SBML Model Report

Model name: "Croft2013 - GPCR-RGS interaction that compartmentalizes RGS activity"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following three authors: Vijayalakshmi Chelliah[1], Manuel Esparza-Franco[2] and Wayne Croft[3] at September thirteenth 2013 at 12:39 a. m. and last time modified at April 28th 2014 at 4:04 p. m. Table 1 gives an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	28
events	1	constraints	0
reactions	44	function definitions	0
global parameters	2	unit definitions	4
rules	0	initial assignments	0

Model Notes

Croft2013 - GPCR-RGS interaction that compartmentalizes RGS activity

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Through modelling studies, the classic quaternary complex (ligand-GPCR-G-RGS) has been extended to include an additional layer of regulation through GPCR-RGS interactions, which facilitate the compartmentalization of RGS activity into the plasma membrane and non-plasma compartments.

This model is described in the article:A physiologically required G protein-coupled receptor (GPCR)-regulator of G protein signaling (RGS) interaction that compartmentalizes RGS activity.Croft W, Hill C, McCann E, Bond M, Esparza-Franco M, Bennett J, Rand D, Davey J, Ladds G.J Biol Chem. 2013 Sep 20;288(38):27327-42.

Abstract:

G protein-coupled receptors (GPCRs) can interact with regulator of G protein signaling (RGS) proteins. However, the effects of such interactions on signal transduction and their physiological relevance have been largely undetermined. Ligand-bound GPCRs initiate by promoting exchange of GDP for GTP on the G subunit of heterotrimeric G proteins. Signaling is terminated by hydrolysis of GTP to GDP through intrinsic GTPase activity of the G subunit, a reaction catalyzed by RGS proteins. Using yeast as a tool to study GPCR signaling in isolation, we define an interaction between the cognate GPCR (Mam2) and RGS (Rgs1), mapping the interaction domains. This reaction tethers Rgs1 at the plasma membrane and is essential for physiological signaling response. In vivo quantitative data inform the development of a kinetic model of the GTPase cycle, which extends previous attempts by including GPCR-RGS interactions. In vivo and in silico data confirm that GPCR-RGS interactions can impose an additional layer of regulation through mediating RGS subcellular localization to compartmentalize RGS activity within a cell, thus highlighting their importance as potential targets to modulate GPCR signaling pathways.

Author's comment on reproducing the plots:
To reproduce dose-response plots in the publication, the model is simulated with 12 different ligand concentrations (see parameter Ligand_conc).
For each ligand concentration, a single value corresponding to total amount of output must be obtained, by calculating the area under the curve of the trajectory of species z3, from time=0 to time=30.
These total output values are then used to build a dose-response plot (authors used GraphPad Prism).
Mutant strains are simulated with alternative parameter values or initial conditions specified in the Supplementary Material.

This model is hosted on BioModels Database and identifiedby: BIOMD0000000479 .

To cite BioModels Database, please use: BioModels Database: An enhanced, curated and annotated resourcefor published quantitative kinetic models .

2 Unit Definitions

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

2.1 Unit `nanoMolar`

Name nM

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

2.2 Unit `hour`

Name hr

Definition 3600 s

2.3 Unit `FirstOrder`

Name 1/hr

Definition $(3600\ \mathrm{s})^{-1}$

2.4 Unit `SecondOrder`

Name 1/(nM*hr)

Definition $\mathrm{nmol}^{-1} \cdot 1 \cdot (3600\ \mathrm{s})^{-1}$

2.5 Unit `substance`

Notes Mole is the predefined SBML unit for `substance`.

Definition mol

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 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`compartment`	cell	0000290	3	1	litre	☑	

3.1 Compartment `compartment`

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

Name cell

SBO:0000290 physical compartment

4 Species

This model contains 28 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
L	L	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
R	R	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
LR	LR	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
Gabg	Gabg	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RGabg	RGabg	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
LRGabg	LRGabg	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RRGSm	RRGSm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
LRRGSm	LRRGSm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RRGSmGabg	RRGSmGabg	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
LRRGSmGabg	LRRGSmGabg	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGTP	GaGTP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
Gbg	Gbg	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
Effector	Effector	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGTPEffector	GaGTPEffector	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RGSc	RGSc	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RGSm	RGSm	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RGSmGaGTP	RGSmGaGTP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGTPEffectorOFF	GaGTPEffectorOFF	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RGSmGaGTPEffectorOFF	RGSmGaGTPEffectorOFF	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGDPP	GaGDPP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
LRRGSmGaGTP	LRRGSmGaGTP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
RRGSmGaGTP	RRGSmGaGTP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
LRRGSmGaGTPEffectorOFF	LRRGSmGaGTPEffectorOFF	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
GaGDP	GaGDP	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
P	P	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
z1	z1	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
z2	z2	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟
z3	z3	compartment	$\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains two global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
`ka`	ka		1.5	$(3600\ \mathrm{s})^{-1}$	☑
`Ligand_conc`	Ligand_conc		0.1	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☑

6 Event

This is an overview of one event. Each event is initiated whenever its trigger condition switches from `false` to `true`. A delay function postpones the effects of an event to a later time point. At the time of execution, an event can assign values to species, parameters or compartments if these are not set to constant.

6.1 Event `Ligand_addition`

Name Ligand_addition

Trigger condition

$$\mathrm{time} \geq 14 \tag{1}$$

Assignment

$$\mathrm{L} = [\mathrm{L}] + \mathrm{Ligand\_conc} \tag{2}$$

7 Reactions

This model contains 44 reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	R1	Receptor-Ligand association	$L + R \xrightarrow{L,\ R} LR$	
2	R2	Receptor-Gprotein association	$R + Gabg \xrightarrow{R,\ Gabg} RGabg$	
3	R3	LR-Gprotein association	$LR + Gabg \xrightarrow{LR,\ Gabg} LRGabg$	
4	R4	Ligand-RGabg association	$L + RGabg \xrightarrow{L,\ RGabg} LRGabg$	
5	R5	Ligand-RRGSm association	$L + RRGSm \xrightarrow{L,\ RRGSm} LRRGSm$	
6	R6	RRGSm-Gprotein association	$RRGSm + Gabg \xrightarrow{RRGSm,\ Gabg} RRGSmGabg$	
7	R7	LRRGSm-Gprotein association	$LRRGSm + Gabg \xrightarrow{LRRGSm,\ Gabg} LRRGSmGabg$	
8	R8	Ligand-RRGSmGabg association	$L + RRGSmGabg \xrightarrow{L,\ RRGSmGabg} LRRGSmGabg$	
9	R9	Gprotein activation by LR	$LRGabg \xrightarrow{LRGabg} LR + GaGTP + Gbg$	
10	R10	Gprotein spontaneous activation	$Gabg \xrightarrow{Gabg} GaGTP + Gbg$	
11	R11	Gprotein activation by LRRGSm	$LRRGSmGabg \xrightarrow{LRRGSmGabg} GaGTP + Gbg + LRRGSm$	
12	R12	Effector-GaGTP association	$Effector + GaGTP \xrightarrow{Effector,\ GaGTP} GaGTPEffector$	
13	R13	RGS in cytosol moves to membrane	$RGSc \xrightarrow{RGSc} RGSm$	
14	R14	RGS in membrane moves to cytosol	$RGSm \xrightarrow{RGSm} RGSc$	
15	R15	Receptor recruits RGSc to membrane	$R + RGSc \xrightarrow{R,\ RGSc} RRGSm$	

