

SBML Model Report

Model name: “SmithAE2002_RanTransport”



May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by Harish Dharuri¹ at January 31st 2008 at 8:56 p.m. and last time modified at April seventh 2014 at 0:12 a.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	5
species types	0	species	26
events	0	constraints	0
reactions	29	function definitions	0
global parameters	12	unit definitions	14
rules	5	initial assignments	0

Model Notes

The model reproduces the compartmental model for Ran transport as depicted in Fig 3 of the paper. Model reproduced using MathSBML.

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2 Unit Definitions

This is an overview of 17 unit definitions of which three are predefined by SBML and not mentioned in the model.

2.1 Unit `substance`

Definition μmol

2.2 Unit `area`

Definition μm^2

2.3 Unit `molecules`

Definition `item`

2.4 Unit `umol_litre_um_3`

Definition $10^{-21} \cdot \text{mol}$

2.5 Unit `um2`

Definition μm^2

2.6 Unit `uM_s_1`

Definition $0.0010 \text{ dimensionless} \cdot \text{m}^{-3} \cdot \text{mol} \cdot \text{s}^{-1}$

2.7 Unit `uM_1_s_1`

Definition $1000 \text{ dimensionless} \cdot \text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$

2.8 Unit `s_1`

Definition s^{-1}

2.9 Unit `uM`

Definition $0.0010 \text{ dimensionless} \cdot \text{m}^{-3} \cdot \text{mol}$

2.10 Unit `s`

Definition `s`

2.11 Unit `uM_um_s_1`

Definition $10^{-9} \text{ dimensionless} \cdot \text{m}^{-2} \cdot \text{mol} \cdot \text{s}^{-1}$

2.12 Unit `pA_um_2`

Definition $\text{dimensionless} \cdot \text{A} \cdot \text{m}^{-2}$

2.13 Unit `um_s_1`

Definition $10^{-6} \text{ dimensionless} \cdot \text{m} \cdot \text{s}^{-1}$

2.14 Unit `um3`

Name `um3`

Definition μm^3

2.15 Unit `volume`

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

Definition `l`

2.16 Unit `length`

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

Definition `m`

2.17 Unit `time`

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

Definition `s`

3 Compartments

This model contains five compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
Cytosol	Cytosol		3	1	μm^3	<input checked="" type="checkbox"/>	PM
EC	EC		3	1.40845070422535	μm^3	<input checked="" type="checkbox"/>	
Nucleus	Nucleus		3	0.408450704225352	μm^3	<input checked="" type="checkbox"/>	Nuc_membran
Nuc_membrane	Nuc_membrane		2	0.245070422535211	μm^2	<input checked="" type="checkbox"/>	Cytosol
PM	PM		2	1.40845070422535	μm^2	<input checked="" type="checkbox"/>	EC

3.1 Compartment Cytosol

This is a three dimensional compartment with a constant size of one μm^3 , which is surrounded by PM (PM).

Name Cytosol

3.2 Compartment EC

This is a three dimensional compartment with a constant size of 1.40845070422535 μm^3 .

Name EC

3.3 Compartment Nucleus

This is a three dimensional compartment with a constant size of 0.408450704225352 μm^3 , which is surrounded by Nuc_membrane (Nuc_membrane).

Name Nucleus

3.4 Compartment Nuc_membrane

This is a two dimensional compartment with a constant size of 0.245070422535211 μm^2 , which is surrounded by Cytosol (Cytosol).

Name Nuc_membrane

3.5 Compartment PM

This is a two dimensional compartment with a constant size of 1.40845070422535 μm^2 , which is surrounded by EC (EC).

Name PM

4 Species

This model contains 26 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
Carrier_Cytosol	Carrier_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
Carrier_RanGTP-Cytosol	Carrier_RanGTP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RanGAP_Cytosol	RanGAP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RanBP1_Cytosol	RanBP1_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RanBP1_Carrier-RanGTP_Cytosol	RanBP1_Carrier_RanGTP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
NTF2_Nucleus	NTF2_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RanGDP_Nucleus	RanGDP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RCC1_Nucleus	RCC1_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RanGTP_Nucleus	RanGTP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
NTF2_RanGDP-Nucleus	NTF2_RanGDP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
Carrier_Nucleus	Carrier_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
RanGDP_Cytosol	RanGDP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
Carrier_RanGTP-Nucleus	Carrier_RanGTP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
NTF2_RanGDP-Cytosol	NTF2_RanGDP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
FRanGTP_Cytosol	FRanGTP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square
FCarrier_RanGTP-Cytosol	FCarrier_RanGTP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	\square	\square

Id	Name	Compartment	Derived Unit	Constant	Boundary Condi- tion
FRanGDP_Cytosol	FRanGDP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
FNTF2_RanGDP- _Cytosol	FNTF2_RanGDP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
FRanBP1_Carrier- _RanGTP_Cytosol	FRanBP1_Carrier_RanGTP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
FCarrier_RanGTP- _Nucleus	FCarrier_RanGTP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
FRanGDP_Nucleus	FRanGDP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
FNTF2_RanGDP- _Nucleus	FNTF2_RanGDP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
FRanGTP_Nucleus	FRanGTP_Nucleus	Nucleus	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
NTF2_Cytosol	NTF2_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
Pipet_Cytosol	Pipet_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>
RanGTP_Cytosol	RanGTP_Cytosol	Cytosol	$\mu\text{mol} \cdot \text{l}^{-1}$	<input type="checkbox"/>	<input type="checkbox"/>

5 Parameters

This model contains twelve global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
RanGAP_Kcat-			6.0	s^{-1}	<input checked="" type="checkbox"/>
_FRanGTP-					
_dephosphorylation					
Vmax_RanGTP-			0.0	0.0010 dimensionless ·	<input type="checkbox"/>
_dephosphorylation-				$m^{-3} \cdot mol \cdot s^{-1}$	
_FRanGTP-					
_dephosphorylation					
RanGAP_Kcat-			6.0	s^{-1}	<input checked="" type="checkbox"/>
_dephosphorylationF					
Vmax-			0.0	0.0010 dimensionless ·	<input type="checkbox"/>
_dephosphorylation-				$m^{-3} \cdot mol \cdot s^{-1}$	
_dephosphorylationF					
RanGAP-			6.0	s^{-1}	<input checked="" type="checkbox"/>
_Kcat_RanGTP-					
_dephosphorylation					
Vmax_RanGTP-			0.0	0.0010 dimensionless ·	<input type="checkbox"/>
_dephosphorylation-				$m^{-3} \cdot mol \cdot s^{-1}$	
_RanGTP-					
_dephosphorylation					
RanGAP_Kcat-			6.0	s^{-1}	<input checked="" type="checkbox"/>
_dephosphorylation					
Vmax-			0.0	0.0010 dimensionless ·	<input type="checkbox"/>
_dephosphorylation-				$m^{-3} \cdot mol \cdot s^{-1}$	
_dephosphorylation					
kinj			25.0	s^{-1}	<input checked="" type="checkbox"/>
start			1.0	s	<input checked="" type="checkbox"/>
tau			0.4	s	<input checked="" type="checkbox"/>
ar_for-			0.0		<input type="checkbox"/>
_Microinj					

6 Rules

This is an overview of five rules.

