**SBML Model Report**

# Model name: "DellOrco2009_phototransduction"

May 6, 2016

## 1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Daniele Dell'Orco[2] at April first 2011 at 12:40 a. m. and last time modified at April first 2014 at 10:23 p. m. Table 1 shows 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 | 71 |
| events | 0 | constraints | 0 |
| reactions | 91 | function definitions | 0 |
| global parameters | 96 | unit definitions | 0 |
| rules | 33 | initial assignments | 0 |

### Model Notes

This a model from the article:
**Network-level analysis of light adaptation in rod cells under normal and altered conditions.** Dell'Orco D, Schmidt H, Mariani S, Fanelli F Mol Biosyst2009 Oct; 5(10):1232-46 19756313,
**Abstract:**

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Photoreceptor cells finely adjust their sensitivity and electrical response according to changes in light stimuli as a direct consequence of the feedback and regulation mechanisms in the phototransduction cascade. In this study, we employed a systems biology approach to develop a dynamic model of vertebrate rod phototransduction that accounts for the details of the underlying biochemistry. Following a bottom-up strategy, we first reproduced the results of a robust model developed by Hamer et al. (Vis. Neurosci., 2005, 22(4), 417), and then added a number of additional cascade reactions including: (a) explicit reactions to simulate the interaction between the activated effector and the regulator of G-protein signalling (RGS); (b) a reaction for the reformation of the G-protein from separate subunits; (c) a reaction for rhodopsin (R) reconstitution from the association of the opsin apoprotein with the 11-cis-retinal chromophore; (d) reactions for the slow activation of the cascade by opsin. The extended network structure successfully reproduced a number of experimental conditions that were inaccessible to prior models. With a single set of parameters the model was able to predict qualitative and quantitative features of rod photoresponses to light stimuli ranging over five orders of magnitude, in normal and altered conditions, including genetic manipulations of the cascade components. In particular, the model reproduced the salient dynamic features of the rod from Rpe65(-/-) animals, a well established model for Leber congenital amaurosis and vitamin A deficiency. The results of this study suggest that a systems-level approach can help to unravel the adaptation mechanisms in normal and in disease-associated conditions on a molecular basis.

**Note:**

Figure 7 of the reference is reproduced here. Each plot is obtained by increasing flash strength. More details about generating the plots can be obtained from the comments in the curation figure (go to curation tab).

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To cite BioModels Database, please use: Li C, Donizelli M, Rodriguez N, Dharuri H, Endler L, Chelliah V, Li L, He E, Henry A, Stefan MI, Snoep JL, Hucka M, Le Novre N, Laibe C (2010) BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models. BMC Syst Biol., 4:92.

## 2 Unit Definitions

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

### 2.1 Unit `substance`

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

**Definition** mol

### 2.2 Unit volume

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

**Definition** l

### 2.3 Unit area

**Notes** Square metre is the predefined SBML unit for area since SBML Level 2 Version 1.

**Definition** $m^2$

### 2.4 Unit length

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

**Definition** m

### 2.5 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 |
|---|---|---|---|---|---|---|---|
| cytosol | cytosol | 0000290 | 3 | 1 | litre | ☑ | |

### 3.1 Compartment cytosol

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

**Name** cytosol

**SBO:0000290** physical compartment

## 4 Species

This model contains 71 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 |
|---|---|---|---|---|---|
| Arr | Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ca2_buff | Ca2_buff | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ca2_free | Ca2_free | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| G_GTP | G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ga_GDP | Ga_GDP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ga_GTP | Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ga_GTP_PDE_a_Ga_GTP | Ga_GTP_PDE_a_Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ga_GTP_a_PDE_a_Ga_GTP | Ga_GTP_a_PDE_a_Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Gbg | Gbg | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Gt | Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ops | Ops | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ops_G | Ops_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ops_G_GTP | Ops_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Ops_Gt | Ops_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| PDE | PDE | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| PDE_Ga_GTP | PDE_Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R | R | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R0 | R0 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R0_G | R0_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |

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| Id | Name | Compartment | Derived Unit | Constant | Boundary Condition |
|---|---|---|---|---|---|
| R0_G_GTP | R0_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R0_Gt | R0_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R0_RKpre | R0_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1 | R1 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1_Arr | R1_Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1_G | R1_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1_G_GTP | R1_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1_Gt | R1_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1_RKpost | R1_RKpost | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R1_RKpre | R1_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2 | R2 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2_Arr | R2_Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2_G | R2_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2_G_GTP | R2_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2_Gt | R2_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2_RKpost | R2_RKpost | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R2_RKpre | R2_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3 | R3 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3_Arr | R3_Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3_G | R3_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3_G_GTP | R3_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3_Gt | R3_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3_RKpost | R3_RKpost | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R3_RKpre | R3_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R4 | R4 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R4_Arr | R4_Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R4_G | R4_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |

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| Id | Name | Compartment | Derived Unit | Constant | Boundary Condition |
|---|---|---|---|---|---|
| R4_G_GTP | R4_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R4_Gt | R4_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R4_RKpost | R4_RKpost | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R4_RKpre | R4_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5 | R5 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5_Arr | R5_Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5_G | R5_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5_G_GTP | R5_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5_Gt | R5_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5_RKpost | R5_RKpost | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R5_RKpre | R5_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6 | R6 | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6_Arr | R6_Arr | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6_G | R6_G | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6_G_GTP | R6_G_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6_Gt | R6_Gt | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6_RKpost | R6_RKpost | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| R6_RKpre | R6_RKpre | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| RGS | RGS | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| RGS_Ga_GTP_a_PDE-_a_Ga_GTP | RGS_Ga_GTP_a_PDE_a_Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| RGS_PDE_a_Ga_GTP | RGS_PDE_a_Ga_GTP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| RK | RK | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| Rec_wCa2_RK | Rec_wCa2_RK | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |
| cGMP | cGMP | cytosol | $\mathrm{mol} \cdot \mathrm{l}^{-1}$ | ⊟ | ⊟ |

## 5 Parameters

This model contains 96 global parameters.

Table 4: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|---|---|---|---|---|---|
| Rtot | Rtot | | $3.6 \cdot 10^{9}$ | | ☑ |
| PDEtot | PDEtot | | $1.335 \cdot 10^{7}$ | | ☑ |
| Gtot | Gtot | | $3.6 \cdot 10^{8}$ | | ☑ |
| Rectot | Rectot | | 35.000 | | ☑ |
| RGStot | RGStot | | 3000000.000 | | ☑ |
| ArrTot | ArrTot | | $3.13 \cdot 10^{7}$ | | ☑ |
| flashBG | flashBG | | 0.000 | | ☑ |
| flash0Dur | flash0Dur | | 0.001 | | ☑ |
| flash0Mag | flash0Mag | | 0.000 | | ☑ |
| flashDel | flashDel | | 0.000 | | ☑ |
| flashDur | flashDur | | 0.001 | | ☑ |
| flashMag | flashMag | | 0.000 | | ☑ |
| otherstimulus | otherstimulus | | 0.000 | | ☑ |
| kRK1_0 | kRK1_0 | | 0.008 | | ☑ |
| omega | omega | | 0.600 | | ☑ |
| kRK2 | kRK2 | | 250.000 | | ☑ |
| RKdark | RKdark | | 10838.000 | | ☑ |
| kRK3_ATP | kRK3_ATP | | 400.000 | | ☑ |
| kRK4 | kRK4 | | 20.000 | | ☑ |
| omega_arr | omega_arr | | 0.813 | | ☑ |
| kArr | kArr | | $6.0918 \cdot 10^{-10}$ | | ☑ |
| kA2 | kA2 | | 0.003 | | ☑ |
| kA3 | kA3 | | 0.045 | | ☑ |
| kOps | kOps | | $6.1172 \cdot 10^{-13}$ | | ☑ |
| kRrecyc | kRrecyc | | $7 \cdot 10^{-4}$ | | ☑ |
| kG1_0 | kG1_0 | | $3.0586111111 \cdot 10^{-5}$ | | ☑ |
| kG2 | kG2 | | 2250.340 | | ☑ |
| kG3 | kG3 | | 2000.000 | | ☑ |
| kG4_GDP | kG4_GDP | | 600.000 | | ☑ |
| kG5_GTP | kG5_GTP | | 750.000 | | ☑ |
| kG6 | kG6 | | 2000.000 | | ☑ |
| kG7 | kG7 | | 200.000 | | ☑ |
| kGrecyc | kGrecyc | | 2.000 | | ☑ |
| kGshutoff | kGshutoff | | 0.050 | | ☑ |
| kP1 | kP1 | | 0.055 | | ☑ |
| kP1_rev | kP1_rev | | 0.000 | | ☑ |
| kP2 | kP2 | | 940.706 | | ☑ |

