP](#)

Initial concentration 0 μmol · l⁻¹

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

$$\frac{d}{dt}\text{RCC1_RanGDP} = v_1 - v_2 \quad (20)$$

6.3 Species [GDP](#)

Initial concentration 1.6 μmol · 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:

$$\frac{d}{dt}\text{GDP} = 0 \quad (21)$$

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`).

$$\frac{d}{dt}\text{RCC1} = v_4 - v_1 \quad (22)$$

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`).

$$\frac{d}{dt}\text{RCC1_RanGTP} = v_3 - v_4 \quad (23)$$

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`).

$$\frac{d}{dt}\text{RCC1_Ran} = v_2 - v_3 \quad (24)$$

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:

$$\frac{d}{dt}\text{GTP} = 0 \quad (25)$$

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`).

$$\frac{d}{dt}\text{RanGTP_nuc} = v_4 - v_5 \quad (26)$$

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`).

$$\frac{d}{dt}\text{RanGAP} = 0 \quad (27)$$

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`).

$$\frac{d}{dt}\text{RanBP1} = v_8 - v_7 \quad (28)$$

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`).

$$\frac{d}{dt}\text{RanGTP_cy} = v_5 - v_7 - v_9 \quad (29)$$

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`).

$$\frac{d}{dt}\text{RanGTP_RanBP1} = v_7 - v_8 \quad (30)$$

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`).

$$\frac{d}{dt}\text{RanGDP_cy} = v_6 + v_8 + v_9 \quad (31)$$

SBML²TeX 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.

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