6.1 Rule `Vmax_RanGTP_dephosphorylation_FRanGTP_dephosphorylation`

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

$$\begin{aligned} \text{Vmax_RanGTP_dephosphorylation_FRanGTP_dephosphorylation} \\ = \text{RanGAP_Kcat_FRanGTP_dephosphorylation} \cdot [\text{RanGAP_Cytosol}] \end{aligned} \quad (1)$$

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

6.2 Rule `Vmax_dephosphorylation_dephosphorylationF`

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

$$\begin{aligned} \text{Vmax_dephosphorylation_dephosphorylationF} = [\text{RanGAP_Cytosol}] \\ \cdot \text{RanGAP_Kcat_dephosphorylationF} \end{aligned} \quad (2)$$

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

6.3 Rule `Vmax_RanGTP_dephosphorylation_RanGTP_dephosphorylation`

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

$$\begin{aligned} \text{Vmax_RanGTP_dephosphorylation_RanGTP_dephosphorylation} \\ = \text{RanGAP_Kcat_RanGTP_dephosphorylation} \cdot [\text{RanGAP_Cytosol}] \end{aligned} \quad (3)$$

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

6.4 Rule `Vmax_dephosphorylation_dephosphorylation`

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

$$\begin{aligned} \text{Vmax_dephosphorylation_dephosphorylation} = [\text{RanGAP_Cytosol}] \\ \cdot \text{RanGAP_Kcat_dephosphorylation} \end{aligned} \quad (4)$$

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

6.5 Rule `ar_for_Microinj`

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

$$\begin{aligned} \text{ar_for_Microinj} \\ = \begin{cases} \text{kinj} \cdot 0.0016611295681 \cdot [\text{Pipet_Cytosol}] & \text{if } (t > \text{start}) \wedge (t < \text{start} + \text{tau}) \\ 0 & \text{otherwise} \end{cases} \end{aligned} \quad (5)$$

7 Reactions

This model contains 29 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

Nº	Id	Name	Reaction Equation	SBO
1	Carrier- _FRanGTP- _binding	Carrier FRanGTP binding	$\text{Carrier_Cytosol} + \text{FRanGTP_Cytosol} \rightleftharpoons \text{FCarrier_RanGTP_Cytosol}$	
2	FRanGTP- _dephosphorylation	FRanGTP dephosphorylation	$\text{FRanGTP_Cytosol} \xrightleftharpoons{\text{RanGAP_Cytosol}} \text{FRanGDP_Cytosol}$	
3	dephosphorylationF	dephosphorylationF	$\text{FRanBP1_Carrier_RanGTP_Cytosol} \xrightleftharpoons{\text{RanGAP_Cytosol}} \text{FRanGDP_Cytosol} + \text{RanBP1_Cytosol} + \text{Carrier_Cytosol}$	
4	FRanGTP- _Carrier- _binding	FRanGTP Carrier binding	$\text{Carrier_Nucleus} + \text{FRanGTP_Nucleus} \rightleftharpoons \text{FCarrier_RanGTP_Nucleus}$	
5	NTF2_FRanGDP- _Unbinding	NTF2_FRanGDP Unbinding	$\text{NTF2_Cytosol} + \text{FRanGDP_Cytosol} \rightleftharpoons \text{FNTF2_RanGDP_Cytosol}$	
6	RanBP1.bindingF	RanBP1 bindingF	$\text{FCarrier_RanGTP_Cytosol} + \text{RanBP1_Cytosol} \rightleftharpoons \text{FRanBP1_Carrier_RanGTP_Cytosol}$	
7	NTF2_FRanGDP- _unbinding	NTF2_FRanGDP unbinding	$\text{FNTF2_RanGDP_Nucleus} \rightleftharpoons \text{NTF2_Nucleus} + \text{FRanGDP_Nucleus}$	
8	Microinj	Microinj	$\emptyset \xrightleftharpoons{\text{Pipet_Cytosol}} \text{FRanGDP_Cytosol}$	
9	FRanGDP_to- _FRanGTP	FRanGDP to FRanGTP	$\text{FRanGDP_Nucleus} \xrightleftharpoons{\text{RCC1_Nucleus, NTF2_RanGDP_Nucleus, RanGDP_Nucleus}} \text{FRanGTP_Nucleus}$	

Nº	Id	Name	Reaction Equation	SBO
10	RanGTP- _dephosphorylation	RanGTP dephosphorylation	$\text{RanGTP_Cytosol} \xrightleftharpoons{\text{RanGAP_Cytosol}} \text{RanGDP_Cytosol}$	
11	RanGTP_Carrier- _binding	RanGTP Carrier binding	$\text{RanGTP_Nucleus} + \text{Carrier_Nucleus} \rightleftharpoons \text{Carrier_RanGTP_Nucleus}$	+
12	NTF2_RanGDP- _Unbinding	NTF2_RanGDP Unbinding	$\text{RanGDP_Cytosol} + \text{NTF2_Cytosol} \rightleftharpoons \text{NTF2_RanGDP_Cytosol}$	+
13	dephosphorylation	dephosphorylation	$\text{RanBP1_Carrier_RanGTP_Cytosol} \xrightleftharpoons{\text{RanGAP_Cytosol}} \text{RanGDP_Cytosol} + \text{Carrier_Cytosol} + \text{RanBP1_Cytosol}$	
14	RanGDP_to- _RanGTP	RanGDP to RanGTP	$\text{RanGDP_Nucleus} \xrightleftharpoons{\text{RCC1_Nucleus, NTF2_RanGDP_Nucleus}} \text{RanGTP_Nucleus}$	
15	NTF2_RAN_Nuc- _Exchange	NTF2_RAN_Nuc_Exchange	$4 \text{ NTF2_RanGDP_Nucleus} \xrightleftharpoons{\text{RCC1_Nucleus}} 4 \text{ NTF2_Nucleus} + \text{RanGDP_Nucleus} + 3 \text{ RanGTP_Nucleus}$	
16	NTF2_RanGDP- _unbinding	NTF2_RanGDP unbinding	$\text{NTF2_RanGDP_Nucleus} \rightleftharpoons \text{RanGDP_Nucleus} + \text{NTF2_Nucleus}$	+
17	Carrier_RanGTP- _binding	Carrier RanGTP binding	$\text{RanGTP_Cytosol} + \text{Carrier_Cytosol} \rightleftharpoons \text{Carrier_RanGTP_Cytosol}$	+
18	NTF2_FRAN_Nuc- _Exchange	NTF2_FRAN_Nuc_Exchange	$4 \text{ NTF2_RanGDP_Nucleus} \xrightleftharpoons{\text{RCC1_Nucleus, NTF2_RanGDP_Nucleus, RanGDP_Nucleus}} 4 \text{ NTF2_Nucleus} + 3 \text{ FRanGTP_Nucleus} + \text{FRanGDP_Nucleus}$	
19	RanBP1_binding	RanBP1 binding	$\text{RanBP1_Cytosol} + \text{Carrier_RanGTP_Cytosol} \rightleftharpoons \text{RanBP1_Carrier_RanGTP_Cytosol}$	+
20	Carrier_RanGTP- _flux	Carrier_RanGTP flux	$\text{Carrier_RanGTP_Cytosol} \rightleftharpoons \text{Carrier_RanGTP_Nucleus}$	
21	NTF2_flux	NTF2 flux	$\text{NTF2_Cytosol} \rightleftharpoons \text{NTF2_Nucleus}$	
22	NTF2_RanGDP- _flux	NTF2_RanGDP flux	$\text{NTF2_RanGDP_Cytosol} \rightleftharpoons \text{NTF2_RanGDP_Nucleus}$	
23	Carrier_flux	Carrier flux	$\text{Carrier_Cytosol} \rightleftharpoons \text{Carrier_Nucleus}$	

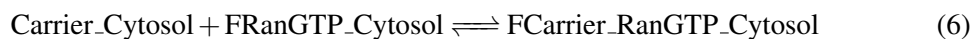
Nº	Id	Name	Reaction Equation	SBO
24	FRanGDP_flux	FRanGDP flux	$\text{FRanGDP_Cytosol} \rightleftharpoons \text{FRanGDP_Nucleus}$	
25	Carrier- FRanGTP_flux	Carrier_FRanGTP flux	$\text{FCarrier_RanGTP_Cytosol} \rightleftharpoons \text{FCarrier_RanGTP_Nucleus}$	
26	FNTF2_RanGDP- _flux	FNTF2_RanGDP flux	$\text{FNTF2_RanGDP_Cytosol} \rightleftharpoons \text{FNTF2_RanGDP_Nucleus}$	
27	FRanGTP_flux	FRanGTP flux	$\text{FRanGTP_Cytosol} \rightleftharpoons \text{FRanGTP_Nucleus}$	
28	RanGDP_flux	RanGDP flux	$\text{RanGDP_Cytosol} \rightleftharpoons \text{RanGDP_Nucleus}$	
29	RanGTP_flux	RanGTP flux	$\text{RanGTP_Cytosol} \rightleftharpoons \text{RanGTP_Nucleus}$	

7.1 Reaction Carrier_FRanGTP_binding

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

Name Carrier FRanGTP binding

Reaction equation



Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
Carrier_Cytosol	Carrier_Cytosol	
FRanGTP_Cytosol	FRanGTP_Cytosol	

Product

Table 7: Properties of each product.