| Id | Name | SBO | Value | Unit | Constant |
|---|---|---|---|---|---|
| kP3 | kP3 | | $1.49834 \cdot 10^{-9}$ | | ☑ |
| kP4 | kP4 | | 21.088 | | ☑ |
| kPDEshutoff | kPDEshutoff | | 0.033 | | ☑ |
| kRGS1 | kRGS1 | | $1.57 \cdot 10^{-7}$ | | ☑ |
| kRGS2 | kRGS2 | | 256.070 | | ☑ |
| kRec3 | kRec3 | | 9.688 | | ☑ |
| kRec4 | kRec4 | | 0.610 | | ☑ |
| Kp | Kp | | 0.425 | | ☑ |
| w | w | | 2.000 | | ☑ |
| Vcyto | Vcyto | | 1.000 | | ☑ |
| Kc | Kc | | 0.170 | | ☑ |
| m | m | | 2.500 | | ☑ |
| betadark | betadark | | 1.200 | | ☑ |
| betasub | betasub | | $4.3 \cdot 10^{-4}$ | | ☑ |
| fCa | fCa | | 0.200 | | ☑ |
| Jdark | Jdark | | 29.778 | | ☑ |
| F | F | | 96485.342 | | ☑ |
| cGMPdark | cGMPdark | | 4.000 | | ☑ |
| ncg | ncg | | 3.000 | | ☑ |
| gammaCa | gammaCa | | 47.554 | | ☑ |
| Ca2dark | Ca2dark | | 0.600 | | ☑ |
| Ca2_0 | Ca2_0 | | 0.010 | | ☑ |
| k1 | k1 | | 0.382 | | ☑ |
| k2 | k2 | | 1.909 | | ☑ |
| eT | eT | | 400.000 | | ☑ |
| ktherm | ktherm | | 0.024 | | ☑ |
| background | background | | 0.000 | | ⊟ |
| premag | premag | | 0.000 | | ⊟ |
| mag | mag | | 0.000 | | ⊟ |
| predur | predur | | 0.000 | | ⊟ |
| dur | dur | | 0.000 | | ⊟ |
| del | del | | 0.000 | | ⊟ |
| preflash | preflash | | 0.000 | | ⊟ |
| testflash | testflash | | 0.000 | | ⊟ |
| stimulus | stimulus | | 0.000 | | ⊟ |
| numConcFactor | numConcFactor | | 0.000 | | ⊟ |
| kRK1_1 | kRK1_1 | | 0.000 | | ⊟ |
| kRK1_2 | kRK1_2 | | 0.000 | | ⊟ |
| kRK1_3 | kRK1_3 | | 0.000 | | ⊟ |
| kRK1_4 | kRK1_4 | | 0.000 | | ⊟ |
| kRK1_5 | kRK1_5 | | 0.000 | | ⊟ |
| kRK1_6 | kRK1_6 | | 0.000 | | ⊟ |

| Id | Name | SBO | Value | Unit | Constant |
|---|---|---|---|---|---|
| kA1_1 | kA1_1 | | 0.000 | | ⊟ |
| kA1_2 | kA1_2 | | 0.000 | | ⊟ |
| kA1_3 | kA1_3 | | 0.000 | | ⊟ |
| kA1_4 | kA1_4 | | 0.000 | | ⊟ |
| kA1_5 | kA1_5 | | 0.000 | | ⊟ |
| kA1_6 | kA1_6 | | 0.000 | | ⊟ |
| kG1_1 | kG1_1 | | 0.000 | | ⊟ |
| kG1_2 | kG1_2 | | 0.000 | | ⊟ |
| kG1_3 | kG1_3 | | 0.000 | | ⊟ |
| kG1_4 | kG1_4 | | 0.000 | | ⊟ |
| kG1_5 | kG1_5 | | 0.000 | | ⊟ |
| kG1_6 | kG1_6 | | 0.000 | | ⊟ |
| E | E | | 0.000 | | ⊟ |
| Rec_wCa2 | Rec_wCa2 | | 0.000 | | ⊟ |
| alfamax | alfamax | | 0.000 | | ⊟ |
| J | J | | 0.000 | | ⊟ |
| deltaJ | deltaJ | | 0.000 | | ⊟ |

# 6 Rules

This is an overview of 33 rules.

## 6.1 Rule background

Rule background is an assignment rule for parameter background:

$$\text{background} = \text{flashBG} \tag{1}$$

## 6.2 Rule premag

Rule premag is an assignment rule for parameter premag:

$$\text{premag} = \frac{\text{flash0Mag}}{\text{flash0Dur}} \tag{2}$$

## 6.3 Rule mag

Rule mag is an assignment rule for parameter mag:

$$\text{mag} = \frac{\text{flashMag}}{\text{flashDur}} \tag{3}$$

### 6.4 Rule predur

Rule predur is an assignment rule for parameter predur:

$$\text{predur} = \text{flash0Dur} \tag{4}$$

### 6.5 Rule dur

Rule dur is an assignment rule for parameter dur:

$$\text{dur} = \text{flashDur} \tag{5}$$

### 6.6 Rule del

Rule del is an assignment rule for parameter del:

$$\text{del} = \text{flashDel} \tag{6}$$

### 6.7 Rule preflash

Rule preflash is an assignment rule for parameter preflash:

$$\text{preflash} = \begin{cases} \text{premag} & \text{if time} \leq \text{predur} \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

### 6.8 Rule testflash

Rule testflash is an assignment rule for parameter testflash:

$$\text{testflash} = \begin{cases} \text{mag} & \text{if } (\text{time} \geq \text{del}) \wedge (\text{time} \leq \text{del} + \text{dur}) \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

### 6.9 Rule stimulus

Rule stimulus is an assignment rule for parameter stimulus:

$$\text{stimulus} = \text{background} + \text{preflash} + \text{testflash} + \text{otherstimulus} \tag{9}$$

### 6.10 Rule numConcFactor

Rule numConcFactor is an assignment rule for parameter numConcFactor:

$$\text{numConcFactor} = \frac{1}{602200.0 \cdot \text{Vcyto}} \tag{10}$$

### 6.11 Rule kRK1_1

Rule kRK1_1 is an assignment rule for parameter kRK1_1:

$$\text{kRK1\_1} = \text{kRK1\_0} \cdot \exp(\text{omega}) \tag{11}$$

### 6.12 Rule kRK1_2

Rule kRK1_2 is an assignment rule for parameter kRK1_2:

$$\mathrm{kRK1\_2} = \mathrm{kRK1\_0} \cdot \exp(\mathrm{omega} \cdot 2) \tag{12}$$

### 6.13 Rule kRK1_3

Rule kRK1_3 is an assignment rule for parameter kRK1_3:

$$\mathrm{kRK1\_3} = \mathrm{kRK1\_0} \cdot \exp(\mathrm{omega} \cdot 3) \tag{13}$$

### 6.14 Rule kRK1_4

Rule kRK1_4 is an assignment rule for parameter kRK1_4:

$$\mathrm{kRK1\_4} = \mathrm{kRK1\_0} \cdot \exp(\mathrm{omega} \cdot 4) \tag{14}$$

### 6.15 Rule kRK1_5

Rule kRK1_5 is an assignment rule for parameter kRK1_5:

$$\mathrm{kRK1\_5} = \mathrm{kRK1\_0} \cdot \exp(\mathrm{omega} \cdot 5) \tag{15}$$

### 6.16 Rule kRK1_6

Rule kRK1_6 is an assignment rule for parameter kRK1_6:

$$\mathrm{kRK1\_6} = 0 \tag{16}$$

### 6.17 Rule kA1_1

Rule kA1_1 is an assignment rule for parameter kA1_1:

$$\mathrm{kA1\_1} = \mathrm{kArr} \cdot \exp \mathrm{omega\_arr} \tag{17}$$

### 6.18 Rule kA1_2

Rule kA1_2 is an assignment rule for parameter kA1_2:

$$\mathrm{kA1\_2} = \mathrm{kArr} \cdot \exp(\mathrm{omega\_arr} \cdot 2) \tag{18}$$

### 6.19 Rule kA1_3

Rule kA1_3 is an assignment rule for parameter kA1_3:

$$\mathrm{kA1\_3} = \mathrm{kArr} \cdot \exp(\mathrm{omega\_arr} \cdot 3) \tag{19}$$

### 6.20 Rule kA1_4

Rule kA1_4 is an assignment rule for parameter kA1_4:

$$\mathrm{kA1\_4} = \mathrm{kArr} \cdot \exp\left(\mathrm{omega\_arr} \cdot 4\right) \tag{20}$$

### 6.21 Rule kA1_5

Rule kA1_5 is an assignment rule for parameter kA1_5:

$$\mathrm{kA1\_5} = \mathrm{kArr} \cdot \exp\left(\mathrm{omega\_arr} \cdot 5\right) \tag{21}$$