№	Id	Name	Reaction Equation	SBO
16	R16	R-RGSm dissociation	$\mathrm{RRGSm} \xrightarrow{\mathrm{RRGSm}} \mathrm{R} + \mathrm{RGSm}$	
17	R17	LR recruits RGSc to membrane	$\mathrm{LR} + \mathrm{RGSc} \xrightarrow{\mathrm{LR,\ RGSc}} \mathrm{LRRGSm}$	
18	R18	LR-RGSm dissociation	$\mathrm{LRRGSm} \xrightarrow{\mathrm{LRRGSm}} \mathrm{LR} + \mathrm{RGSm}$	
19	R19	RGabg recruits RGSc to membrane	$\mathrm{RGabg} + \mathrm{RGSc} \xrightarrow{\mathrm{RGabg,\ RGSc}} \mathrm{RRGSmGabg}$	
20	R20	RRGSmGabg dissociation	$\mathrm{RRGSmGabg} \xrightarrow{\mathrm{RRGSmGabg}} \mathrm{RGabg} + \mathrm{RGSm}$	
21	R21	LRGabg recruits RGSc to membrane	$\mathrm{LRGabg} + \mathrm{RGSc} \xrightarrow{\mathrm{LRGabg,\ RGSc}} \mathrm{LRRGSmGabg}$	
22	R22	GaGTP recruits RGSc to membrane	$\mathrm{GaGTP} + \mathrm{RGSc} \xrightarrow{\mathrm{GaGTP,\ RGSc}} \mathrm{RGSmGaGTP}$	
23	R23	RGSmGaGTP dissociation	$\mathrm{RGSmGaGTP} \xrightarrow{\mathrm{RGSmGaGTP}} \mathrm{GaGTP} + \mathrm{RGSc}$	
24	R24	GaGTPEffectorOFF recruits RGS from cytosol	$\mathrm{GaGTPEffectorOFF} + \mathrm{RGSc} \xrightarrow{\mathrm{GaGTPEffectorOFF,\ RGSc}} \mathrm{RGSmGaGTPEffectorOFF}$	
25	R25	Effector turns off	$\mathrm{GaGTPEffector} \xrightarrow{\mathrm{GaGTPEffector}} \mathrm{GaGTPEffectorOFF}$	
26	R26	GaGTP hydrolyzes GTP	$\mathrm{GaGTP} \xrightarrow{\mathrm{GaGTP}} \mathrm{GaGDPP}$	
27	R27	GaGTP-RGSm association	$\mathrm{GaGTP} + \mathrm{RGSm} \xrightarrow{\mathrm{GaGTP,\ RGSm}} \mathrm{RGSmGaGTP}$	
28	R28	RGSmGaGTP hydrolyzes GTP	$\mathrm{RGSmGaGTP} \xrightarrow{\mathrm{RGSmGaGTP}} \mathrm{GaGDPP} + \mathrm{RGSc}$	
29	R29	GaGTP-LRRGSm association	$\mathrm{GaGTP} + \mathrm{LRRGSm} \xrightarrow{\mathrm{GaGTP,\ LRRGSm}} \mathrm{LRRGSmGaGTP}$	
30	R30	LRRGSmGaGTP hydrolyzes GTP	$\mathrm{LRRGSmGaGTP} \xrightarrow{\mathrm{LRRGSmGaGTP}} \mathrm{GaGDPP} + \mathrm{LRRGSm}$	
31	R31	GaGTP-RRGSm association	$\mathrm{GaGTP} + \mathrm{RRGSm} \xrightarrow{\mathrm{GaGTP,\ RRGSm}} \mathrm{RRGSmGaGTP}$	
32	R32	RRGSmGaGTP hydrolyzes GTP	$\mathrm{RRGSmGaGTP} \xrightarrow{\mathrm{RRGSmGaGTP}} \mathrm{GaGDPP} + \mathrm{RRGSm}$	
33	R33	GaGTPEffectorOFF hydrolyzes GTP	$\mathrm{GaGTPEffectorOFF} \xrightarrow{\mathrm{GaGTPEffectorOFF}} \mathrm{GaGDPP} + \mathrm{Effector}$	

№	Id	Name	Reaction Equation	SBO
34	R34	GaGTPEffectorOFF-RGSm association	$\text{GaGTPEffectorOFF} + \text{RGSm} \xrightarrow{\text{GaGTPEffectorOFF, RGSm}} \text{RGSmGaGTPEffectorOFF}$	
35	R35	RGSmGaGTPEffectorOFF hydrolyzes GTP	$\text{RGSmGaGTPEffectorOFF} \xrightarrow{\text{RGSmGaGTPEffectorOFF}} \text{GaGDPP} + \text{RGSc} + \text{Effector}$	
36	R36	GaGTPEffectorOFF-LRRGSm association	$\text{GaGTPEffectorOFF} + \text{LRRGSm} \xrightarrow{\text{GaGTPEffectorOFF, LRRGSm}} \text{LRRGSmGaGTPEffectorOFF}$	
37	R37	LRRGSmGaGTPEffectorOFF hydrolyzes GTP	$\text{LRRGSmGaGTPEffectorOFF} \xrightarrow{\text{LRRGSmGaGTPEffectorOFF}} \text{GaGDPP} + \text{LRRGSm} + \text{Effector}$	
38	R38	Phosphate release	$\text{GaGDPP} \xrightarrow{\text{GaGDPP}} \text{GaGDP} + \text{P}$	
39	R39	Gprotein subunits association	$\text{GaGDP} + \text{Gbg} \xrightarrow{\text{GaGDP, Gbg}} \text{Gabg}$	
40	R40	Phosphate degradation	$\text{P} \xrightarrow{\text{P}} \emptyset$	
41	R41	Delay 1	$\emptyset \xrightarrow{\text{GaGTPEffector, GaGTPEffector}} \text{z1}$	
42	R42	Delay 2	$\text{z1} \xrightarrow{\text{z1}} \text{z2}$	
43	R43	Delay 3	$\text{z2} \xrightarrow{\text{z2}} \text{z3}$	
44	R44	Final output	$\text{z3} \xrightarrow{\text{z3}} \emptyset$	

7.1 Reaction R1

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

Name Receptor-Ligand association

Reaction equation

$$\mathrm{L} + \mathrm{R} \xrightarrow{\mathrm{L,\ R}} \mathrm{LR} \tag{3}$$

Reactants

Table 6: Properties of each reactant.

Id	Name	SBO
L	L	
R	R	

Modifiers

Table 7: Properties of each modifier.

Id	Name	SBO
L	L	
R	R	

Product

Table 8: Properties of each product.

Id	Name	SBO
LR	LR	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_1 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{L}] \cdot [\mathrm{R}] \cdot \mathrm{k1} \tag{4}$$

Table 9: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.003	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.2 Reaction R2

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

Name Receptor-Gprotein association

Reaction equation

$$\text{R} + \text{Gabg} \xrightarrow{\text{R, Gabg}} \text{RGabg} \tag{5}$$

Reactants

Table 10: Properties of each reactant.

Id	Name	SBO
R	R	
Gabg	Gabg	

Modifiers

Table 11: Properties of each modifier.

Id	Name	SBO
R	R	
Gabg	Gabg	

Product

Table 12: Properties of each product.