Id	Name	SBO
FCarrier_RanGTP_Cytosol	FCarrier_RanGTP_Cytosol	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot 1^{-2} \cdot \mu\text{mol}$

$$v_1 = (\text{Kon_Carrier_RanGTP_binding} \cdot [\text{Carrier_Cytosol}] \cdot [\text{FRanGTP_Cytosol}] + ((\text{Koff_Carrier_RanGTP_binding} \cdot [\text{FCarrier_RanGTP_Cytosol}]))) \cdot \text{vol}(\text{Cytosol}) \quad (7)$$

Table 8: Properties of each parameter.

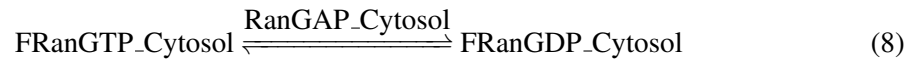
Id	Name	SBO	Value	Unit	Constant
Kon_Carrier- _RanGTP- _binding			0.0	1000 dimensionless · m ³ · mol ⁻¹ · s ⁻¹	✓
Koff- _Carrier- _RanGTP- _binding			0.0	s ⁻¹	✓

7.2 Reaction FRanGTP_dephosphorylation

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

Name FRanGTP dephosphorylation

Reaction equation



Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
FRanGTP_Cytosol	FRanGTP_Cytosol	

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
RanGAP_Cytosol	RanGAP_Cytosol	

Product

Table 11: Properties of each product.

Id	Name	SBO
FRanGDP_Cytosol	FRanGDP_Cytosol	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \frac{V_{\text{max_RanGTP_dephosphorylation_FRanGTP_dephosphorylation}} \cdot [\text{FRanGTP_Cytosol}]}{K_{\text{m_RanGTP_dephosphorylation}} + [\text{FRanGTP_Cytosol}]} \cdot \text{vol}(\text{Cytosol}) \quad (9)$$

Table 12: Properties of each parameter.

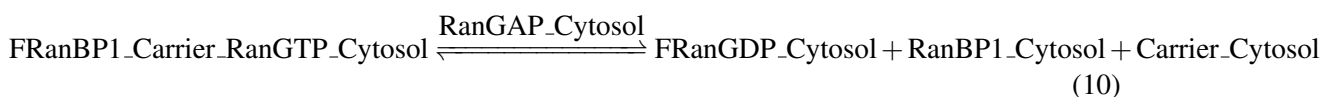
Id	Name	SBO	Value	Unit	Constant
Km_RanGTP- _dephosphorylation			0.43	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.3 Reaction dephosphorylationF

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

Name dephosphorylationF

Reaction equation



Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
FRanBP1_Carrier_RanGTP_Cytosol	FRanBP1_Carrier_RanGTP_Cytosol	

Modifier

Table 14: Properties of each modifier.

Id	Name	SBO
RanGAP_Cytosol	RanGAP_Cytosol	

Products

Table 15: Properties of each product.

Id	Name	SBO
FRanGDP_Cytosol	FRanGDP_Cytosol	
RanBP1_Cytosol	RanBP1_Cytosol	
Carrier_Cytosol	Carrier_Cytosol	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \frac{V_{\max_dephosphorylation_dephosphorylationF} \cdot [\text{FRanBP1_Carrier_RanGTP_Cytosol}]}{K_{m_dephosphorylation} + [\text{FRanBP1_Carrier_RanGTP_Cytosol}]} \cdot \text{vol}(\text{Cytosol}) \quad (11)$$

Table 16: Properties of each parameter.

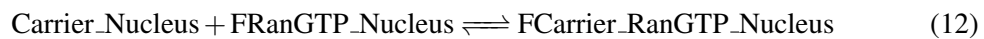
Id	Name	SBO	Value	Unit	Constant
Km- _dephosphorylation			0.43	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.4 Reaction FRanGTP_Carrier_binding

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

Name FRanGTP Carrier binding

Reaction equation



Reactants

Table 17: Properties of each reactant.

Id	Name	SBO
Carrier_Nucleus	Carrier_Nucleus	
FRanGTP_Nucleus	FRanGTP_Nucleus	

Product

Table 18: Properties of each product.

Id	Name	SBO
FCarrier_RanGTP_Nucleus	FCarrier_RanGTP_Nucleus	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot \text{l}^{-2} \cdot \mu\text{mol}$

$$v_4 = (\text{Kon_RanGTP_Carrier_binding} \cdot [\text{Carrier_Nucleus}] \cdot [\text{FRanGTP_Nucleus}] + ((\text{Koff_RanGTP_Carrier_binding} \cdot [\text{FCarrier_RanGTP_Nucleus}]))) \cdot \text{vol}(\text{Nucleus}) \quad (13)$$

Table 19: Properties of each parameter.

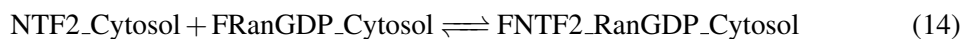
Id	Name	SBO	Value	Unit	Constant
Kon_RanGTP- _Carrier- _binding			100.0	1000 dimensionless · $\text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	<input checked="" type="checkbox"/>
Koff_RanGTP- _Carrier- _binding			1.0	s^{-1}	<input checked="" type="checkbox"/>

7.5 Reaction NTF2_FRanGDP_Unbinding

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

Name NTF2_FRanGDP Unbinding

Reaction equation



Reactants

Table 20: Properties of each reactant.

Id	Name	SBO
NTF2_Cytosol	NTF2_Cytosol	
FRanGDP_Cytosol	FRanGDP_Cytosol	

Product

Table 21: Properties of each product.

Id	Name	SBO
FNTF2_RanGDP_Cytosol	FNTF2_RanGDP_Cytosol	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot \text{l}^{-2} \cdot \mu\text{mol}$

$$v_5 = (\text{Kon_NTF2_RanGDP_binding} \cdot [\text{NTF2_Cytosol}] \cdot [\text{FRanGDP_Cytosol}] + ((\text{Koff_NTF2_RanGDP_binding} \cdot [\text{FNTF2_RanGDP_Cytosol}]))) \cdot \text{vol}(\text{Cytosol}) \quad (15)$$

Table 22: Properties of each parameter.

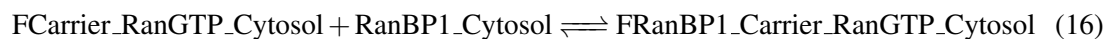
Id	Name	SBO	Value	Unit	Constant
Kon_NTF2- _RanGDP- _binding			100.0	1000 dimensionless · $\text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	<input checked="" type="checkbox"/>
Koff_NTF2- _RanGDP- _binding			2.5	s^{-1}	<input checked="" type="checkbox"/>

7.6 Reaction RanBP1_bindingF

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

Name RanBP1 bindingF

Reaction equation



Reactants

Table 23: Properties of each reactant.