### 6.22 Rule kA1_6

Rule kA1_6 is an assignment rule for parameter kA1_6:

$$\mathrm{kA1\_6} = \mathrm{kArr} \cdot \exp\left(\mathrm{omega\_arr} \cdot 6\right) \tag{22}$$

### 6.23 Rule kG1_1

Rule kG1_1 is an assignment rule for parameter kG1_1:

$$\mathrm{kG1\_1} = \mathrm{kG1\_0} \cdot \exp\left(\mathrm{omega}\right) \tag{23}$$

### 6.24 Rule kG1_2

Rule kG1_2 is an assignment rule for parameter kG1_2:

$$\mathrm{kG1\_2} = \mathrm{kG1\_0} \cdot \exp\left(\mathrm{omega} \cdot 2\right) \tag{24}$$

### 6.25 Rule kG1_3

Rule kG1_3 is an assignment rule for parameter kG1_3:

$$\mathrm{kG1\_3} = \mathrm{kG1\_0} \cdot \exp\left(\mathrm{omega} \cdot 3\right) \tag{25}$$

### 6.26 Rule kG1_4

Rule kG1_4 is an assignment rule for parameter kG1_4:

$$\mathrm{kG1\_4} = \mathrm{kG1\_0} \cdot \exp\left(\mathrm{omega} \cdot 4\right) \tag{26}$$

### 6.27 Rule kG1_5

Rule kG1_5 is an assignment rule for parameter kG1_5:

$$\mathrm{kG1\_5} = \mathrm{kG1\_0} \cdot \exp\left(\mathrm{omega} \cdot 5\right) \tag{27}$$

### 6.28 Rule kG1_6

Rule kG1_6 is an assignment rule for parameter kG1_6:

$$\mathrm{kG1\_6} = \mathrm{kG1\_0} \cdot \exp\left(\mathrm{omega} \cdot 6\right) \tag{28}$$

### 6.29 Rule E

Rule E is an assignment rule for parameter E:

$$\mathrm{E} = [\mathrm{PDE\_a\_Ga\_GTP}] + 2 \cdot [\mathrm{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP}] \tag{29}$$

### 6.30 Rule Rec_wCa2

Rule Rec_wCa2 is an assignment rule for parameter Rec_wCa2:

$$\mathrm{Rec\_wCa2} = \frac{\mathrm{Rectot} - [\mathrm{Rec\_wCa2\_RK}] \cdot \mathrm{numConcFactor}}{1 + \left(\frac{\mathrm{Kp}}{[\mathrm{Ca2\_free}]}\right)^{\mathrm{w}}} \tag{30}$$

### 6.31 Rule alfamax

Rule alfamax is an assignment rule for parameter alfamax:

$$\mathrm{alfamax} = \mathrm{betadark} \cdot \mathrm{cGMPdark} \cdot \left(1 + \left(\frac{\mathrm{Ca2dark}}{\mathrm{Kc}}\right)^{\mathrm{m}}\right) \tag{31}$$

### 6.32 Rule J

Rule J is an assignment rule for parameter J:

$$\mathrm{J} = \frac{2}{2 + \mathrm{fCa}} \cdot \left(\frac{[\mathrm{cGMP}]}{\mathrm{cGMPdark}}\right)^{\mathrm{ncg}} \cdot \mathrm{Jdark} + \frac{\frac{\mathrm{fCa}}{\mathrm{fCa}+2} \cdot ([\mathrm{Ca2\_free}] - \mathrm{Ca2\_0})}{\mathrm{Ca2dark} - \mathrm{Ca2\_0}} \cdot \mathrm{Jdark} \tag{32}$$

### 6.33 Rule deltaJ

Rule deltaJ is an assignment rule for parameter deltaJ:

$$\mathrm{deltaJ} = \mathrm{Jdark} - \mathrm{J} \tag{33}$$

## 7 Reactions

This model contains 91 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 | v_r1 | v_r1 | $R \longrightarrow R0$ | |
| 2 | v_r2_0 | v_r2_0 | $R0 + RK \rightleftharpoons R0\_RKpre$ | |
| 3 | v_r2_1 | v_r2_1 | $R1 + RK \rightleftharpoons R1\_RKpre$ | |
| 4 | v_r2_2 | v_r2_2 | $R2 + RK \rightleftharpoons R2\_RKpre$ | |
| 5 | v_r2_3 | v_r2_3 | $R3 + RK \rightleftharpoons R3\_RKpre$ | |
| 6 | v_r2_4 | v_r2_4 | $R4 + RK \rightleftharpoons R4\_RKpre$ | |
| 7 | v_r2_5 | v_r2_5 | $R5 + RK \rightleftharpoons R5\_RKpre$ | |
| 8 | v_r2_6 | v_r2_6 | $R6 + RK \rightleftharpoons R6\_RKpre$ | |
| 9 | v_r3_0 | v_r3_0 | $R0\_RKpre \longrightarrow R1\_RKpost$ | |
| 10 | v_r3_1 | v_r3_1 | $R1\_RKpre \longrightarrow R2\_RKpost$ | |
| 11 | v_r3_2 | v_r3_2 | $R2\_RKpre \longrightarrow R3\_RKpost$ | |
| 12 | v_r3_3 | v_r3_3 | $R3\_RKpre \longrightarrow R4\_RKpost$ | |
| 13 | v_r3_4 | v_r3_4 | $R4\_RKpre \longrightarrow R5\_RKpost$ | |
| 14 | v_r3_5 | v_r3_5 | $R5\_RKpre \longrightarrow R6\_RKpost$ | |
| 15 | v_r4_1 | v_r4_1 | $R1\_RKpost \longrightarrow R1 + RK$ | |
| 16 | v_r4_2 | v_r4_2 | $R2\_RKpost \longrightarrow R2 + RK$ | |
| 17 | v_r4_3 | v_r4_3 | $R3\_RKpost \longrightarrow R3 + RK$ | |
| 18 | v_r4_4 | v_r4_4 | $R4\_RKpost \longrightarrow R4 + RK$ | |
| 19 | v_r4_5 | v_r4_5 | $R5\_RKpost \longrightarrow R5 + RK$ | |
| 20 | v_r4_6 | v_r4_6 | $R6\_RKpost \longrightarrow R6 + RK$ | |
| 21 | v_r5_1 | v_r5_1 | $Arr + R1 \rightleftharpoons R1\_Arr$ | |
| 22 | v_r5_2 | v_r5_2 | $Arr + R2 \rightleftharpoons R2\_Arr$ | |
| 23 | v_r5_3 | v_r5_3 | $Arr + R3 \rightleftharpoons R3\_Arr$ | |