Id	Name	SBO
RGabg	RGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_2 = \text{vol}\,(\text{compartment}) \cdot [\text{R}] \cdot [\text{Gabg}] \cdot \text{k2} \tag{6}$$

Table 13: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k2	k2		0.005	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.3 Reaction R3

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

Name LR-Gprotein association

Reaction equation

$$\text{LR} + \text{Gabg} \xrightarrow{\text{LR, Gabg}} \text{LRGabg} \tag{7}$$

Reactants

Table 14: Properties of each reactant.

Id	Name	SBO
LR	LR	
Gabg	Gabg	

Modifiers

Table 15: Properties of each modifier.

Id	Name	SBO
LR	LR	
Gabg	Gabg	

Product

Table 16: Properties of each product.

Id	Name	SBO
LRGabg	LRGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_3 = \text{vol}(\text{compartment}) \cdot [\text{LR}] \cdot [\text{Gabg}] \cdot \text{k3} \tag{8}$$

Table 17: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k3	k3		0.02	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.4 Reaction R4

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

Name Ligand-RGabg association

Reaction equation

$$\text{L} + \text{RGabg} \xrightarrow{\text{L, RGabg}} \text{LRGabg} \tag{9}$$

Reactants

Table 18: Properties of each reactant.

Id	Name	SBO
L	L	
RGabg	RGabg	

Modifiers

Table 19: Properties of each modifier.

Id	Name	SBO
L	L	

Id	Name	SBO
RGabg	RGabg	

Product

Table 20: Properties of each product.

Id	Name	SBO
LRGabg	LRGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_4 = \text{vol}\,(\text{compartment}) \cdot [\text{L}] \cdot [\text{RGabg}] \cdot \text{k4} \tag{10}$$

Table 21: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k4	k4		0.005	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.5 Reaction R5

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

Name Ligand-RRGSm association

Reaction equation

$$\text{L} + \text{RRGSm} \xrightarrow{\text{L, RRGSm}} \text{LRRGSm} \tag{11}$$

Reactants

Table 22: Properties of each reactant.

Id	Name	SBO
L	L	
RRGSm	RRGSm	

Modifiers

Table 23: Properties of each modifier.

Id	Name	SBO
L	L	
RRGSm	RRGSm	

Product

Table 24: Properties of each product.

Id	Name	SBO
LRRGSm	LRRGSm	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_5 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{L}] \cdot [\mathrm{RRGSm}] \cdot \mathrm{k5} \tag{12}$$

Table 25: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k5	k5		0.005	$\mathrm{nmol}^{-1} \cdot 1 \cdot (3600\ \mathrm{s})^{-1}$	☑

7.6 Reaction R6

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

Name RRGSm-Gprotein association

Reaction equation

$$\mathrm{RRGSm} + \mathrm{Gabg} \xrightarrow{\mathrm{RRGSm,\ Gabg}} \mathrm{RRGSmGabg} \tag{13}$$

Reactants

Table 26: Properties of each reactant.

Id	Name	SBO
RRGSm	RRGSm	
Gabg	Gabg	

Modifiers

Table 27: Properties of each modifier.

Id	Name	SBO
RRGSm	RRGSm	
Gabg	Gabg	

Product

Table 28: Properties of each product.

Id	Name	SBO
RRGSmGabg	RRGSmGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_6 = \text{vol}\,(\text{compartment}) \cdot [\text{RRGSm}] \cdot [\text{Gabg}] \cdot \text{k6} \tag{14}$$

Table 29: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k6	k6		0.005	$\text{nmol}^{-1} \cdot \text{l} \cdot (3600\ \text{s})^{-1}$	☑

7.7 Reaction R7

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

Name LRRGSm-Gprotein association

Reaction equation

$$\text{LRRGSm} + \text{Gabg} \xrightarrow{\text{LRRGSm, Gabg}} \text{LRRGSmGabg} \tag{15}$$

Reactants

Table 30: Properties of each reactant.

Id	Name	SBO
LRRGSm	LRRGSm	
Gabg	Gabg	

Modifiers

Table 31: Properties of each modifier.

Id	Name	SBO
LRRGSm	LRRGSm	
Gabg	Gabg	

Product

Table 32: Properties of each product.

Id	Name	SBO
LRRGSmGabg	LRRGSmGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_7 = \text{vol}\,(\text{compartment}) \cdot [\text{LRRGSm}] \cdot [\text{Gabg}] \cdot \text{k7} \tag{16}$$

Table 33: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k7	k7		0.02	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.8 Reaction R8

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

Name Ligand-RRGSmGabg association

Reaction equation

$$\mathrm{L} + \mathrm{RRGSmGabg} \xrightarrow{\mathrm{L,\ RRGSmGabg}} \mathrm{LRRGSmGabg} \tag{17}$$

Reactants

Table 34: Properties of each reactant.

Id	Name	SBO
L	L	
RRGSmGabg	RRGSmGabg	

Modifiers

Table 35: Properties of each modifier.

Id	Name	SBO
L	L	
RRGSmGabg	RRGSmGabg	

Product

Table 36: Properties of each product.

Id	Name	SBO
LRRGSmGabg	LRRGSmGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_8 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{L}] \cdot [\mathrm{RRGSmGabg}] \cdot \mathrm{k8} \tag{18}$$

Table 37: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k8	k8		0.005	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.9 Reaction R9

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

Name Gprotein activation by LR

Reaction equation

$$\text{LRGabg} \xrightarrow{\text{LRGabg}} \text{LR} + \text{GaGTP} + \text{Gbg} \tag{19}$$

Reactant

Table 38: Properties of each reactant.

Id	Name	SBO
LRGabg	LRGabg	

Modifier

Table 39: Properties of each modifier.

Id	Name	SBO
LRGabg	LRGabg	

Products

Table 40: Properties of each product.

Id	Name	SBO
LR	LR	
GaGTP	GaGTP	
Gbg	Gbg	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_9 = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{LRGabg}] \cdot \mathrm{k9} \tag{20}$$

Table 41: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k9	k9		50.0	$(3600\ \mathrm{s})^{-1}$	☑

7.10 Reaction R10

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

Name Gprotein spontaneous activation

Reaction equation

$$\mathrm{Gabg} \xrightarrow{\mathrm{Gabg}} \mathrm{GaGTP} + \mathrm{Gbg} \tag{21}$$

Reactant

Table 42: Properties of each reactant.

Id	Name	SBO
Gabg	Gabg	

Modifier

Table 43: Properties of each modifier.

Id	Name	SBO
Gabg	Gabg	

Products

Table 44: Properties of each product.

Id	Name	SBO
GaGTP	GaGTP	
Gbg	Gbg	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{10} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{Gabg}] \cdot \mathrm{k10} \tag{22}$$

Table 45: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k10	k10		0.2	$(3600\ \mathrm{s})^{-1}$	☑

7.11 Reaction R11

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

Name Gprotein activation by LRRGSm

Reaction equation

$$\mathrm{LRRGSmGabg} \xrightarrow{\mathrm{LRRGSmGabg}} \mathrm{GaGTP} + \mathrm{Gbg} + \mathrm{LRRGSm} \tag{23}$$

Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
LRRGSmGabg	LRRGSmGabg	

Modifier

Table 47: Properties of each modifier.

Id	Name	SBO
LRRGSmGabg	LRRGSmGabg	

Products

Table 48: Properties of each product.