Id	Name	SBO
FCarrier_RanGTP_Cytosol	FCarrier_RanGTP_Cytosol	
RanBP1_Cytosol	RanBP1_Cytosol	

Product

Table 24: Properties of each product.

Id	Name	SBO
FRanBP1_Carrier_RanGTP_Cytosol	FRanBP1_Carrier_RanGTP_Cytosol	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot \text{l}^{-2} \cdot \mu\text{mol}$

$$v_6 = (\text{Kon_RanBP1_binding} \cdot [\text{FCarrier_RanGTP_Cytosol}] \cdot [\text{RanBP1_Cytosol}] + ((\text{Koff_RanBP1_binding} \cdot [\text{FRanBP1_Carrier_RanGTP_Cytosol}]))) \cdot \text{vol}(\text{Cytosol}) \quad (17)$$

Table 25: Properties of each parameter.

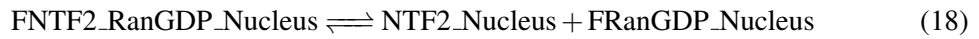
Id	Name	SBO	Value	Unit	Constant
Kon_RanBP1- _binding			100.0	1000 dimensionless · $\text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	<input checked="" type="checkbox"/>
Koff_RanBP1- _binding			0.5	s^{-1}	<input checked="" type="checkbox"/>

7.7 Reaction NTF2_FRanGDP_unbinding

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

Name NTF2_FRanGDP unbinding

Reaction equation



Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
FNTF2_RanGDP_Nucleus	FNTF2_RanGDP_Nucleus	

Products

Table 27: Properties of each product.

Id	Name	SBO
NTF2_Nucleus	NTF2_Nucleus	
FRanGDP_Nucleus	FRanGDP_Nucleus	

Kinetic Law

Derived unit $\text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1} \cdot \mu\text{m}^3$

$$v_7 = (\text{Koff_NTF2_RanGDP_unbinding} \cdot [\text{FNTF2_RanGDP_Nucleus}] + ((\text{Kon_NTF2_RanGDP_unbinding} \cdot [\text{NTF2_Nucleus}] \cdot [\text{FRanGDP_Nucleus}]))) \cdot \text{vol}(\text{Nucleus}) \quad (19)$$

Table 28: Properties of each parameter.

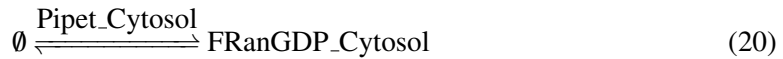
Id	Name	SBO	Value	Unit	Constant
Koff_NTF2- _RanGDP- _unbinding			2.5	s^{-1}	<input checked="" type="checkbox"/>
Kon_NTF2- _RanGDP- _unbinding			100.0	$1000 \text{ dimensionless} \cdot \text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	<input checked="" type="checkbox"/>

7.8 Reaction Microinj

This is a reversible reaction of no reactant forming one product influenced by one modifier.

Name Microinj

Reaction equation



Modifier

Table 29: Properties of each modifier.

Id	Name	SBO
Pipet_Cytosol	Pipet_Cytosol	

Product

Table 30: Properties of each product.

Id	Name	SBO
FRanGDP_Cytosol	FRanGDP_Cytosol	

Id	Name	SBO
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Kinetic Law

Derived unit contains undeclared units

$$v_8 = ar_for_Microinj \cdot vol(Cytosol) \cdot 1 \quad (21)$$

7.9 Reaction FRanGDP_to_FRanGTP

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

Name FRanGDP to FRanGTP

Reaction equation



Reactant

Table 31: Properties of each reactant.

Id	Name	SBO
FRanGDP_Nucleus	FRanGDP_Nucleus	

Modifiers

Table 32: Properties of each modifier.

Id	Name	SBO
RCC1_Nucleus	RCC1_Nucleus	
NTF2_RanGDP_Nucleus	NTF2_RanGDP_Nucleus	
RanGDP_Nucleus	RanGDP_Nucleus	

Product

Table 33: Properties of each product.

Id	Name	SBO
FRanGTP_Nucleus	FRanGTP_Nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = 0.75 \cdot \text{RCC1Kcat} \cdot [\text{RCC1_Nucleus}] \cdot [\text{FRanGDP_Nucleus}] \cdot \frac{1}{\text{RCC1Km} + [\text{FRanGDP_Nucleus}] + [\text{NTF2_RanGDP_Nucleus}]} \cdot \text{vol}(\text{Nucleus}) \quad (23)$$

Table 34: Properties of each parameter.

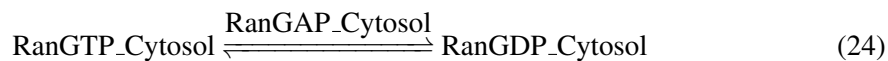
Id	Name	SBO	Value	Unit	Constant
RCC1Kcat			8.5	s ⁻¹	<input checked="" type="checkbox"/>
RCC1Km			1.1	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.10 Reaction RanGTP_dephosphorylation

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

Name RanGTP dephosphorylation

Reaction equation



Reactant

Table 35: Properties of each reactant.

Id	Name	SBO
RanGTP_Cytosol	RanGTP_Cytosol	

Modifier

Table 36: Properties of each modifier.

Id	Name	SBO
RanGAP_Cytosol	RanGAP_Cytosol	

Product

Table 37: Properties of each product.

Id	Name	SBO
RanGDP_Cytosol	RanGDP_Cytosol	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \frac{V_{\max_RanGTP_dephosphorylation_RanGTP_dephosphorylation} \cdot [RanGTP_Cytosol]}{1 + \frac{[RanGTP_Cytosol]}{K_{m_RanGTP_dephosphorylation} + [RanGTP_Cytosol]}} \cdot \text{vol}(\text{Cytosol}) \quad (25)$$

Table 38: Properties of each parameter.

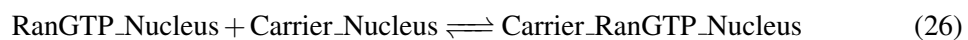
Id	Name	SBO	Value	Unit	Constant
Km_RanGTP-dephosphorylation			0.43	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.11 Reaction [RanGTP_Carrier_binding](#)

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

Name RanGTP Carrier binding

Reaction equation



Reactants

Table 39: Properties of each reactant.

Id	Name	SBO
RanGTP_Nucleus	RanGTP_Nucleus	
Carrier_Nucleus	Carrier_Nucleus	

Product

Table 40: Properties of each product.

Id	Name	SBO
Carrier_RanGTP_Nucleus	Carrier_RanGTP_Nucleus	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot \text{l}^{-2} \cdot \mu\text{mol}$

$$v_{11} = (\text{Kon_RanGTP_Carrier_binding} \cdot [\text{RanGTP_Nucleus}] \cdot [\text{Carrier_Nucleus}] + ((\text{Koff_RanGTP_Carrier_binding} \cdot [\text{Carrier_RanGTP_Nucleus}]))) \cdot \text{vol}(\text{Nucleus}) \quad (27)$$

Table 41: Properties of each parameter.

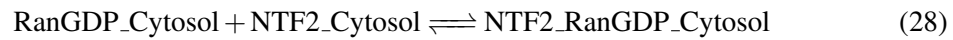
Id	Name	SBO	Value	Unit	Constant
Kon_RanGTP- _Carrier- _binding			100.0	1000 dimensionless· $\text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	<input checked="" type="checkbox"/>
Koff_RanGTP- _Carrier- _binding			1.0	s^{-1}	<input checked="" type="checkbox"/>

7.12 Reaction NTF2_RanGDP_Unbinding

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

Name NTF2_RanGDP Unbinding

Reaction equation



Reactants

Table 42: Properties of each reactant.