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| № | Id | Name | Reaction Equation | SBO |
|---|---|---|---|---|
| 24 | v_r5_4 | v_r5_4 | $\mathrm{Arr} + \mathrm{R4} \rightleftharpoons \mathrm{R4\_Arr}$ | |
| 25 | v_r5_5 | v_r5_5 | $\mathrm{Arr} + \mathrm{R5} \rightleftharpoons \mathrm{R5\_Arr}$ | |
| 26 | v_r5_6 | v_r5_6 | $\mathrm{Arr} + \mathrm{R6} \rightleftharpoons \mathrm{R6\_Arr}$ | |
| 27 | v_r6_1 | v_r6_1 | $\mathrm{R1\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops}$ | |
| 28 | v_r6_2 | v_r6_2 | $\mathrm{R2\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops}$ | |
| 29 | v_r6_3 | v_r6_3 | $\mathrm{R3\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops}$ | |
| 30 | v_r6_4 | v_r6_4 | $\mathrm{R4\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops}$ | |
| 31 | v_r6_5 | v_r6_5 | $\mathrm{R5\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops}$ | |
| 32 | v_r6_6 | v_r6_6 | $\mathrm{R6\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops}$ | |
| 33 | v_r7_0 | v_r7_0 | $\mathrm{R0} \longrightarrow \mathrm{Ops}$ | |
| 34 | v_r7_1 | v_r7_1 | $\mathrm{R1} \longrightarrow \mathrm{Ops}$ | |
| 35 | v_r7_2 | v_r7_2 | $\mathrm{R2} \longrightarrow \mathrm{Ops}$ | |
| 36 | v_r7_3 | v_r7_3 | $\mathrm{R3} \longrightarrow \mathrm{Ops}$ | |
| 37 | v_r7_4 | v_r7_4 | $\mathrm{R4} \longrightarrow \mathrm{Ops}$ | |
| 38 | v_r7_5 | v_r7_5 | $\mathrm{R5} \longrightarrow \mathrm{Ops}$ | |
| 39 | v_r7_6 | v_r7_6 | $\mathrm{R6} \longrightarrow \mathrm{Ops}$ | |
| 40 | v_r8 | v_r8 | $\mathrm{Gt} + \mathrm{Ops} \rightleftharpoons \mathrm{Ops\_Gt}$ | |
| 41 | v_r9 | v_r9 | $\mathrm{Ops\_Gt} \rightleftharpoons \mathrm{Ops\_G}$ | |
| 42 | v_r10 | v_r10 | $\mathrm{Ops\_G} \longrightarrow \mathrm{Ops\_G\_GTP}$ | |
| 43 | v_r11 | v_r11 | $\mathrm{Ops\_G\_GTP} \longrightarrow \mathrm{G\_GTP} + \mathrm{Ops}$ | |
| 44 | v_r12 | v_r12 | $\mathrm{Ops} \longrightarrow \mathrm{R}$ | |
| 45 | v_r13_0 | v_r13_0 | $\mathrm{Gt} + \mathrm{R0} \rightleftharpoons \mathrm{R0\_Gt}$ | |
| 46 | v_r13_1 | v_r13_1 | $\mathrm{Gt} + \mathrm{R1} \rightleftharpoons \mathrm{R1\_Gt}$ | |
| 47 | v_r13_2 | v_r13_2 | $\mathrm{Gt} + \mathrm{R2} \rightleftharpoons \mathrm{R2\_Gt}$ | |
| 48 | v_r13_3 | v_r13_3 | $\mathrm{Gt} + \mathrm{R3} \rightleftharpoons \mathrm{R3\_Gt}$ | |
| 49 | v_r13_4 | v_r13_4 | $\mathrm{Gt} + \mathrm{R4} \rightleftharpoons \mathrm{R4\_Gt}$ | |
| 50 | v_r13_5 | v_r13_5 | $\mathrm{Gt} + \mathrm{R5} \rightleftharpoons \mathrm{R5\_Gt}$ | |
| 51 | v_r13_6 | v_r13_6 | $\mathrm{Gt} + \mathrm{R6} \rightleftharpoons \mathrm{R6\_Gt}$ | |
| 52 | v_r14_0 | v_r14_0 | $\mathrm{R0\_Gt} \rightleftharpoons \mathrm{R0\_G}$ | |

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| № | Id | Name | Reaction Equation | SBO |
|---|---|---|---|---|
| 53 | v_r14_1 | v_r14_1 | R1_Gt $\rightleftharpoons$ R1_G | |
| 54 | v_r14_2 | v_r14_2 | R2_Gt $\rightleftharpoons$ R2_G | |
| 55 | v_r14_3 | v_r14_3 | R3_Gt $\rightleftharpoons$ R3_G | |
| 56 | v_r14_4 | v_r14_4 | R4_Gt $\rightleftharpoons$ R4_G | |
| 57 | v_r14_5 | v_r14_5 | R5_Gt $\rightleftharpoons$ R5_G | |
| 58 | v_r14_6 | v_r14_6 | R6_Gt $\rightleftharpoons$ R6_G | |
| 59 | v_r15_0 | v_r15_0 | R0_G $\longrightarrow$ R0_G_GTP | |
| 60 | v_r15_1 | v_r15_1 | R1_G $\longrightarrow$ R1_G_GTP | |
| 61 | v_r15_2 | v_r15_2 | R2_G $\longrightarrow$ R2_G_GTP | |
| 62 | v_r15_3 | v_r15_3 | R3_G $\longrightarrow$ R3_G_GTP | |
| 63 | v_r15_4 | v_r15_4 | R4_G $\longrightarrow$ R4_G_GTP | |
| 64 | v_r15_5 | v_r15_5 | R5_G $\longrightarrow$ R5_G_GTP | |
| 65 | v_r15_6 | v_r15_6 | R6_G $\longrightarrow$ R6_G_GTP | |
| 66 | v_r16_0 | v_r16_0 | R0_G_GTP $\longrightarrow$ G_GTP + R0 | |
| 67 | v_r16_1 | v_r16_1 | R1_G_GTP $\longrightarrow$ G_GTP + R1 | |
| 68 | v_r16_2 | v_r16_2 | R2_G_GTP $\longrightarrow$ G_GTP + R2 | |
| 69 | v_r16_3 | v_r16_3 | R3_G_GTP $\longrightarrow$ G_GTP + R3 | |
| 70 | v_r16_4 | v_r16_4 | R4_G_GTP $\longrightarrow$ G_GTP + R4 | |
| 71 | v_r16_5 | v_r16_5 | R5_G_GTP $\longrightarrow$ G_GTP + R5 | |
| 72 | v_r16_6 | v_r16_6 | R6_G_GTP $\longrightarrow$ G_GTP + R6 | |
| 73 | v_r17 | v_r17 | G_GTP $\longrightarrow$ Ga_GTP + Gbg | |
| 74 | v_r18 | v_r18 | Ga_GTP + PDE $\rightleftharpoons$ PDE_Ga_GTP | |
| 75 | v_r19 | v_r19 | PDE_Ga_GTP $\longrightarrow$ PDE_a_Ga_GTP | |
| 76 | v_r20 | v_r20 | Ga_GTP + PDE_a_Ga_GTP $\longrightarrow$ Ga_GTP_PDE_a_Ga_GTP | |
| 77 | v_r21 | v_r21 | Ga_GTP_PDE_a_Ga_GTP $\longrightarrow$ Ga_GTP_a_PDE_a_Ga_GTP | |
| 78 | v_r22 | v_r22 | Ga_GTP_a_PDE_a_Ga_GTP + RGS $\longrightarrow$ RGS_Ga_GTP_a_PDE_a_Ga_GTP | |
| 79 | v_r23 | v_r23 | RGS_Ga_GTP_a_PDE_a_Ga_GTP $\longrightarrow$ Ga_GDP + PDE_a_Ga_GTP + RGS | |

| № | Id | Name | Reaction Equation | SBO |
|---|---|---|---|---|
| 80 | v_r24 | v_r24 | $\mathrm{PDE\_a\_Ga\_GTP} + \mathrm{RGS} \longrightarrow \mathrm{RGS\_PDE\_a\_Ga\_GTP}$ | |
| 81 | v_r25 | v_r25 | $\mathrm{RGS\_PDE\_a\_Ga\_GTP} \longrightarrow \mathrm{Ga\_GDP} + \mathrm{PDE} + \mathrm{RGS}$ | |
| 82 | v_r26 | v_r26 | $\mathrm{PDE\_a\_Ga\_GTP} \longrightarrow \mathrm{Ga\_GDP} + \mathrm{PDE}$ | |
| 83 | v_r27 | v_r27 | $\mathrm{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} \longrightarrow \mathrm{Ga\_GDP} + \mathrm{PDE\_a\_Ga\_GTP}$ | |
| 84 | v_r28 | v_r28 | $\mathrm{Ga\_GTP} \longrightarrow \mathrm{Ga\_GDP}$ | |
| 85 | v_r29 | v_r29 | $\mathrm{Ga\_GDP} + \mathrm{Gbg} \longrightarrow \mathrm{Gt}$ | |
| 86 | v_r30 | v_r30 | $\mathrm{RK} \overset{\mathrm{Ca2\_free}}{\rightleftharpoons} \mathrm{Rec\_wCa2\_RK}$ | |
| 87 | v_r31 | v_r31 | $\mathrm{Ca2\_free} \rightleftharpoons \mathrm{Ca2\_buff}$ | |
| 88 | v_r32 | v_r32 | $\mathrm{Ca2\_free} \longrightarrow \emptyset$ | |
| 89 | v_r33 | v_r33 | $\emptyset \xrightarrow{\mathrm{cGMP}} \mathrm{Ca2\_free}$ | |
| 90 | v_r34 | v_r34 | $\emptyset \xrightarrow{\mathrm{Ca2\_free}} \mathrm{cGMP}$ | |
| 91 | v_r35 | v_r35 | $\mathrm{cGMP} \xrightarrow{\mathrm{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP,\ PDE\_a\_Ga\_GTP}} \emptyset$ | |

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## 7.1 Reaction v_r1

This is an irreversible reaction of one reactant forming one product.