Id	Name	SBO
GaGTP	GaGTP	
Gbg	Gbg	
LRRGSm	LRRGSm	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{11} = \text{vol}\,(\text{compartment}) \cdot [\text{LRRGSmGabg}] \cdot \text{k11} \tag{24}$$

Table 49: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k11	k11		40.0	$(3600\ \text{s})^{-1}$	☑

7.12 Reaction R12

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

Name Effector-GaGTP association

Reaction equation

$$\text{Effector} + \text{GaGTP} \xrightarrow{\text{Effector, GaGTP}} \text{GaGTPEffector} \tag{25}$$

Reactants

Table 50: Properties of each reactant.

Id	Name	SBO
Effector	Effector	
GaGTP	GaGTP	

Modifiers

Table 51: Properties of each modifier.

Id	Name	SBO
`Effector`	Effector	
`GaGTP`	GaGTP	

Product

Table 52: Properties of each product.

Id	Name	SBO
`GaGTPEffector`	GaGTPEffector	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{12} = \text{vol}\,(\text{compartment}) \cdot [\text{Effector}] \cdot [\text{GaGTP}] \cdot \text{k12} \tag{26}$$

Table 53: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k12	k12		10.0	$\text{nmol}^{-1} \cdot \text{l} \cdot (3600\ \text{s})^{-1}$	☑

7.13 Reaction `R13`

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

Name RGS in cytosol moves to membrane

Reaction equation

$$\text{RGSc} \xrightarrow{\text{RGSc}} \text{RGSm} \tag{27}$$

Reactant

Table 54: Properties of each reactant.

Id	Name	SBO
`RGSc`	RGSc	

Id	Name	SBO

Modifier

Table 55: Properties of each modifier.

Id	Name	SBO
RGSc	RGSc	

Product

Table 56: Properties of each product.

Id	Name	SBO
RGSm	RGSm	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{13} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RGSc}] \cdot \mathrm{k13} \tag{28}$$

Table 57: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k13	k13		$5 \cdot 10^{-4}$	$(3600\ \mathrm{s})^{-1}$	☑

7.14 Reaction R14

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

Name RGS in membrane moves to cytosol

Reaction equation

$$\mathrm{RGSm} \xrightarrow{\mathrm{RGSm}} \mathrm{RGSc} \tag{29}$$

Reactant

Table 58: Properties of each reactant.

Id	Name	SBO
RGSm	RGSm	

Modifier

Table 59: Properties of each modifier.

Id	Name	SBO
RGSm	RGSm	

Product

Table 60: Properties of each product.

Id	Name	SBO
RGSc	RGSc	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{14} = \mathrm{vol}(\mathrm{compartment}) \cdot [\mathrm{RGSm}] \cdot \mathrm{k14} \tag{30}$$

Table 61: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k14	k14		0.005	$(3600\ \mathrm{s})^{-1}$	☑

7.15 Reaction R15

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

Name Receptor recruits RGSc to membrane

Reaction equation

$$\mathrm{R} + \mathrm{RGSc} \xrightarrow{\mathrm{R,\ RGSc}} \mathrm{RRGSm} \tag{31}$$

Reactants

Table 62: Properties of each reactant.

Id	Name	SBO
R	R	
RGSc	RGSc	

Modifiers

Table 63: Properties of each modifier.

Id	Name	SBO
R	R	
RGSc	RGSc	

Product

Table 64: Properties of each product.

Id	Name	SBO
RRGSm	RRGSm	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{15} = \text{vol}\,(\text{compartment}) \cdot [\text{R}] \cdot [\text{RGSc}] \cdot \text{k15} \tag{32}$$

Table 65: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k15	k15		0.1	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.16 Reaction R16

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

Name R-RGSm dissociation

Reaction equation

$$\mathrm{RRGSm} \xrightarrow{\mathrm{RRGSm}} \mathrm{R} + \mathrm{RGSm} \tag{33}$$

Reactant

Table 66: Properties of each reactant.

Id	Name	SBO
RRGSm	RRGSm	

Modifier

Table 67: Properties of each modifier.

Id	Name	SBO
RRGSm	RRGSm	

Products

Table 68: Properties of each product.

Id	Name	SBO
R	R	
RGSm	RGSm	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{16} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RRGSm}] \cdot \mathrm{k16} \tag{34}$$

Table 69: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k16	k16		100.0	$(3600\ \mathrm{s})^{-1}$	☑

7.17 Reaction R17

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

Name LR recruits RGSc to membrane

Reaction equation

$$\mathrm{LR} + \mathrm{RGSc} \xrightarrow{\mathrm{LR,\ RGSc}} \mathrm{LRRGSm} \tag{35}$$

Reactants

Table 70: Properties of each reactant.

Id	Name	SBO
LR	LR	
RGSc	RGSc	

Modifiers

Table 71: Properties of each modifier.

Id	Name	SBO
LR	LR	
RGSc	RGSc	

Product

Table 72: Properties of each product.

Id	Name	SBO
LRRGSm	LRRGSm	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{17} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{LR}] \cdot [\mathrm{RGSc}] \cdot \mathrm{k17} \tag{36}$$

Table 73: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k17	k17		0.1	$\mathrm{nmol}^{-1} \cdot \mathrm{l} \cdot (3600\ \mathrm{s})^{-1}$	☑

7.18 Reaction R18

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

Name LR-RGSm dissociation

Reaction equation

$$\mathrm{LRRGSm} \xrightarrow{\mathrm{LRRGSm}} \mathrm{LR} + \mathrm{RGSm} \tag{37}$$

Reactant

Table 74: Properties of each reactant.

Id	Name	SBO
LRRGSm	LRRGSm	

Modifier

Table 75: Properties of each modifier.

Id	Name	SBO
LRRGSm	LRRGSm	

Products

Table 76: Properties of each product.

Id	Name	SBO
LR	LR	
RGSm	RGSm	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{18} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{LRRGSm}] \cdot \mathrm{k18} \tag{38}$$

Table 77: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k18	k18		100.0	$(3600\ \mathrm{s})^{-1}$	☑

7.19 Reaction R19

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

Name RGabg recruits RGSc to membrane

Reaction equation

$$\mathrm{RGabg} + \mathrm{RGSc} \xrightarrow{\mathrm{RGabg,\ RGSc}} \mathrm{RRGSmGabg} \tag{39}$$

Reactants

Table 78: Properties of each reactant.

Id	Name	SBO
RGabg	RGabg	
RGSc	RGSc	

Modifiers

Table 79: Properties of each modifier.

Id	Name	SBO
RGabg	RGabg	
RGSc	RGSc	

Product

Table 80: Properties of each product.

Id	Name	SBO
RRGSmGabg	RRGSmGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{19} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RGabg}] \cdot [\mathrm{RGSc}] \cdot \mathrm{k19} \tag{40}$$

Table 81: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k19	k19		0.1	$\mathrm{nmol}^{-1} \cdot 1 \cdot (3600\ \mathrm{s})^{-1}$	☑

7.20 Reaction R20

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

Name RRGSmGabg dissociation

Reaction equation

$$\mathrm{RRGSmGabg} \xrightarrow{\mathrm{RRGSmGabg}} \mathrm{RGabg} + \mathrm{RGSm} \tag{41}$$

Reactant

Table 82: Properties of each reactant.

Id	Name	SBO
RRGSmGabg	RRGSmGabg	

Modifier

Table 83: Properties of each modifier.

Id	Name	SBO
RRGSmGabg	RRGSmGabg	

Products

Table 84: Properties of each product.