Id	Name	SBO
RanGDP_Cytosol	RanGDP_Cytosol	
NTF2_Cytosol	NTF2_Cytosol	

Product

Table 43: Properties of each product.

Id	Name	SBO
NTF2_RanGDP_Cytosol	NTF2_RanGDP_Cytosol	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot \text{l}^{-2} \cdot \mu\text{mol}$

$$v_{12} = (\text{Kon_NTF2_RanGDP_binding} \cdot [\text{RanGDP_Cytosol}] \cdot [\text{NTF2_Cytosol}] + ((\text{Koff_NTF2_RanGDP_binding} \cdot [\text{NTF2_RanGDP_Cytosol}]))) \cdot \text{vol}(\text{Cytosol}) \quad (29)$$

Table 44: Properties of each parameter.

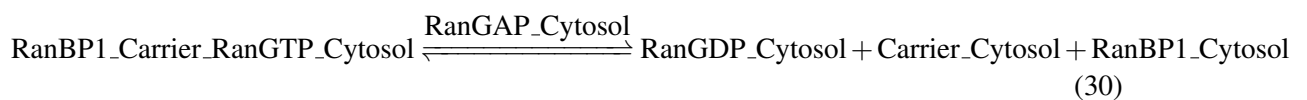
Id	Name	SBO	Value	Unit	Constant
Kon_NTF2- _RanGDP- _binding			100.0	1000 dimensionless · $\text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	✓
Koff_NTF2- _RanGDP- _binding			2.5	s^{-1}	✓

7.13 Reaction dephosphorylation

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

Name dephosphorylation

Reaction equation



Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
RanBP1_Carrier_RanGTP_Cytosol	RanBP1_Carrier_RanGTP_Cytosol	

Modifier

Table 46: Properties of each modifier.

Id	Name	SBO
RanGAP_Cytosol	RanGAP_Cytosol	

Products

Table 47: Properties of each product.

Id	Name	SBO
RanGDP_Cytosol	RanGDP_Cytosol	
Carrier_Cytosol	Carrier_Cytosol	
RanBP1_Cytosol	RanBP1_Cytosol	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \frac{V_{\max_dephosphorylation_dephosphorylation} \cdot [\text{RanBP1_Carrier_RanGTP_Cytosol}]}{1 + \frac{[\text{RanBP1_Carrier_RanGTP_Cytosol}]}{K_{m_dephosphorylation}}} \cdot \text{vol}(\text{Cytosol}) \quad (31)$$

Table 48: Properties of each parameter.

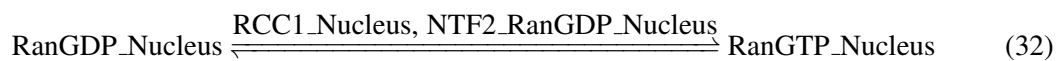
Id	Name	SBO	Value	Unit	Constant
Km- _dephosphorylation			0.43	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.14 Reaction RanGDP_to_RanGTP

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

Name RanGDP to RanGTP

Reaction equation



Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
RanGDP_Nucleus	RanGDP_Nucleus	

Modifiers

Table 50: Properties of each modifier.

Id	Name	SBO
RCC1_Nucleus	RCC1_Nucleus	
NTF2_RanGDP_Nucleus	NTF2_RanGDP_Nucleus	

Product

Table 51: Properties of each product.

Id	Name	SBO
RanGTP_Nucleus	RanGTP_Nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = 0.75 \cdot \text{RCC1Kcat} \cdot [\text{RCC1_Nucleus}] \cdot [\text{RanGDP_Nucleus}] \cdot \frac{1}{\text{RCC1Km} + [\text{RanGDP_Nucleus}] + [\text{NTF2_RanGDP_Nucleus}]} \cdot \text{vol}(\text{Nucleus}) \quad (33)$$

Table 52: Properties of each parameter.

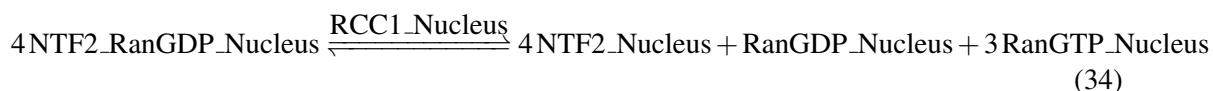
Id	Name	SBO	Value	Unit	Constant
RCC1Kcat			8.5	s ⁻¹	✓
RCC1Km			1.1	0.0010 dimensionless · m ⁻³ · mol	✓

7.15 Reaction NTF2_RAN_Nuc_Exchange

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

Name NTF2_RAN_Nuc_Exchange

Reaction equation



Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
NTF2_RanGDP_Nucleus	NTF2_RanGDP_Nucleus	

Modifier

Table 54: Properties of each modifier.

Id	Name	SBO
RCC1_Nucleus	RCC1_Nucleus	

Products

Table 55: Properties of each product.

Id	Name	SBO
NTF2_Nucleus	NTF2_Nucleus	
RanGDP_Nucleus	RanGDP_Nucleus	
RanGTP_Nucleus	RanGTP_Nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = 0.25 \cdot \text{RCC1Kcat} \cdot [\text{RCC1_Nucleus}] \cdot [\text{NTF2_RanGDP_Nucleus}] \cdot \frac{1}{\text{RCC1Km} + [\text{RanGDP_Nucleus}] + [\text{NTF2_RanGDP_Nucleus}]} \cdot \text{vol}(\text{Nucleus}) \quad (35)$$

Table 56: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
RCC1Kcat			8.5	s ⁻¹	<input checked="" type="checkbox"/>
RCC1Km			1.1	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.16 Reaction NTF2_RanGDP_unbinding

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

Name NTF2_RanGDP unbinding

Reaction equation



Reactant

Table 57: Properties of each reactant.

Id	Name	SBO
NTF2_RanGDP_Nucleus	NTF2_RanGDP_Nucleus	

Products

Table 58: Properties of each product.

Id	Name	SBO
RanGDP_Nucleus	RanGDP_Nucleus	
NTF2_Nucleus	NTF2_Nucleus	

Kinetic Law

Derived unit s⁻¹ · μmol · l⁻¹ · μm³

$$v_{16} = (\text{Koff_NTF2_RanGDP_unbinding} \cdot [\text{NTF2_RanGDP_Nucleus}] + ((\text{Kon_NTF2_RanGDP_unbinding} \cdot [\text{RanGDP_Nucleus}] \cdot [\text{NTF2_Nucleus}]))) \cdot \text{vol}(\text{Nucleus}) \quad (37)$$

Table 59: Properties of each parameter.

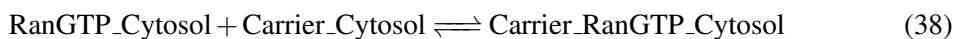
Id	Name	SBO	Value	Unit	Constant
Koff_NTF2- _RanGDP- _unbinding			2.5	s ⁻¹	<input checked="" type="checkbox"/>
Kon_NTF2- _RanGDP- _unbinding			100.0	1000 dimensionless · m ³ · mol ⁻¹ · s ⁻¹	<input checked="" type="checkbox"/>

7.17 Reaction Carrier_RanGTP_binding

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

Name Carrier RanGTP binding

Reaction equation



Reactants

Table 60: Properties of each reactant.

Id	Name	SBO
RanGTP_Cytosol	RanGTP_Cytosol	
Carrier_Cytosol	Carrier_Cytosol	

Product

Table 61: Properties of each product.