**Name** v_r1

### Reaction equation

$$\mathrm{R} \longrightarrow \mathrm{R0} \tag{34}$$

### Reactant

Table 6: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R | R | |

### Product

Table 7: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R0 | R0 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_1 = \frac{\text{stimulus} \cdot [\mathrm{R}]}{\text{Rtot}} \tag{35}$$

## 7.2 Reaction v_r2_0

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

**Name** v_r2_0

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\mathrm{R0} + \mathrm{RK} \rightleftharpoons \mathrm{R0\_RKpre} \tag{36}$$

### Reactants

Table 8: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R0 | R0 | |
| RK | RK | |

### Product

Table 9: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R0_RKpre | R0_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_2 = \mathrm{kRK1\_0} \cdot [\mathrm{RK}] \cdot [\mathrm{R0}] - \mathrm{kRK2} \cdot [\mathrm{R0\_RKpre}] \tag{37}$$

## 7.3 Reaction v_r2_1

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

**Name** v_r2_1

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\mathrm{R1} + \mathrm{RK} \rightleftharpoons \mathrm{R1\_RKpre} \tag{38}$$

### Reactants

Table 10: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1 | R1 | |
| RK | RK | |

### Product

Table 11: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1_RKpre | R1_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_3 = \text{kRK1\_1} \cdot [\text{RK}] \cdot [\text{R1}] - \text{kRK2} \cdot [\text{R1\_RKpre}] \tag{39}$$

## 7.4 Reaction v_r2_2

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

**Name** v_r2_2

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\text{R2} + \text{RK} \rightleftharpoons \text{R2\_RKpre} \tag{40}$$

### Reactants

Table 12: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2 | R2 | |
| RK | RK | |

### Product

Table 13: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R2_RKpre | R2_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_4 = \text{kRK1\_2} \cdot [\text{RK}] \cdot [\text{R2}] - \text{kRK2} \cdot [\text{R2\_RKpre}] \tag{41}$$

## 7.5 Reaction v_r2_3

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

**Name** v_r2_3

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\mathrm{R3} + \mathrm{RK} \rightleftharpoons \mathrm{R3\_RKpre} \tag{42}$$

### Reactants

Table 14: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3 | R3 | |
| RK | RK | |

### Product

Table 15: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3_RKpre | R3_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_5 = \mathrm{kRK1\_3} \cdot [\mathrm{RK}] \cdot [\mathrm{R3}] - \mathrm{kRK2} \cdot [\mathrm{R3\_RKpre}] \tag{43}$$

## 7.6 Reaction v_r2_4

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

**Name** v_r2_4

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\mathrm{R4} + \mathrm{RK} \rightleftharpoons \mathrm{R4\_RKpre} \tag{44}$$

### Reactants

Table 16: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4 | R4 | |
| RK | RK | |

### Product

Table 17: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4_RKpre | R4_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_6 = \text{kRK1\_4} \cdot [\text{RK}] \cdot [\text{R4}] - \text{kRK2} \cdot [\text{R4\_RKpre}] \tag{45}$$

## 7.7 Reaction v_r2_5

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

**Name** v_r2_5

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\text{R5} + \text{RK} \rightleftharpoons \text{R5\_RKpre} \tag{46}$$

### Reactants

Table 18: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5 | R5 | |
| RK | RK | |

### Product

Table 19: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5_RKpre | R5_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_7 = \text{kRK1\_5} \cdot [\text{RK}] \cdot [\text{R5}] - \text{kRK2} \cdot [\text{R5\_RKpre}] \tag{47}$$

## 7.8 Reaction v_r2_6

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

**Name** v_r2_6

**Notes** Rn and RK binding before phospohorylation occurs

### Reaction equation

$$\text{R6} + \text{RK} \rightleftharpoons \text{R6\_RKpre} \tag{48}$$

### Reactants

Table 20: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6 | R6 | |
| RK | RK | |

### Product

Table 21: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6_RKpre | R6_RKpre | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_8 = \text{kRK1\_6} \cdot [\text{RK}] \cdot [\text{R6}] - \text{kRK2} \cdot [\text{R6\_RKpre}] \tag{49}$$

## 7.9 Reaction v_r3_0

This is an irreversible reaction of one reactant forming one product.

**Name** v_r3_0

**Notes** Phosphorylation of Rn to Rn+1. In these reactions ATP (left) and ADP (right) are included in the rate constants

### Reaction equation

$$\text{R0\_RKpre} \longrightarrow \text{R1\_RKpost} \tag{50}$$

### Reactant

Table 22: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R0_RKpre | R0_RKpre | |

### Product

Table 23: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1_RKpost | R1_RKpost | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_9 = \text{kRK3\_ATP} \cdot [\text{R0\_RKpre}] \tag{51}$$

## 7.10 Reaction v_r3_1

This is an irreversible reaction of one reactant forming one product.

**Name** v_r3_1

**Notes** Phosphorylation of Rn to Rn+1. In these reactions ATP (left) and ADP (right) are included in the rate constants

### Reaction equation

$$\text{R1\_RKpre} \longrightarrow \text{R2\_RKpost} \tag{52}$$

### Reactant

Table 24: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1_RKpre | R1_RKpre | |

### Product

Table 25: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R2_RKpost | R2_RKpost | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{10} = \text{kRK3\_ATP} \cdot [\text{R1\_RKpre}] \tag{53}$$

## 7.11 Reaction v_r3_2

This is an irreversible reaction of one reactant forming one product.

**Name** v_r3_2

**Notes** Phosphorylation of Rn to Rn+1. In these reactions ATP (left) and ADP (right) are included in the rate constants

### Reaction equation

$$\text{R2\_RKpre} \longrightarrow \text{R3\_RKpost} \tag{54}$$

### Reactant

Table 26: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2_RKpre | R2_RKpre | |

### Product

Table 27: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3_RKpost | R3_RKpost | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{11} = \text{kRK3\_ATP} \cdot [\text{R2\_RKpre}] \tag{55}$$

## 7.12 Reaction v_r3_3

This is an irreversible reaction of one reactant forming one product.

**Name** v_r3_3

**Notes** Phosphorylation of Rn to Rn+1. In these reactions ATP (left) and ADP (right) are included in the rate constants

### Reaction equation

$$\text{R3\_RKpre} \longrightarrow \text{R4\_RKpost} \tag{56}$$

### Reactant

Table 28: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3_RKpre | R3_RKpre | |

### Product

Table 29: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4_RKpost | R4_RKpost | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{12} = \text{kRK3\_ATP} \cdot [\text{R3\_RKpre}] \tag{57}$$

## 7.13 Reaction v_r3_4

This is an irreversible reaction of one reactant forming one product.

**Name** v_r3_4

**Notes** Phosphorylation of Rn to Rn+1. In these reactions ATP (left) and ADP (right) are included in the rate constants

### Reaction equation

$$\text{R4\_RKpre} \longrightarrow \text{R5\_RKpost} \tag{58}$$

### Reactant

Table 30: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4_RKpre | R4_RKpre | |

### Product

Table 31: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5_RKpost | R5_RKpost | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{13} = \text{kRK3\_ATP} \cdot [\text{R4\_RKpre}] \tag{59}$$

## 7.14 Reaction v_r3_5

This is an irreversible reaction of one reactant forming one product.

**Name** v_r3_5

**Notes** Phosphorylation of Rn to Rn+1. In these reactions ATP (left) and ADP (right) are included in the rate constants

### Reaction equation

$$\text{R5\_RKpre} \longrightarrow \text{R6\_RKpost} \tag{60}$$

### Reactant

Table 32: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5_RKpre | R5_RKpre | |

### Product

Table 33: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6_RKpost | R6_RKpost | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{14} = \text{kRK3\_ATP} \cdot [\text{R5\_RKpre}] \tag{61}$$

## 7.15 Reaction v_r4_1

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

**Name** v_r4_1

**Notes** Dissociation of Rn and RK

### Reaction equation

$$\text{R1\_RKpost} \longrightarrow \text{R1} + \text{RK} \tag{62}$$

### Reactant

Table 34: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1_RKpost | R1_RKpost | |

### Products

Table 35: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1 | R1 | |
| RK | RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{15} = \text{kRK4} \cdot [\text{R1\_RKpost}] \tag{63}$$

## 7.16 Reaction v_r4_2

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

**Name** v_r4_2

**Notes** Dissociation of Rn and RK

### Reaction equation

$$\text{R2\_RKpost} \longrightarrow \text{R2} + \text{RK} \tag{64}$$

### Reactant

Table 36: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2_RKpost | R2_RKpost | |

### Products

Table 37: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R2 | R2 | |
| RK | RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{16} = \text{kRK4} \cdot [\text{R2\_RKpost}] \tag{65}$$

## 7.17 Reaction v_r4_3

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

**Name** v_r4_3

**Notes** Dissociation of Rn and RK

### Reaction equation

$$\text{R3\_RKpost} \longrightarrow \text{R3} + \text{RK} \tag{66}$$

### Reactant

Table 38: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3_RKpost | R3_RKpost | |

### Products

Table 39: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3 | R3 | |
| RK | RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{17} = \text{kRK4} \cdot [\text{R3\_RKpost}] \tag{67}$$