Id	Name	SBO
RGabg	RGabg	
RGSm	RGSm	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{20} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RRGSmGabg}] \cdot \mathrm{k20} \tag{42}$$

Table 85: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k20	k20		0.1	$(3600\ \mathrm{s})^{-1}$	☑

7.21 Reaction R21

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

Name LRGabg recruits RGSc to membrane

Reaction equation

$$\mathrm{LRGabg} + \mathrm{RGSc} \xrightarrow{\text{LRGabg, RGSc}} \mathrm{LRRGSmGabg} \tag{43}$$

Reactants

Table 86: Properties of each reactant.

Id	Name	SBO
LRGabg	LRGabg	
RGSc	RGSc	

Modifiers

Table 87: Properties of each modifier.

Id	Name	SBO
LRGabg	LRGabg	

Id	Name	SBO
RGSc	RGSc	

Product

Table 88: Properties of each product.

Id	Name	SBO
LRRGSmGabg	LRRGSmGabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{21} = \text{vol}\,(\text{compartment}) \cdot [\text{LRGabg}] \cdot [\text{RGSc}] \cdot \text{k21} \tag{44}$$

Table 89: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k21	k21		0.1	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.22 Reaction R22

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

Name GaGTP recruits RGSc to membrane

Reaction equation

$$\text{GaGTP} + \text{RGSc} \xrightarrow{\text{GaGTP, RGSc}} \text{RGSmGaGTP} \tag{45}$$

Reactants

Table 90: Properties of each reactant.

Id	Name	SBO
GaGTP	GaGTP	
RGSc	RGSc	

Modifiers

Table 91: Properties of each modifier.

Id	Name	SBO
GaGTP	GaGTP	
RGSc	RGSc	

Product

Table 92: Properties of each product.

Id	Name	SBO
RGSmGaGTP	RGSmGaGTP	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{22} = \text{vol}\,(\text{compartment}) \cdot [\text{GaGTP}] \cdot [\text{RGSc}] \cdot \text{k22} \tag{46}$$

Table 93: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k22	k22		60.0	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.23 Reaction R23

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

Name RGSmGaGTP dissociation

Reaction equation

$$\text{RGSmGaGTP} \xrightarrow{\text{RGSmGaGTP}} \text{GaGTP} + \text{RGSc} \tag{47}$$

Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
RGSmGaGTP	RGSmGaGTP	

Modifier

Table 95: Properties of each modifier.

Id	Name	SBO
RGSmGaGTP	RGSmGaGTP	

Products

Table 96: Properties of each product.

Id	Name	SBO
GaGTP	GaGTP	
RGSc	RGSc	

Kinetic Law

Derived unit $1^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{23} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RGSmGaGTP}] \cdot \mathrm{k23} \tag{48}$$

Table 97: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k23	k23		0.05	$(3600\ \mathrm{s})^{-1}$	☑

7.24 Reaction R24

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

Name GaGTPEffectorOFF recruits RGS from cytosol

Reaction equation

$$\mathrm{GaGTPEffectorOFF} + \mathrm{RGSc} \xrightarrow{\mathrm{GaGTPEffectorOFF,\ RGSc}} \mathrm{RGSmGaGTPEffectorOFF} \tag{49}$$

Reactants

Table 98: Properties of each reactant.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	
RGSc	RGSc	

Modifiers

Table 99: Properties of each modifier.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	
RGSc	RGSc	

Product

Table 100: Properties of each product.

Id	Name	SBO
RGSmGaGTPEffectorOFF	RGSmGaGTPEffectorOFF	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{24} = \text{vol}\,(\text{compartment}) \cdot [\text{GaGTPEffectorOFF}] \cdot [\text{RGSc}] \cdot \text{k24} \tag{50}$$

Table 101: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k24	k24		10^{-4}	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.25 Reaction R25

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

Name Effector turns off

Reaction equation

$$\text{GaGTPEffector} \xrightarrow{\text{GaGTPEffector}} \text{GaGTPEffectorOFF} \tag{51}$$

Reactant

Table 102: Properties of each reactant.

Id	Name	SBO
GaGTPEffector	GaGTPEffector	

Modifier

Table 103: Properties of each modifier.

Id	Name	SBO
GaGTPEffector	GaGTPEffector	

Product

Table 104: Properties of each product.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{25} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{GaGTPEffector}] \cdot \mathrm{k25} \tag{52}$$

Table 105: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k25	k25		1.0	$(3600\ \mathrm{s})^{-1}$	☑

7.26 Reaction R26

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

Name GaGTP hydrolyzes GTP

Reaction equation

$$\text{GaGTP} \xrightarrow{\text{GaGTP}} \text{GaGDPP} \tag{53}$$

Reactant

Table 106: Properties of each reactant.

Id	Name	SBO
GaGTP	GaGTP	

Modifier

Table 107: Properties of each modifier.

Id	Name	SBO
GaGTP	GaGTP	

Product

Table 108: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{26} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{GaGTP}] \cdot \mathrm{k26} \tag{54}$$

Table 109: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k26	k26		0.005	$(3600\ \mathrm{s})^{-1}$	☑

7.27 Reaction R27

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

Name GaGTP-RGSm association

Reaction equation

$$\mathrm{GaGTP} + \mathrm{RGSm} \xrightarrow{\mathrm{GaGTP,\ RGSm}} \mathrm{RGSmGaGTP} \tag{55}$$

Reactants

Table 110: Properties of each reactant.

Id	Name	SBO
GaGTP	GaGTP	
RGSm	RGSm	

Modifiers

Table 111: Properties of each modifier.

Id	Name	SBO
GaGTP	GaGTP	
RGSm	RGSm	

Product

Table 112: Properties of each product.

Id	Name	SBO
RGSmGaGTP	RGSmGaGTP	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{27} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{GaGTP}] \cdot [\mathrm{RGSm}] \cdot \mathrm{k27} \tag{56}$$

Table 113: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k27	k27		500.0	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.28 Reaction R28

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

Name RGSmGaGTP hydrolyzes GTP

Reaction equation

$$\text{RGSmGaGTP} \xrightarrow{\text{RGSmGaGTP}} \text{GaGDPP} + \text{RGSc} \tag{57}$$

Reactant

Table 114: Properties of each reactant.

Id	Name	SBO
RGSmGaGTP	RGSmGaGTP	

Modifier

Table 115: Properties of each modifier.

Id	Name	SBO
RGSmGaGTP	RGSmGaGTP	

Products

Table 116: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	
RGSc	RGSc	

Kinetic Law

Derived unit $\text{l}^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{28} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RGSmGaGTP}] \cdot \mathrm{k28} \tag{58}$$

Table 117: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k28	k28		2.5	$(3600\ \mathrm{s})^{-1}$	☑

7.29 Reaction R29

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

Name GaGTP-LRRGSm association

Reaction equation

$$\mathrm{GaGTP} + \mathrm{LRRGSm} \xrightarrow{\mathrm{GaGTP,\ LRRGSm}} \mathrm{LRRGSmGaGTP} \tag{59}$$

Reactants

Table 118: Properties of each reactant.

Id	Name	SBO
GaGTP	GaGTP	
LRRGSm	LRRGSm	

Modifiers

Table 119: Properties of each modifier.

Id	Name	SBO
GaGTP	GaGTP	
LRRGSm	LRRGSm	

Product

Table 120: Properties of each product.

Id	Name	SBO
LRRGSmGaGTP	LRRGSmGaGTP	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{29} = \text{vol}(\text{compartment}) \cdot [\text{GaGTP}] \cdot [\text{LRRGSm}] \cdot \text{k29} \tag{60}$$

Table 121: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k29	k29		100.0	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.30 Reaction R30

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

Name LRRGSmGaGTP hydrolyzes GTP

Reaction equation

$$\text{LRRGSmGaGTP} \xrightarrow{\text{LRRGSmGaGTP}} \text{GaGDPP} + \text{LRRGSm} \tag{61}$$

Reactant

Table 122: Properties of each reactant.