Id	Name	SBO
Carrier_RanGTP_Cytosol	Carrier_RanGTP_Cytosol	

Kinetic Law

Derived unit (0.0010000000000000005 m)⁶ · s⁻¹ · l⁻² · μmol

$$v_{17} = (\text{Kon_Carrier_RanGTP_binding} \cdot [\text{RanGTP_Cytosol}] \cdot [\text{Carrier_Cytosol}] + ((\text{Koff_Carrier_RanGTP_binding} \cdot [\text{Carrier_RanGTP_Cytosol}]))) \cdot \text{vol}(\text{Cytosol}) \quad (39)$$

Table 62: Properties of each parameter.

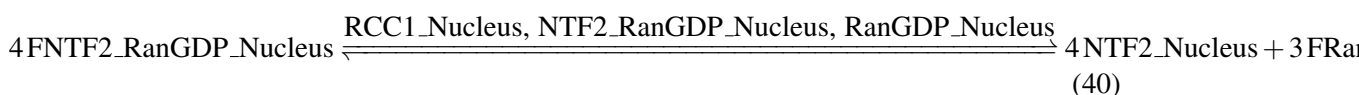
Id	Name	SBO	Value	Unit	Constant
Kon_Carrier- _RanGTP- _binding			0.0	1000 dimensionless · m ³ · mol ⁻¹ · s ⁻¹	<input checked="" type="checkbox"/>
Koff- _Carrier- _RanGTP- _binding			0.0	s ⁻¹	<input checked="" type="checkbox"/>

7.18 Reaction NTF2_FRAN_Nuc_Exchange

This is a reversible reaction of one reactant forming three products influenced by three modifiers.

Name NTF2_FRAN_Nuc_Exchange

Reaction equation



Reactant

Table 63: Properties of each reactant.

Id	Name	SBO
FNTF2_RanGDP_Nucleus	FNTF2_RanGDP_Nucleus	

Modifiers

Table 64: Properties of each modifier.

Id	Name	SBO
RCC1_Nucleus	RCC1_Nucleus	
NTF2_RanGDP_Nucleus	NTF2_RanGDP_Nucleus	
RanGDP_Nucleus	RanGDP_Nucleus	

Products

Table 65: Properties of each product.

Id	Name	SBO
NTF2_Nucleus	NTF2_Nucleus	
FRanGTP_Nucleus	FRanGTP_Nucleus	
FRanGDP_Nucleus	FRanGDP_Nucleus	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = 0.25 \cdot \text{RCC1Kcat} \cdot [\text{RCC1_Nucleus}] \cdot [\text{FNTF2_RanGDP_Nucleus}] \cdot \frac{1}{\text{RCC1Km} + [\text{RanGDP_Nucleus}] + [\text{FNTF2_RanGDP_Nucleus}]} \cdot \text{vol}(\text{Nucleus}) \quad (41)$$

Table 66: Properties of each parameter.

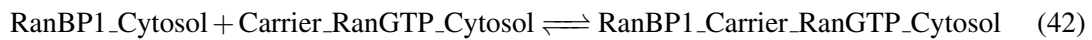
Id	Name	SBO	Value	Unit	Constant
RCC1Kcat			8.5	s ⁻¹	<input checked="" type="checkbox"/>
RCC1Km			1.1	0.0010 dimensionless · m ⁻³ · mol	<input checked="" type="checkbox"/>

7.19 Reaction RanBP1_binding

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

Name RanBP1 binding

Reaction equation



Reactants

Table 67: Properties of each reactant.

Id	Name	SBO
RanBP1_Cytosol	RanBP1_Cytosol	
Carrier_RanGTP_Cytosol	Carrier_RanGTP_Cytosol	

Product

Table 68: Properties of each product.

Id	Name	SBO
RanBP1_Carrier_RanGTP_Cytosol	RanBP1_Carrier_RanGTP_Cytosol	

Kinetic Law

Derived unit $(0.0010000000000000005 \text{ m})^6 \cdot \text{s}^{-1} \cdot \text{l}^{-2} \cdot \mu\text{mol}$

$$v_{19} = (\text{Kon_RanBP1_binding} \cdot [\text{RanBP1_Cytosol}] \cdot [\text{Carrier_RanGTP_Cytosol}] + ((\text{Koff_RanBP1_binding} \cdot [\text{RanBP1_Carrier_RanGTP_Cytosol}]))) \cdot \text{vol}(\text{Cytosol}) \quad (43)$$

Table 69: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kon_RanBP1-_binding			100.0	1000 dimensionless · m ³ · mol ⁻¹ · s ⁻¹	✓
Koff_RanBP1-_binding			0.5	s ⁻¹	✓

7.20 Reaction Carrier_RanGTP_flux

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

Name Carrier_RanGTP flux

Reaction equation



Reactant

Table 70: Properties of each reactant.

Id	Name	SBO
Carrier_RanGTP_Cytosol	Carrier_RanGTP_Cytosol	

Product

Table 71: Properties of each product.

Id	Name	SBO
Carrier_RanGTP_Nucleus	Carrier_RanGTP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{20} = \text{Carrier_RanGTP_Kperm} \cdot ([\text{Carrier_RanGTP_Cytosol}] + ([\text{Carrier_RanGTP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (45)$$

Table 72: Properties of each parameter.

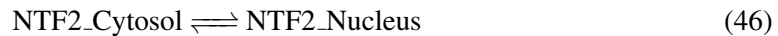
Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m ⁻²	✓
Carrier- _RanGTP_Kperm			0.173	10 ⁻⁶ dimensionless · m · s ⁻¹	✓

7.21 Reaction NTF2_flux

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

Name NTF2 flux

Reaction equation



Reactant

Table 73: Properties of each reactant.

Id	Name	SBO
NTF2_Cytosol	NTF2_Cytosol	

Product

Table 74: Properties of each product.

Id	Name	SBO
NTF2_Nucleus	NTF2_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{21} = \text{NTF2_Kperm} \cdot ([\text{NTF2_Cytosol}] + ([\text{NTF2_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (47)$$

Table 75: Properties of each parameter.

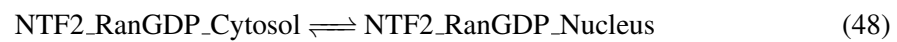
Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
NTF2_Kperm			3.733	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.22 Reaction NTF2_RanGDP_flux

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

Name NTF2_RanGDP flux

Reaction equation



Reactant

Table 76: Properties of each reactant.

Id	Name	SBO
NTF2_RanGDP_Cytosol	NTF2_RanGDP_Cytosol	

Product

Table 77: Properties of each product.

Id	Name	SBO
NTF2_RanGDP_Nucleus	NTF2_RanGDP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{22} = \text{NTF2_RanGDP_Kperm} \cdot ([\text{NTF2_RanGDP_Cytosol}] + ([\text{NTF2_RanGDP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (49)$$

Table 78: Properties of each parameter.

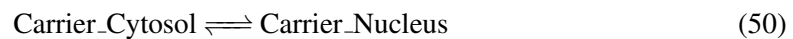
Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
NTF2_RanGDP- _Kperm			3.733	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.23 Reaction Carrier_flux

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

Name Carrier flux

Reaction equation



Reactant

Table 79: Properties of each reactant.

Id	Name	SBO
Carrier_Cytosol	Carrier_Cytosol	

Product

Table 80: Properties of each product.

Id	Name	SBO
Carrier_Nucleus	Carrier_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{23} = \text{Carrier_Kperm} \cdot ([\text{Carrier_Cytosol}] + ([\text{Carrier_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (51)$$

Table 81: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
Carrier- _Kperm			1.867	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.24 Reaction FRanGDP_flux

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

Name FRanGDP flux

Reaction equation



Reactant

Table 82: Properties of each reactant.

Id	Name	SBO
FRanGDP_Cytosol	FRanGDP_Cytosol	

Product

Table 83: Properties of each product.

Id	Name	SBO
FRanGDP_Nucleus	FRanGDP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{24} = \text{RanGDP_Kperm} \cdot ([\text{FRanGDP_Cytosol}] + ([\text{FRanGDP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (53)$$

Table 84: Properties of each parameter.