## 7.18 Reaction v_r4_4

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

**Name** v_r4_4

**Notes** Dissociation of Rn and RK

### Reaction equation

$$\text{R4\_RKpost} \longrightarrow \text{R4} + \text{RK} \tag{68}$$

### Reactant

Table 40: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4_RKpost | R4_RKpost | |

### Products

Table 41: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4 | R4 | |
| RK | RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{18} = \text{kRK4} \cdot [\text{R4\_RKpost}] \tag{69}$$

## 7.19 Reaction v_r4_5

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

**Name** v_r4_5

**Notes** Dissociation of Rn and RK

### Reaction equation

$$\text{R5\_RKpost} \longrightarrow \text{R5} + \text{RK} \tag{70}$$

### Reactant

Table 42: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5_RKpost | R5_RKpost | |

### Products

Table 43: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5 | R5 | |
| RK | RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{19} = \text{kRK4} \cdot [\text{R5\_RKpost}] \tag{71}$$

## 7.20 Reaction v_r4_6

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

**Name** v_r4_6

**Notes** Dissociation of Rn and RK

### Reaction equation

$$\text{R6\_RKpost} \longrightarrow \text{R6} + \text{RK} \tag{72}$$

### Reactant

Table 44: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6_RKpost | R6_RKpost | |

### Products

Table 45: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6 | R6 | |
| RK | RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{20} = \text{kRK4} \cdot [\text{R6\_RKpost}] \tag{73}$$

## 7.21 Reaction v_r5_1

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

**Name** v_r5_1

**Notes** Binding of activated R to Arrestin

### Reaction equation

$$\text{Arr} + \text{R1} \rightleftharpoons \text{R1\_Arr} \tag{74}$$

### Reactants

Table 46: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| R1 | R1 | |

### Product

Table 47: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1_Arr | R1_Arr | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{21} = \text{kA1\_1} \cdot [\text{Arr}] \cdot [\text{R1}] - \text{kA2} \cdot [\text{R1\_Arr}] \tag{75}$$

## 7.22 Reaction v_r5_2

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

**Name** v_r5_2

**Notes** Binding of activated R to Arrestin

### Reaction equation

$$\mathrm{Arr} + \mathrm{R2} \rightleftharpoons \mathrm{R2\_Arr} \tag{76}$$

### Reactants

Table 48: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| `Arr` | Arr | |
| `R2` | R2 | |

### Product

Table 49: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| `R2_Arr` | R2_Arr | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{22} = \mathrm{kA1\_2} \cdot [\mathrm{Arr}] \cdot [\mathrm{R2}] - \mathrm{kA2} \cdot [\mathrm{R2\_Arr}] \tag{77}$$

## 7.23 Reaction `v_r5_3`

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

**Name** v_r5_3

**Notes** Binding of activated R to Arrestin

### Reaction equation

$$\mathrm{Arr} + \mathrm{R3} \rightleftharpoons \mathrm{R3\_Arr} \tag{78}$$

### Reactants

Table 50: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| R3 | R3 | |

### Product

Table 51: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3_Arr | R3_Arr | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{23} = \mathrm{kA1\_3} \cdot [\mathrm{Arr}] \cdot [\mathrm{R3}] - \mathrm{kA2} \cdot [\mathrm{R3\_Arr}] \tag{79}$$

## 7.24 Reaction v_r5_4

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

**Name** v_r5_4

**Notes** Binding of activated R to Arrestin

### Reaction equation

$$\mathrm{Arr} + \mathrm{R4} \rightleftharpoons \mathrm{R4\_Arr} \tag{80}$$

### Reactants

Table 52: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| R4 | R4 | |

### Product

Table 53: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4_Arr | R4_Arr | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{24} = \mathrm{kA1\_4} \cdot [\mathrm{Arr}] \cdot [\mathrm{R4}] - \mathrm{kA2} \cdot [\mathrm{R4\_Arr}] \tag{81}$$

## 7.25 Reaction v_r5_5

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

**Name** v_r5_5

**Notes** Binding of activated R to Arrestin

### Reaction equation

$$\mathrm{Arr} + \mathrm{R5} \rightleftharpoons \mathrm{R5\_Arr} \tag{82}$$

### Reactants

Table 54: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| R5 | R5 | |

### Product

Table 55: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5_Arr | R5_Arr | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{25} = \mathrm{kA1\_5} \cdot [\mathrm{Arr}] \cdot [\mathrm{R5}] - \mathrm{kA2} \cdot [\mathrm{R5\_Arr}] \tag{83}$$

## 7.26 Reaction v_r5_6

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

**Name** v_r5_6

**Notes** Binding of activated R to Arrestin

### Reaction equation

$$\mathrm{Arr} + \mathrm{R6} \rightleftharpoons \mathrm{R6\_Arr} \tag{84}$$

### Reactants

Table 56: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| R6 | R6 | |

### Product

Table 57: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6_Arr | R6_Arr | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{26} = \mathrm{kA1\_6} \cdot [\mathrm{Arr}] \cdot [\mathrm{R6}] - \mathrm{kA2} \cdot [\mathrm{R6\_Arr}] \tag{85}$$

## 7.27 Reaction v_r6_1

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

**Name** v_r6_1

**Notes** Arrestin mediated R -> ops

### Reaction equation

$$\mathrm{R1\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops} \tag{86}$$

### Reactant

Table 58: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1_Arr | R1_Arr | |

### Products

Table 59: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{27} = \mathrm{kA3} \cdot [\mathrm{R1\_Arr}] \tag{87}$$

## 7.28 Reaction v_r6_2

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

**Name** v_r6_2

**Notes** Arrestin mediated R -> ops

### Reaction equation

$$\mathrm{R2\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops} \tag{88}$$

### Reactant

Table 60: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2_Arr | R2_Arr | |

### Products

Table 61: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{28} = \mathrm{kA3} \cdot [\mathrm{R2\_Arr}] \tag{89}$$

## 7.29 Reaction v_r6_3

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

**Name** v_r6_3

**Notes** Arrestin mediated R -> ops

### Reaction equation

$$\mathrm{R3\_Arr} \longrightarrow \mathrm{Arr} + \mathrm{Ops} \tag{90}$$

### Reactant

Table 62: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3_Arr | R3_Arr | |

### Products

Table 63: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{29} = \text{kA3} \cdot [\text{R3\_Arr}] \tag{91}$$

## 7.30 Reaction v_r6_4

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

**Name** v_r6_4

**Notes** Arrestin mediated R -> ops

### Reaction equation

$$\text{R4\_Arr} \longrightarrow \text{Arr} + \text{Ops} \tag{92}$$

### Reactant

Table 64: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4_Arr | R4_Arr | |

### Products

Table 65: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{30} = \text{kA3} \cdot [\text{R4\_Arr}] \tag{93}$$

## 7.31 Reaction v_r6_5

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

**Name** v_r6_5

**Notes** Arrestin mediated R -> ops

### Reaction equation

$$\text{R5\_Arr} \longrightarrow \text{Arr} + \text{Ops} \tag{94}$$

### Reactant

Table 66: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5_Arr | R5_Arr | |

### Products

Table 67: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{31} = \text{kA3} \cdot [\text{R5\_Arr}] \tag{95}$$

## 7.32 Reaction v_r6_6

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

**Name** v_r6_6

**Notes** Arrestin mediated R -> ops

### Reaction equation

$$\text{R6\_Arr} \longrightarrow \text{Arr} + \text{Ops} \tag{96}$$

### Reactant

Table 68: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6_Arr | R6_Arr | |

### Products

Table 69: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Arr | Arr | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{32} = \mathrm{kA3} \cdot [\mathrm{R6\_Arr}] \tag{97}$$

## 7.33 Reaction v_r7_0

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_0

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\mathrm{R0} \longrightarrow \mathrm{Ops} \tag{98}$$

### Reactant

Table 70: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R0 | R0 | |

### Product

Table 71: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{33} = \text{ktherm} \cdot [\text{R0}] \tag{99}$$

## 7.34 Reaction v_r7_1

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_1

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\text{R1} \longrightarrow \text{Ops} \tag{100}$$

### Reactant

Table 72: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1 | R1 | |

### Product

Table 73: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{34} = \text{ktherm} \cdot [\text{R1}] \tag{101}$$

## 7.35 Reaction v_r7_2

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_2

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\mathrm{R2} \longrightarrow \mathrm{Ops} \tag{102}$$

### Reactant

Table 74: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2 | R2 | |

### Product

Table 75: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{35} = \mathrm{ktherm} \cdot [\mathrm{R2}] \tag{103}$$

## 7.36 Reaction v_r7_3

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_3

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\mathrm{R3} \longrightarrow \mathrm{Ops} \tag{104}$$

### Reactant

Table 76: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3 | R3 | |

### Product

Table 77: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{36} = \text{ktherm} \cdot [\text{R3}] \tag{105}$$

## 7.37 Reaction v_r7_4

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_4

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\text{R4} \longrightarrow \text{Ops} \tag{106}$$

### Reactant

Table 78: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4 | R4 | |

### Product

Table 79: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{37} = \text{ktherm} \cdot [\text{R4}] \tag{107}$$

## 7.38 Reaction v_r7_5

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_5

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\text{R5} \longrightarrow \text{Ops} \tag{108}$$

### Reactant

Table 80: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5 | R5 | |

### Product

Table 81: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{38} = \text{ktherm} \cdot [\text{R5}] \tag{109}$$

## 7.39 Reaction v_r7_6

This is an irreversible reaction of one reactant forming one product.