Id	Name	SBO
LRRGSmGaGTP	LRRGSmGaGTP	

Modifier

Table 123: Properties of each modifier.

Id	Name	SBO
LRRGSmGaGTP	LRRGSmGaGTP	

Products

Table 124: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	
LRRGSm	LRRGSm	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{30} = \text{vol}(\text{compartment}) \cdot [\text{LRRGSmGaGTP}] \cdot \text{k30} \tag{62}$$

Table 125: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k30	k30		2.5	$(3600\ \text{s})^{-1}$	☑

7.31 Reaction R31

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

Name GaGTP-RRGSm association

Reaction equation

$$\text{GaGTP} + \text{RRGSm} \xrightarrow{\text{GaGTP, RRGSm}} \text{RRGSmGaGTP} \tag{63}$$

Reactants

Table 126: Properties of each reactant.

Id	Name	SBO
GaGTP	GaGTP	
RRGSm	RRGSm	

Modifiers

Table 127: Properties of each modifier.

Id	Name	SBO
GaGTP	GaGTP	

Id	Name	SBO
RRGSm	RRGSm	

Product

Table 128: Properties of each product.

Id	Name	SBO
RRGSmGaGTP	RRGSmGaGTP	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{31} = \text{vol}(\text{compartment}) \cdot [\text{GaGTP}] \cdot [\text{RRGSm}] \cdot \text{k31} \tag{64}$$

Table 129: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k31	k31		0.5	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.32 Reaction R32

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

Name RRGSmGaGTP hydrolyzes GTP

Reaction equation

$$\text{RRGSmGaGTP} \xrightarrow{\text{RRGSmGaGTP}} \text{GaGDPP} + \text{RRGSm} \tag{65}$$

Reactant

Table 130: Properties of each reactant.

Id	Name	SBO
RRGSmGaGTP	RRGSmGaGTP	

Modifier

Table 131: Properties of each modifier.

Id	Name	SBO
RRGSmGaGTP	RRGSmGaGTP	

Products

Table 132: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	
RRGSm	RRGSm	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{32} = \text{vol}(\text{compartment}) \cdot [\text{RRGSmGaGTP}] \cdot \text{k32} \tag{66}$$

Table 133: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k32	k32		0.5	$(3600\ \text{s})^{-1}$	☑

7.33 Reaction R33

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

Name GaGTPEffectorOFF hydrolyzes GTP

Reaction equation

$$\text{GaGTPEffectorOFF} \xrightarrow{\text{GaGTPEffectorOFF}} \text{GaGDPP} + \text{Effector} \tag{67}$$

Reactant

Table 134: Properties of each reactant.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	

Modifier

Table 135: Properties of each modifier.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	

Products

Table 136: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	
Effector	Effector	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{33} = \text{vol}(\text{compartment}) \cdot [\text{GaGTPEffectorOFF}] \cdot \text{k33} \tag{68}$$

Table 137: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k33	k33		0.005	$(3600\ \text{s})^{-1}$	☑

7.34 Reaction R34

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

Name GaGTPEffectorOFF-RGSm association

Reaction equation

$$\text{GaGTPEffectorOFF} + \text{RGSm} \xrightarrow{\text{GaGTPEffectorOFF, RGSm}} \text{RGSmGaGTPEffectorOFF} \tag{69}$$

Reactants

Table 138: Properties of each reactant.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	
RGSm	RGSm	

Modifiers

Table 139: Properties of each modifier.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	
RGSm	RGSm	

Product

Table 140: Properties of each product.

Id	Name	SBO
RGSmGaGTPEffectorOFF	RGSmGaGTPEffectorOFF	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{34} = \text{vol}\,(\text{compartment}) \cdot [\text{GaGTPEffectorOFF}] \cdot [\text{RGSm}] \cdot \text{k34} \tag{70}$$

Table 141: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k34	k34		50.0	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.35 Reaction R35

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

Name RGSmGaGTPEffectorOFF hydrolyzes GTP

Reaction equation

$$\text{RGSmGaGTPEffectorOFF} \xrightarrow{\text{RGSmGaGTPEffectorOFF}} \text{GaGDPP} + \text{RGSc} + \text{Effector} \qquad (71)$$

Reactant

Table 142: Properties of each reactant.

Id	Name	SBO
RGSmGaGTPEffectorOFF	RGSmGaGTPEffectorOFF	

Modifier

Table 143: Properties of each modifier.

Id	Name	SBO
RGSmGaGTPEffectorOFF	RGSmGaGTPEffectorOFF	

Products

Table 144: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	
RGSc	RGSc	
Effector	Effector	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{35} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{RGSmGaGTPEffectorOFF}] \cdot \mathrm{k35} \qquad (72)$$

Table 145: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k35	k35		0.3	$(3600\ \mathrm{s})^{-1}$	☑

7.36 Reaction R36

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

Name GaGTPEffectorOFF-LRRGSm association

Reaction equation

$$\text{GaGTPEffectorOFF} + \text{LRRGSm} \xrightarrow{\text{GaGTPEffectorOFF, LRRGSm}} \text{LRRGSmGaGTPEffectorOFF} \tag{73}$$

Reactants

Table 146: Properties of each reactant.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	
LRRGSm	LRRGSm	

Modifiers

Table 147: Properties of each modifier.

Id	Name	SBO
GaGTPEffectorOFF	GaGTPEffectorOFF	
LRRGSm	LRRGSm	

Product

Table 148: Properties of each product.

Id	Name	SBO
LRRGSmGaGTPEffectorOFF	LRRGSmGaGTPEffectorOFF	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{36} = \text{vol}(\text{compartment}) \cdot [\text{GaGTPEffectorOFF}] \cdot [\text{LRRGSm}] \cdot \text{k36} \tag{74}$$

Table 149: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k36	k36		50.0	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.37 Reaction R37

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

Name LRRGSmGaGTPEffectorOFF hydrolyzes GTP

Reaction equation

$$\text{LRRGSmGaGTPEffectorOFF} \xrightarrow{\text{LRRGSmGaGTPEffectorOFF}} \text{GaGDPP} + \text{LRRGSm} + \text{Effector} \tag{75}$$

Reactant

Table 150: Properties of each reactant.

Id	Name	SBO
LRRGSmGaGTPEffectorOFF	LRRGSmGaGTPEffectorOFF	

Modifier

Table 151: Properties of each modifier.

Id	Name	SBO
LRRGSmGaGTPEffectorOFF	LRRGSmGaGTPEffectorOFF	

Products

Table 152: Properties of each product.

Id	Name	SBO
GaGDPP	GaGDPP	
LRRGSm	LRRGSm	
Effector	Effector	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{37} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{LRRGSmGaGTPEffectorOFF}] \cdot \mathrm{k37} \tag{76}$$

Table 153: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k37	k37		0.3	$(3600\ \mathrm{s})^{-1}$	☑

7.38 Reaction R38

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

Name Phosphate release

Reaction equation

$$\mathrm{GaGDPP} \xrightarrow{\mathrm{GaGDPP}} \mathrm{GaGDP} + \mathrm{P} \tag{77}$$

Reactant

Table 154: Properties of each reactant.