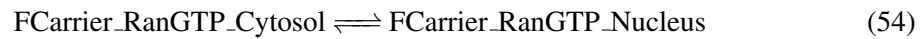
Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
RanGDP_Kperm			0.0	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.25 Reaction Carrier_FRanGTP_flux

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

Name Carrier_FRanGTP flux

Reaction equation



Reactant

Table 85: Properties of each reactant.

Id	Name	SBO
FCarrier_RanGTP_Cytosol	FCarrier_RanGTP_Cytosol	

Product

Table 86: Properties of each product.

Id	Name	SBO
FCarrier_RanGTP_Nucleus	FCarrier_RanGTP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{25} = \text{Carrier_RanGTP_Kperm} \cdot ([\text{FCarrier_RanGTP_Cytosol}] + ([\text{FCarrier_RanGTP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (55)$$

Table 87: Properties of each parameter.

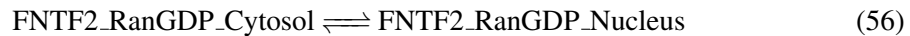
Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m ⁻²	✓
Carrier- _RanGTP_Kperm			0.173	10 ⁻⁶ dimensionless · m · s ⁻¹	✓

7.26 Reaction FNTF2_RanGDP_flux

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

Name FNTF2_RanGDP flux

Reaction equation



Reactant

Table 88: Properties of each reactant.

Id	Name	SBO
FNTF2_RanGDP_Cytosol	FNTF2_RanGDP_Cytosol	

Product

Table 89: Properties of each product.

Id	Name	SBO
FNTF2_RanGDP_Nucleus	FNTF2_RanGDP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{26} = \text{NTF2_RanGDP_Kperm} \cdot ([\text{FNTF2_RanGDP_Cytosol}] + ([\text{FNTF2_RanGDP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (57)$$

Table 90: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
	NTF2_RanGDP_Kperm		3.733	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.27 Reaction [FRanGTP_flux](#)

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

Name FRanGTP flux

Reaction equation



Reactant

Table 91: Properties of each reactant.

Id	Name	SBO
FRanGTP_Cytosol	FRanGTP_Cytosol	

Product

Table 92: Properties of each product.

Id	Name	SBO
FRanGTP_Nucleus	FRanGTP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{27} = \text{RanGTP_Kperm} \cdot ([\text{FRanGTP_Cytosol}] + ([\text{FRanGTP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (59)$$

Table 93: Properties of each parameter.

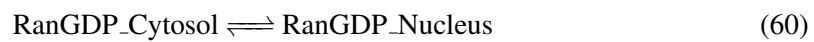
Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
RanGTP_Kperm			0.0	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.28 Reaction RanGDP_flux

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

Name RanGDP flux

Reaction equation



Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
RanGDP_Cytosol	RanGDP_Cytosol	

Product

Table 95: Properties of each product.

Id	Name	SBO
RanGDP_Nucleus	RanGDP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{28} = \text{RanGDP_Kperm} \cdot ([\text{RanGDP_Cytosol}] + ([\text{RanGDP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (61)$$

Table 96: Properties of each parameter.

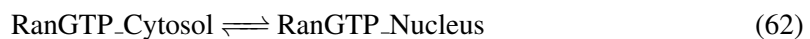
Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m ⁻²	<input checked="" type="checkbox"/>
RanGDP_Kperm			0.0	10 ⁻⁶ dimensionless · m · s ⁻¹	<input checked="" type="checkbox"/>

7.29 Reaction RanGTP_flux

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

Name RanGTP flux

Reaction equation



Reactant

Table 97: Properties of each reactant.

Id	Name	SBO
RanGTP_Cytosol	RanGTP_Cytosol	

Product

Table 98: Properties of each product.

Id	Name	SBO
RanGTP_Nucleus	RanGTP_Nucleus	

Kinetic Law

Derived unit $(1.0000000000000004 \cdot 10^{-4} \text{ m})^3 \cdot \text{s}^{-1} \cdot \mu\text{mol} \cdot \text{l}^{-1}$

$$v_{29} = \text{RanGTP_Kperm} \cdot ([\text{RanGTP_Cytosol}] + ([\text{RanGTP_Nucleus}])) \cdot \text{area}(\text{Nuc_membrane}) \quad (63)$$

Table 99: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m ⁻²	✓
RanGTP_Kperm			0.0	10 ⁻⁶ dimensionless · m · s ⁻¹	✓

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 `Carrier_Cytosol`

Name `Carrier_Cytosol`

Initial concentration $11.8952664327711 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in five reactions (as a reactant in `Carrier_FRanGTP_binding`, `Carrier-RanGTP_binding`, `Carrier_flux` and as a product in `dephosphorylationF`, `dephosphorylation`).

$$\frac{d}{dt} \text{Carrier_Cytosol} = v_3 + v_{13} - v_1 - v_{17} - v_{23} \quad (64)$$

8.2 Species `Carrier_RanGTP_Cytosol`

Name `Carrier_RanGTP_Cytosol`

Initial concentration $0.00182967434742422 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in `RanBP1_binding`, `Carrier_RanGTP_flux` and as a product in `Carrier_RanGTP_binding`).

$$\frac{d}{dt}\text{Carrier_RanGTP_Cytosol} = v_{17} - v_{19} - v_{20} \quad (65)$$

8.3 Species `RanGAP_Cytosol`

Name `RanGAP_Cytosol`

Initial concentration $0.5 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a modifier in `FRanGTP_dephosphorylation`, `dephosphorylationF`, `RanGTP_dephosphorylation`, `dephosphorylation`).

$$\frac{d}{dt}\text{RanGAP_Cytosol} = 0 \quad (66)$$

8.4 Species `RanBP1_Cytosol`

Name `RanBP1_Cytosol`

Initial concentration $2.91577340630959 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a reactant in `RanBP1_bindingF`, `RanBP1_binding` and as a product in `dephosphorylationF`, `dephosphorylation`).

$$\frac{d}{dt}\text{RanBP1_Cytosol} = v_3 + v_{13} - v_6 - v_{19} \quad (67)$$

8.5 Species `RanBP1_Carrier_RanGTP_Cytosol`

Name `RanBP1_Carrier_RanGTP_Cytosol`

Initial concentration $0.0842265936904004 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a reactant in `dephosphorylation` and as a product in `RanBP1_binding`).

$$\frac{d}{dt}\text{RanBP1_Carrier_RanGTP_Cytosol} = v_{19} - v_{13} \quad (68)$$

8.6 Species NTF2_Nucleus

Name NTF2_Nucleus

Initial concentration 0.560888580955963 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in five reactions (as a product in [NTF2_FRanGDP_unbinding](#), [NTF2_RAN_Nuc_Exchange](#), [NTF2_RanGDP_unbinding](#), [NTF2_FRAN_Nuc_Exchange](#), [NTF2_flux](#)).

$$\frac{d}{dt}\text{NTF2_Nucleus} = v_7 + 4 v_{15} + v_{16} + 4 v_{18} + v_{21} \quad (69)$$

8.7 Species RanGDP_Nucleus

Name RanGDP_Nucleus

Initial concentration 0.0466849733424111 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in six reactions (as a reactant in [RanGDP_to_RanGTP](#) and as a product in [NTF2_RAN_Nuc_Exchange](#), [NTF2_RanGDP_unbinding](#), [RanGDP_flux](#) and as a modifier in [FRanGDP_to_FRanGTP](#), [NTF2_FRAN_Nuc_Exchange](#)).

$$\frac{d}{dt}\text{RanGDP_Nucleus} = v_{15} + v_{16} + v_{28} - v_{14} \quad (70)$$