**Name** v_r7_6

**Notes** Thermal decay of R's catalytic active form MetaII. Rate constant from Xu et al. We assume that the rate constant is independent of the phosphorylation state. See Mitchell DC, Kibelbek J, Litman BJ. (Biochemistry, 1992) for further detail

### Reaction equation

$$\text{R6} \longrightarrow \text{Ops} \tag{110}$$

### Reactant

Table 82: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6 | R6 | |

### Product

Table 83: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{39} = \text{ktherm} \cdot [\text{R6}] \tag{111}$$

## 7.40 Reaction v_r8

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

**Name** v_r8

**Notes** We assume the reverse reaction to occur with the same rate as v_r13_*

### Reaction equation

$$\mathrm{Gt} + \mathrm{Ops} \rightleftharpoons \mathrm{Ops\_Gt} \tag{112}$$

### Reactants

Table 84: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| Ops | Ops | |

### Product

Table 85: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops_Gt | Ops_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{40} = \mathrm{kOps} \cdot [\mathrm{Ops}] \cdot [\mathrm{Gt}] - \mathrm{kG2} \cdot [\mathrm{Ops\_Gt}] \tag{113}$$

## 7.41 Reaction v_r9

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

**Name** v_r9

**Notes** GDP dissociation from Ops_Gt, GDP is taken into account in the rate constant. Here we assume the same kinetics as in reactions v_r14_*

### Reaction equation

$$\mathrm{Ops\_Gt} \rightleftharpoons \mathrm{Ops\_G} \tag{114}$$

### Reactant

Table 86: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ops_Gt | Ops_Gt | |

### Product

Table 87: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops_G | Ops_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{41} = \text{kG3} \cdot [\text{Ops\_Gt}] - \text{kG4\_GDP} \cdot [\text{Ops\_G}] \tag{115}$$

## 7.42 Reaction v_r10

This is an irreversible reaction of one reactant forming one product.

**Name** v_r10

**Notes** GTP binding to Ops_G, GDP is taken into account in the rate constant. We assume the same kinetics as in reactions v_r15_*

### Reaction equation

$$\text{Ops\_G} \longrightarrow \text{Ops\_G\_GTP} \tag{116}$$

### Reactant

Table 88: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ops_G | Ops_G | |

### Product

Table 89: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ops_G_GTP | Ops_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{42} = \text{kG5\_GTP} \cdot [\text{Ops\_G}] \tag{117}$$

## 7.43 Reaction v_r11

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

**Name** v_r11

**Notes** Ops_G_GTP dissociation to Ops and G_GTP, here G_GTP is the Gt heterotrimer with bound GTP. We assume the same kinetics as in reactions v_r16_*

### Reaction equation

$$\text{Ops\_G\_GTP} \longrightarrow \text{G\_GTP} + \text{Ops} \tag{118}$$

### Reactant

Table 90: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ops_G_GTP | Ops_G_GTP | |

### Products

Table 91: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| Ops | Ops | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{43} = \text{kG6} \cdot [\text{Ops\_G\_GTP}] \tag{119}$$

## 7.44 Reaction v_r12

This is an irreversible reaction of one reactant forming one product.

**Name** v_r12

**Notes** Similarly to Firsov et al. (2006) we consider the rate of Rho regeneration from Ops + 11cis_ret combination as a first order kinetics with the rate constant kRecyc implicitely including 11cis_ret concentration. See paper for details.

### Reaction equation

$$\text{Ops} \longrightarrow \text{R} \tag{120}$$

### Reactant

Table 92: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ops | Ops | |

### Product

Table 93: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R | R | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{44} = \text{kRrecyc} \cdot [\text{Ops}] \tag{121}$$

## 7.45 Reaction v_r13_0

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

**Name** v_r13_0

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\mathrm{Gt} + \mathrm{R0} \rightleftharpoons \mathrm{R0\_Gt} \tag{122}$$

### Reactants

Table 94: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R0 | R0 | |

### Product

Table 95: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R0_Gt | R0_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{45} = \mathrm{kG1\_0} \cdot [\mathrm{Gt}] \cdot [\mathrm{R0}] - \mathrm{kG2} \cdot [\mathrm{R0\_Gt}] \tag{123}$$

## 7.46 Reaction v_r13_1

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

**Name** v_r13_1

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\mathrm{Gt} + \mathrm{R1} \rightleftharpoons \mathrm{R1\_Gt} \tag{124}$$

### Reactants

Table 96: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R1 | R1 | |

### Product

Table 97: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1_Gt | R1_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{46} = \mathrm{kG1\_1} \cdot [\mathrm{Gt}] \cdot [\mathrm{R1}] - \mathrm{kG2} \cdot [\mathrm{R1\_Gt}] \tag{125}$$

## 7.47 Reaction v_r13_2

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

**Name** v_r13_2

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\mathrm{Gt} + \mathrm{R2} \rightleftharpoons \mathrm{R2\_Gt} \tag{126}$$

### Reactants

Table 98: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R2 | R2 | |

### Product

Table 99: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R2_Gt | R2_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{47} = \text{kG1\_2} \cdot [\text{Gt}] \cdot [\text{R2}] - \text{kG2} \cdot [\text{R2\_Gt}] \tag{127}$$

## 7.48 Reaction v_r13_3

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

**Name** v_r13_3

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\text{Gt} + \text{R3} \rightleftharpoons \text{R3\_Gt} \tag{128}$$

### Reactants

Table 100: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R3 | R3 | |

### Product

Table 101: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3_Gt | R3_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{48} = \text{kG1\_3} \cdot [\text{Gt}] \cdot [\text{R3}] - \text{kG2} \cdot [\text{R3\_Gt}] \tag{129}$$

## 7.49 Reaction v_r13_4

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

**Name** v_r13_4

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\mathrm{Gt} + \mathrm{R4} \rightleftharpoons \mathrm{R4\_Gt} \tag{130}$$

### Reactants

Table 102: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R4 | R4 | |

### Product

Table 103: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4_Gt | R4_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{49} = \mathrm{kG1\_4} \cdot [\mathrm{Gt}] \cdot [\mathrm{R4}] - \mathrm{kG2} \cdot [\mathrm{R4\_Gt}] \tag{131}$$

## 7.50 Reaction v_r13_5

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

**Name** v_r13_5

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\mathrm{Gt} + \mathrm{R5} \rightleftharpoons \mathrm{R5\_Gt} \tag{132}$$

### Reactants

Table 104: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R5 | R5 | |

### Product

Table 105: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5_Gt | R5_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{50} = \mathrm{kG1\_5} \cdot [\mathrm{Gt}] \cdot [\mathrm{R5}] - \mathrm{kG2} \cdot [\mathrm{R5\_Gt}] \tag{133}$$

## 7.51 Reaction v_r13_6

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

**Name** v_r13_6

**Notes** Rhodopsin and transducin binding

### Reaction equation

$$\mathrm{Gt} + \mathrm{R6} \rightleftharpoons \mathrm{R6\_Gt} \tag{134}$$

### Reactants

Table 106: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |
| R6 | R6 | |

### Product

Table 107: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6_Gt | R6_Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{51} = \mathrm{kG1\_6} \cdot [\mathrm{Gt}] \cdot [\mathrm{R6}] - \mathrm{kG2} \cdot [\mathrm{R6\_Gt}] \tag{135}$$

## 7.52 Reaction v_r14_0

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

**Name** v_r14_0

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\mathrm{R0\_Gt} \rightleftharpoons \mathrm{R0\_G} \tag{136}$$

### Reactant

Table 108: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R0_Gt | R0_Gt | |

### Product

Table 109: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R0_G | R0_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{52} = \mathrm{kG3} \cdot [\mathrm{R0\_Gt}] - \mathrm{kG4\_GDP} \cdot [\mathrm{R0\_G}] \tag{137}$$

## 7.53 Reaction v_r14_1

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

**Name** v_r14_1

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\mathrm{R1\_Gt} \rightleftharpoons \mathrm{R1\_G} \tag{138}$$