Id	Name	SBO
GaGDPP	GaGDPP	

Modifier

Table 155: Properties of each modifier.

Id	Name	SBO
GaGDPP	GaGDPP	

Products

Table 156: Properties of each product.

Id	Name	SBO
GaGDP	GaGDP	
P	P	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{38} = \text{vol}(\text{compartment}) \cdot [\text{GaGDPP}] \cdot \text{k38} \tag{78}$$

Table 157: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k38	k38		1000.0	$(3600\ \text{s})^{-1}$	☑

7.39 Reaction R39

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

Name Gprotein subunits association

Reaction equation

$$\text{GaGDP} + \text{Gbg} \xrightarrow{\text{GaGDP, Gbg}} \text{Gabg} \tag{79}$$

Reactants

Table 158: Properties of each reactant.

Id	Name	SBO
GaGDP	GaGDP	
Gbg	Gbg	

Modifiers

Table 159: Properties of each modifier.

Id	Name	SBO
GaGDP	GaGDP	

Id	Name	SBO
Gbg	Gbg	

Product

Table 160: Properties of each product.

Id	Name	SBO
Gabg	Gabg	

Kinetic Law

Derived unit $1^{-2} \cdot 9.999999999999998 \cdot 10^{-10}\ \text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_{39} = \text{vol}\,(\text{compartment}) \cdot [\text{GaGDP}] \cdot [\text{Gbg}] \cdot \text{k39} \tag{80}$$

Table 161: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k39	k39		1000.0	$\text{nmol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$	☑

7.40 Reaction R40

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

Name Phosphate degradation

Reaction equation

$$\text{P} \xrightarrow{\text{P}} \emptyset \tag{81}$$

Reactant

Table 162: Properties of each reactant.

Id	Name	SBO
P	P	

Modifier

Table 163: Properties of each modifier.

Id	Name	SBO
P	P	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{40} = \text{vol}\,(\text{compartment}) \cdot [\text{P}] \cdot \text{k40} \tag{82}$$

Table 164: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k40	k40		10.0	$(3600\ \text{s})^{-1}$	☑

7.41 Reaction R41

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

Name Delay 1

Reaction equation

$$\emptyset \xrightarrow{\text{GaGTPEffector, GaGTPEffector}} \text{z1} \tag{83}$$

Modifiers

Table 165: Properties of each modifier.

Id	Name	SBO
GaGTPEffector	GaGTPEffector	
GaGTPEffector	GaGTPEffector	

Product

Table 166: Properties of each product.

Id	Name	SBO
z1	z1	

Kinetic Law

Derived unit $1^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{41} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{GaGTPEffector}] \cdot \mathrm{ka} \tag{84}$$

7.42 Reaction R42

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

Name Delay 2

Reaction equation

$$\mathrm{z1} \xrightarrow{\mathrm{z1}} \mathrm{z2} \tag{85}$$

Reactant

Table 167: Properties of each reactant.

Id	Name	SBO
z1	z1	

Modifier

Table 168: Properties of each modifier.

Id	Name	SBO
z1	z1	

Product

Table 169: Properties of each product.

Id	Name	SBO
z2	z2	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{42} = \text{vol}\,(\text{compartment}) \cdot [\text{z1}] \cdot \text{ka} \tag{86}$$

7.43 Reaction R43

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

Name Delay 3

Reaction equation

$$\text{z2} \xrightarrow{\text{z2}} \text{z3} \tag{87}$$

Reactant

Table 170: Properties of each reactant.

Id	Name	SBO
z2	z2	

Modifier

Table 171: Properties of each modifier.

Id	Name	SBO
z2	z2	

Product

Table 172: Properties of each product.

Id	Name	SBO
z3	z3	

Kinetic Law

Derived unit $1^{-1} \cdot \text{nmol} \cdot (3600\ \text{s})^{-1}$

$$v_{43} = \text{vol}\,(\text{compartment}) \cdot [\text{z2}] \cdot \text{ka} \tag{88}$$

7.44 Reaction R44

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

Name Final output

Reaction equation

$$\mathrm{z3} \xrightarrow{\mathrm{z3}} \emptyset \tag{89}$$

Reactant

Table 173: Properties of each reactant.

Id	Name	SBO
z3	z3	

Modifier

Table 174: Properties of each modifier.

Id	Name	SBO
z3	z3	

Kinetic Law

Derived unit $\mathrm{l}^{-1} \cdot \mathrm{nmol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{44} = \mathrm{vol}\,(\mathrm{compartment}) \cdot [\mathrm{z3}] \cdot \mathrm{ka} \tag{90}$$

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 L

Name L

SBO:0000280 ligand

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

Involved in event Ligand_addition

This species takes part in eight reactions (as a reactant in R1, R4, R5, R8 and as a modifier in R1, R4, R5, R8).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{L} = -\ v_1 - v_4 - v_5 - v_8 \tag{91}$$

Furthermore, one event influences this species' rate of change.

8.2 Species R

Name R

SBO:0000244 receptor

Initial concentration $205\ \mathrm{nmol}\cdot\mathrm{l}^{-1}\cdot\mathrm{l}^{-1}$

This species takes part in seven reactions (as a reactant in R1, R2, R15 and as a product in R16 and as a modifier in R1, R2, R15).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R} = v_{16} - v_1 - v_2 - v_{15} \tag{92}$$

8.3 Species LR

Name LR

SBO:0000296 macromolecular complex

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

This species takes part in seven reactions (as a reactant in R3, R17 and as a product in R1, R9, R18 and as a modifier in R3, R17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{LR} = v_1 + v_9 + v_{18} - v_3 - v_{17} \tag{93}$$

8.4 Species Gabg

Name Gabg

SBO:0000297 protein complex

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

This species takes part in eleven reactions (as a reactant in R2, R3, R6, R7, R10 and as a product in R39 and as a modifier in R2, R3, R6, R7, R10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gabg} = v_{39} - v_2 - v_3 - v_6 - v_7 - v_{10} \tag{94}$$

8.5 Species RGabg

Name RGabg

SBO:0000297 protein complex

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

This species takes part in six reactions (as a reactant in R4, R19 and as a product in R2, R20 and as a modifier in R4, R19).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGabg} = v_2 + v_{20} - v_4 - v_{19} \tag{95}$$

8.6 Species LRGabg

Name LRGabg

SBO:0000296 macromolecular complex

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

This species takes part in six reactions (as a reactant in R9, R21 and as a product in R3, R4 and as a modifier in R9, R21).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{LRGabg} = v_3 + v_4 - v_9 - v_{21} \tag{96}$$

8.7 Species RRGSm

Name RRGSm

SBO:0000297 protein complex

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

This species takes part in ten reactions (as a reactant in R5, R6, R16, R31 and as a product in R15, R32 and as a modifier in R5, R6, R16, R31).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RRGSm} = v_{15} + v_{32} - v_5 - v_6 - v_{16} - v_{31} \tag{97}$$

8.8 Species LRRGSm

Name LRRGSm

SBO:0000296 macromolecular complex

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

This species takes part in 13 reactions (as a reactant in R7, R18, R29, R36 and as a product in R5, R11, R17, R30, R37 and as a modifier in R7, R18, R29, R36).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{LRRGSm} = v_5 + v_{11} + v_{17} + v_{30} + v_{37} - v_7 - v_{18} - v_{29} - v_{36} \tag{98}$$