8.8 Species RCC1_Nucleus

Name RCC1_Nucleus

Initial concentration 0.4 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a modifier in [FRanGDP_to_FRanGTP](#), [RanGDP_to_RanGTP](#), [NTF2_RAN_Nuc_Exchange](#), [NTF2_FRAN_Nuc_Exchange](#)).

$$\frac{d}{dt}\text{RCC1_Nucleus} = 0 \quad (71)$$

8.9 Species RanGTP_Nucleus

Name RanGTP_Nucleus

Initial concentration 0.0118032373274648 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a reactant in [RanGTP_Carrier_binding](#) and as a product in [RanGDP_to_RanGTP](#), [NTF2_RAN_Nuc_Exchange](#), [RanGTP_flux](#)).

$$\frac{d}{dt}\text{RanGTP_Nucleus} = v_{14} + 3 v_{15} + v_{29} - v_{11} \quad (72)$$

8.10 Species NTF2_RanGDP_Nucleus

Name NTF2_RanGDP_Nucleus

Initial concentration 0.939111419044037 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in six reactions (as a reactant in [NTF2_RAN_Nuc_Exchange](#), [NTF2_RanGDP-_unbinding](#) and as a product in [NTF2_RanGDP_flux](#) and as a modifier in [FRanGDP_to_FRanGTP](#), [RanGDP_to_RanGTP](#), [NTF2_FRAN_Nuc_Exchange](#)).

$$\frac{d}{dt}\text{NTF2_RanGDP_Nucleus} = v_{22} - 4 v_{15} - v_{16} \quad (73)$$

8.11 Species Carrier_Nucleus

Name Carrier_Nucleus

Initial concentration 10.8211328580636 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in [FRanGTP_Carrier_binding](#), [RanGTP-_Carrier_binding](#) and as a product in [Carrier_flux](#)).

$$\frac{d}{dt}\text{Carrier_Nucleus} = v_{23} - v_4 - v_{11} \quad (74)$$

8.12 Species RanGDP_Cytosol

Name RanGDP_Cytosol

Initial concentration 1.75546095870568 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a reactant in [NTF2_RanGDP_Unbinding](#), [RanGDP-_flux](#) and as a product in [RanGTP_dephosphorylation](#), [dephosphorylation](#)).

$$\frac{d}{dt}\text{RanGDP_Cytosol} = v_{10} + v_{13} - v_{12} - v_{28} \quad (75)$$

8.13 Species Carrier_RanGTP_Nucleus

Name Carrier_RanGTP_Nucleus

Initial concentration 11.5694219089212 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a product in [RanGTP_Carrier_binding](#), [Carrier-_RanGTP_flux](#)).

$$\frac{d}{dt}\text{Carrier_RanGTP_Nucleus} = v_{11} + v_{20} \quad (76)$$

8.14 Species NTF2_RanGDP_Cytosol

Name NTF2_RanGDP_Cytosol

Initial concentration 1.47617820113791 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a reactant in [NTF2_RanGDP_flux](#) and as a product in [NTF2_RanGDP_Unbinding](#)).

$$\frac{d}{dt}\text{NTF2_RanGDP_Cytosol} = v_{12} - v_{22} \quad (77)$$

8.15 Species FRanGTP_Cytosol

Name FRanGTP_Cytosol

Initial concentration 0 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in [Carrier_FRanGTP_binding](#), [FRanGTP_dephosphorylation](#), [FRanGTP_flux](#)).

$$\frac{d}{dt}\text{FRanGTP_Cytosol} = -v_1 - v_2 - v_{27} \quad (78)$$

8.16 Species FCarrier_RanGTP_Cytosol

Name FCarrier_RanGTP_Cytosol

Initial concentration 0 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in [RanBP1_bindingF](#), [Carrier_FRanGTP_flux](#) and as a product in [Carrier_FRanGTP_binding](#)).

$$\frac{d}{dt}\text{FCarrier_RanGTP_Cytosol} = v_1 - v_6 - v_{25} \quad (79)$$

8.17 Species FRanGDP_Cytosol

Name FRanGDP_Cytosol

Initial concentration 1 $\mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in five reactions (as a reactant in [NTF2_FRanGDP_Unbinding](#), [FRanGDP_flux](#) and as a product in [FRanGTP_dephosphorylation](#), [dephosphorylationF](#), [Microinj](#)).

$$\frac{d}{dt}\text{FRanGDP_Cytosol} = v_2 + v_3 + v_8 - v_5 - v_{24} \quad (80)$$

8.18 Species `FNTF2_RanGDP_Cytosol`

Name `FNTF2_RanGDP_Cytosol`

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a reactant in `FNTF2_RanGDP_flux` and as a product in `NTF2_FRanGDP_Unbinding`).

$$\frac{d}{dt}\text{FNTF2_RanGDP_Cytosol} = v_5 - v_{26} \quad (81)$$

8.19 Species `FRanBP1_Carrier_RanGTP_Cytosol`

Name `FRanBP1_Carrier_RanGTP_Cytosol`

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a reactant in `dephosphorylationF` and as a product in `RanBP1_bindingF`).

$$\frac{d}{dt}\text{FRanBP1_Carrier_RanGTP_Cytosol} = v_6 - v_3 \quad (82)$$

8.20 Species `FCarrier_RanGTP_Nucleus`

Name `FCarrier_RanGTP_Nucleus`

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a product in `FRanGTP_Carrier_binding`, `Carrier_FRanGTP_flux`).

$$\frac{d}{dt}\text{FCarrier_RanGTP_Nucleus} = v_4 + v_{25} \quad (83)$$

8.21 Species `FRanGDP_Nucleus`

Name `FRanGDP_Nucleus`

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a reactant in `FRanGDP_to_FRanGTP` and as a product in `NTF2_FRanGDP_unbinding`, `NTF2_FRAN_Nuc_Exchange`, `FRanGDP_flux`).

$$\frac{d}{dt}\text{FRanGDP_Nucleus} = v_7 + v_{18} + v_{24} - v_9 \quad (84)$$

8.22 Species FNTF2_RanGDP_Nucleus

Name FNTF2_RanGDP_Nucleus

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in [NTF2_FRanGDP_unbinding](#), [NTF2-_FRAN_Nuc_Exchange](#) and as a product in [FNTF2_RanGDP_flux](#)).

$$\frac{d}{dt}\text{FNTF2_RanGDP_Nucleus} = v_{26} - v_7 - 4 v_{18} \quad (85)$$

8.23 Species FRanGTP_Nucleus

Name FRanGTP_Nucleus

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in four reactions (as a reactant in [FRanGTP_Carrier_binding](#) and as a product in [FRanGDP_to_FRanGTP](#), [NTF2_FRAN_Nuc_Exchange](#), [FRanGTP_flux](#)).

$$\frac{d}{dt}\text{FRanGTP_Nucleus} = v_9 + 3 v_{18} + v_{27} - v_4 \quad (86)$$

8.24 Species NTF2_Cytosol

Name NTF2_Cytosol

Initial concentration $0.023821798862085 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in [NTF2_FRanGDP_Unbinding](#), [NTF2-_RanGDP_Unbinding](#), [NTF2_flux](#)).

$$\frac{d}{dt}\text{NTF2_Cytosol} = -v_5 - v_{12} - v_{21} \quad (87)$$

8.25 Species Pipet_Cytosol

Name Pipet_Cytosol

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in one reaction (as a modifier in [Microinj](#)).

$$\frac{d}{dt}\text{Pipet_Cytosol} = 0 \quad (88)$$

8.26 Species `RanGTP_Cytosol`

Name `RanGTP_Cytosol`

Initial concentration $0 \mu\text{mol} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a reactant in `RanGTP_dephosphorylation`, `Carrier-RanGTP_binding`, `RanGTP_flux`).

$$\frac{d}{dt}\text{RanGTP_Cytosol} = -v_{10} - v_{17} - v_{29} \quad (89)$$

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