8.9 Species RRGSmGabg

Name RRGSmGabg

SBO:0000297 protein complex

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

This species takes part in six reactions (as a reactant in R8, R20 and as a product in R6, R19 and as a modifier in R8, R20).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RRGSmGabg} = v_6 + v_{19} - v_8 - v_{20} \tag{99}$$

8.10 Species LRRGSmGabg

Name LRRGSmGabg

SBO:0000296 macromolecular complex

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

This species takes part in five reactions (as a reactant in R11 and as a product in R7, R8, R21 and as a modifier in R11).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{LRRGSmGabg} = v_7 + v_8 + v_{21} - v_{11} \tag{100}$$

8.11 Species GaGTP

Name GaGTP

SBO:0000296 macromolecular complex

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

This species takes part in 16 reactions (as a reactant in R12, R22, R26, R27, R29, R31 and as a product in R9, R10, R11, R23 and as a modifier in R12, R22, R26, R27, R29, R31).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGTP} = v_9 + v_{10} + v_{11} + v_{23} - v_{12} - v_{22} - v_{26} - v_{27} - v_{29} - v_{31} \tag{101}$$

8.12 Species Gbg

Name Gbg

SBO:0000297 protein complex

Initial concentration $205\ \mathrm{nmol} \cdot 1^{-1} \cdot 1^{-1}$

This species takes part in five reactions (as a reactant in R39 and as a product in R9, R10, R11 and as a modifier in R39).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gbg} = v_9 + v_{10} + v_{11} - v_{39} \tag{102}$$

8.13 Species Effector

Name Effector

Initial concentration $305\ \mathrm{nmol} \cdot 1^{-1} \cdot 1^{-1}$

This species takes part in five reactions (as a reactant in R12 and as a product in R33, R35, R37 and as a modifier in R12).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Effector} = v_{33} + v_{35} + v_{37} - v_{12} \tag{103}$$

8.14 Species GaGTPEffector

Name GaGTPEffector

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

This species takes part in five reactions (as a reactant in R25 and as a product in R12 and as a modifier in R25, R41, R41).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGTPEffector} = v_{12} - v_{25} \tag{104}$$

8.15 Species RGSc

Name RGSc

SBO:0000252 polypeptide chain

Initial concentration $60\ \mathrm{nmol} \cdot 1^{-1} \cdot 1^{-1}$

This species takes part in 18 reactions (as a reactant in R13, R15, R17, R19, R21, R22, R24 and as a product in R14, R23, R28, R35 and as a modifier in R13, R15, R17, R19, R21, R22, R24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGSc} = v_{14} + v_{23} + v_{28} + v_{35} - v_{13} - v_{15} - v_{17} - v_{19} - v_{21} - v_{22} - v_{24} \tag{105}$$

8.16 Species RGSm

Name RGSm

SBO:0000252 polypeptide chain

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

This species takes part in ten reactions (as a reactant in R14, R27, R34 and as a product in R13, R16, R18, R20 and as a modifier in R14, R27, R34).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGSm} = v_{13} + v_{16} + v_{18} + v_{20} - v_{14} - v_{27} - v_{34} \tag{106}$$

8.17 Species RGSmGaGTP

Name RGSmGaGTP

SBO:0000296 macromolecular complex

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

This species takes part in six reactions (as a reactant in R23, R28 and as a product in R22, R27 and as a modifier in R23, R28).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGSmGaGTP} = v_{22} + v_{27} - v_{23} - v_{28} \tag{107}$$

8.18 Species GaGTPEffectorOFF

Name GaGTPEffectorOFF

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

This species takes part in nine reactions (as a reactant in R24, R33, R34, R36 and as a product in R25 and as a modifier in R24, R33, R34, R36).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGTPEffectorOFF} = v_{25} - v_{24} - v_{33} - v_{34} - v_{36} \tag{108}$$

8.19 Species RGSmGaGTPEffectorOFF

Name RGSmGaGTPEffectorOFF

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

This species takes part in four reactions (as a reactant in R35 and as a product in R24, R34 and as a modifier in R35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGSmGaGTPEffectorOFF} = v_{24} + v_{34} - v_{35} \tag{109}$$

8.20 Species GaGDPP

Name GaGDPP

SBO:0000296 macromolecular complex

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

This species takes part in nine reactions (as a reactant in R38 and as a product in R26, R28, R30, R32, R33, R35, R37 and as a modifier in R38).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGDPP} = v_{26} + v_{28} + v_{30} + v_{32} + v_{33} + v_{35} + v_{37} - v_{38} \tag{110}$$

8.21 Species LRRGSmGaGTP

Name LRRGSmGaGTP

SBO:0000296 macromolecular complex

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

This species takes part in three reactions (as a reactant in R30 and as a product in R29 and as a modifier in R30).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{LRRGSmGaGTP} = v_{29} - v_{30} \tag{111}$$

8.22 Species RRGSmGaGTP

Name RRGSmGaGTP

SBO:0000296 macromolecular complex

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

This species takes part in three reactions (as a reactant in R32 and as a product in R31 and as a modifier in R32).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RRGSmGaGTP} = v_{31} - v_{32} \tag{112}$$

8.23 Species LRRGSmGaGTPEffectorOFF

Name LRRGSmGaGTPEffectorOFF

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

This species takes part in three reactions (as a reactant in R37 and as a product in R36 and as a modifier in R37).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{LRRGSmGaGTPEffectorOFF} = v_{36} - v_{37} \tag{113}$$

8.24 Species GaGDP

Name GaGDP

SBO:0000296 macromolecular complex

Initial concentration $205\ \mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in R39 and as a product in R38 and as a modifier in R39).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{GaGDP} = v_{38} - v_{39} \tag{114}$$

8.25 Species P

Name P

SBO:0000247 simple chemical

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

This species takes part in three reactions (as a reactant in R40 and as a product in R38 and as a modifier in R40).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{P} = v_{38} - v_{40} \tag{115}$$

8.26 Species z1

Name z1

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

This species takes part in three reactions (as a reactant in R42 and as a product in R41 and as a modifier in R42).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{z1} = v_{41} - v_{42} \tag{116}$$

8.27 Species z2

Name z2

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

This species takes part in three reactions (as a reactant in R43 and as a product in R42 and as a modifier in R43).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{z2} = v_{42} - v_{43} \tag{117}$$

8.28 Species z3

Name z3

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

This species takes part in three reactions (as a reactant in R44 and as a product in R43 and as a modifier in R44).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{z3} = v_{43} - v_{44} \tag{118}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000244 receptor: Participating entity that binds to a specific physical entity and initiates the response to that physical entity.The original concept of the receptor was introduced independently at the end of the 19th century by John Newport Langley (1852-1925) and Paul Ehrlich (1854-1915). Langley JN.On the reaction of cells and of nerve-endings to certain poisons, chiefly as regards the reaction of striated muscle to nicotine and to curari. J Physiol. 1905 Dec 30;33(4-5):374-413

SBO:0000247 simple chemical: Simple, non-repetitive chemical entity

SBO:0000252 polypeptide chain: Naturally occurring macromolecule formed by the repetition of amino-acid residues linked by peptidic bonds. A polypeptide chain is synthesized by the ribosome. CHEBI:1654

SBO:0000280 ligand: In biochemistry, a ligand is an effector, a physical entity that binds to a site on a receptor's surface by intermolecular forces

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

SBO:0000296 macromolecular complex: Non-covalent complex of one or more macromolecules and zero or more simple chemicals

SBO:0000297 protein complex: Macromolecular complex containing one or more polypeptide chains possibly associated with simple chemicals. CHEBI:3608

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