### Reactant

Table 110: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1_Gt | R1_Gt | |

### Product

Table 111: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1_G | R1_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{53} = \mathrm{kG3} \cdot [\mathrm{R1\_Gt}] - \mathrm{kG4\_GDP} \cdot [\mathrm{R1\_G}] \tag{139}$$

## 7.54 Reaction v_r14_2

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

**Name** v_r14_2

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\mathrm{R2\_Gt} \rightleftharpoons \mathrm{R2\_G} \tag{140}$$

### Reactant

Table 112: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2_Gt | R2_Gt | |

### Product

Table 113: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R2_G | R2_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{54} = \text{kG3} \cdot [\text{R2\_Gt}] - \text{kG4\_GDP} \cdot [\text{R2\_G}] \tag{141}$$

## 7.55 Reaction v_r14_3

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

**Name** v_r14_3

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\text{R3\_Gt} \rightleftharpoons \text{R3\_G} \tag{142}$$

### Reactant

Table 114: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3_Gt | R3_Gt | |

### Product

Table 115: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3_G | R3_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{55} = \text{kG3} \cdot [\text{R3\_Gt}] - \text{kG4\_GDP} \cdot [\text{R3\_G}] \tag{143}$$

## 7.56 Reaction v_r14_4

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

**Name** v_r14_4

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\text{R4\_Gt} \rightleftharpoons \text{R4\_G} \tag{144}$$

### Reactant

Table 116: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4_Gt | R4_Gt | |

### Product

Table 117: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4_G | R4_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{56} = \text{kG3} \cdot [\text{R4\_Gt}] - \text{kG4\_GDP} \cdot [\text{R4\_G}] \tag{145}$$

## 7.57 Reaction v_r14_5

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

**Name** v_r14_5

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\text{R5\_Gt} \rightleftharpoons \text{R5\_G} \tag{146}$$

### Reactant

Table 118: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5_Gt | R5_Gt | |

### Product

Table 119: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5_G | R5_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{57} = \mathrm{kG3} \cdot [\mathrm{R5\_Gt}] - \mathrm{kG4\_GDP} \cdot [\mathrm{R5\_G}] \tag{147}$$

## 7.58 Reaction v_r14_6

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

**Name** v_r14_6

**Notes** GDP dissociation from Rn_Gt. GDP is taken into account in the rate constant

### Reaction equation

$$\mathrm{R6\_Gt} \rightleftharpoons \mathrm{R6\_G} \tag{148}$$

### Reactant

Table 120: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6_Gt | R6_Gt | |

### Product

Table 121: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6_G | R6_G | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{58} = \mathrm{kG3} \cdot [\mathrm{R6\_Gt}] - \mathrm{kG4\_GDP} \cdot [\mathrm{R6\_G}] \tag{149}$$

## 7.59 Reaction v_r15_0

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_0

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\mathrm{R0\_G} \longrightarrow \mathrm{R0\_G\_GTP} \tag{150}$$

### Reactant

Table 122: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R0_G | R0_G | |

### Product

Table 123: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R0_G_GTP | R0_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{59} = \mathrm{kG5\_GTP} \cdot [\mathrm{R0\_G}] \tag{151}$$

## 7.60 Reaction v_r15_1

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_1

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\text{R1\_G} \longrightarrow \text{R1\_G\_GTP} \tag{152}$$

### Reactant

Table 124: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1_G | R1_G | |

### Product

Table 125: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R1_G_GTP | R1_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{60} = \text{kG5\_GTP} \cdot [\text{R1\_G}] \tag{153}$$

## 7.61 Reaction v_r15_2

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_2

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\text{R2\_G} \longrightarrow \text{R2\_G\_GTP} \tag{154}$$

### Reactant

Table 126: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2_G | R2_G | |

### Product

Table 127: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R2_G_GTP | R2_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{61} = \text{kG5\_GTP} \cdot [\text{R2\_G}] \tag{155}$$

## 7.62 Reaction v_r15_3

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_3

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\text{R3\_G} \longrightarrow \text{R3\_G\_GTP} \tag{156}$$

### Reactant

Table 128: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3_G | R3_G | |

### Product

Table 129: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R3_G_GTP | R3_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{62} = \text{kG5\_GTP} \cdot [\text{R3\_G}] \tag{157}$$

## 7.63 Reaction v_r15_4

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_4

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\text{R4\_G} \longrightarrow \text{R4\_G\_GTP} \tag{158}$$

### Reactant

Table 130: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4_G | R4_G | |

### Product

Table 131: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R4_G_GTP | R4_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{63} = \text{kG5\_GTP} \cdot [\text{R4\_G}] \tag{159}$$

## 7.64 Reaction v_r15_5

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_5

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\text{R5\_G} \longrightarrow \text{R5\_G\_GTP} \tag{160}$$

### Reactant

Table 132: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5_G | R5_G | |

### Product

Table 133: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R5_G_GTP | R5_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{64} = \text{kG5\_GTP} \cdot [\text{R5\_G}] \tag{161}$$

## 7.65 Reaction v_r15_6

This is an irreversible reaction of one reactant forming one product.

**Name** v_r15_6

**Notes** GTP binding to Rn_G. GTP is taken into account in the rate constant. Here G is still a heterotrimer and GTP binds to such heterotrimer_R complex

### Reaction equation

$$\text{R6\_G} \longrightarrow \text{R6\_G\_GTP} \tag{162}$$

### Reactant

Table 134: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6_G | R6_G | |

### Product

Table 135: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| R6_G_GTP | R6_G_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{65} = \text{kG5\_GTP} \cdot [\text{R6\_G}] \tag{163}$$

## 7.66 Reaction v_r16_0

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

**Name** v_r16_0

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\text{R0\_G\_GTP} \longrightarrow \text{G\_GTP} + \text{R0} \tag{164}$$

### Reactant

Table 136: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R0_G_GTP | R0_G_GTP | |

### Products

Table 137: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R0 | R0 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{66} = \mathrm{kG6} \cdot [\mathrm{R0\_G\_GTP}] \tag{165}$$

## 7.67 Reaction v_r16_1

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

**Name** v_r16_1

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\mathrm{R1\_G\_GTP} \longrightarrow \mathrm{G\_GTP} + \mathrm{R1} \tag{166}$$

### Reactant

Table 138: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R1_G_GTP | R1_G_GTP | |

### Products

Table 139: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R1 | R1 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{67} = \text{kG6} \cdot [\text{R1\_G\_GTP}] \tag{167}$$

## 7.68 Reaction v_r16_2

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

**Name** v_r16_2

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\text{R2\_G\_GTP} \longrightarrow \text{G\_GTP} + \text{R2} \tag{168}$$

### Reactant

Table 140: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R2_G_GTP | R2_G_GTP | |

### Products

Table 141: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R2 | R2 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{68} = \text{kG6} \cdot [\text{R2\_G\_GTP}] \tag{169}$$

## 7.69 Reaction v_r16_3

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

**Name** v_r16_3

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\text{R3\_G\_GTP} \longrightarrow \text{G\_GTP} + \text{R3} \tag{170}$$

### Reactant

Table 142: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R3_G_GTP | R3_G_GTP | |

### Products

Table 143: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R3 | R3 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{69} = \text{kG6} \cdot [\text{R3\_G\_GTP}] \tag{171}$$

## 7.70 Reaction v_r16_4

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

**Name** v_r16_4

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\text{R4\_G\_GTP} \longrightarrow \text{G\_GTP} + \text{R4} \tag{172}$$

### Reactant

Table 144: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R4_G_GTP | R4_G_GTP | |

### Products

Table 145: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R4 | R4 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{70} = \text{kG6} \cdot [\text{R4\_G\_GTP}] \tag{173}$$

## 7.71 Reaction v_r16_5

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

**Name** v_r16_5

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\text{R5\_G\_GTP} \longrightarrow \text{G\_GTP} + \text{R5} \tag{174}$$

### Reactant

Table 146: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R5_G_GTP | R5_G_GTP | |

### Products

Table 147: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R5 | R5 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{71} = \mathrm{kG6} \cdot [\mathrm{R5\_G\_GTP}] \tag{175}$$

## 7.72 Reaction v_r16_6

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

**Name** v_r16_6

**Notes** Rn_G_GTP dissociation to Rn and G_GTP. Here G_GTP is the Gt heterotrimer with bound GTP

### Reaction equation

$$\mathrm{R6\_G\_GTP} \longrightarrow \mathrm{G\_GTP} + \mathrm{R6} \tag{176}$$

### Reactant

Table 148: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| R6_G_GTP | R6_G_GTP | |

### Products

Table 149: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |
| R6 | R6 | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{72} = \text{kG6} \cdot [\text{R6\_G\_GTP}] \tag{177}$$

## 7.73 Reaction v_r17

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

**Name** v_r17

**Notes** Dissociation of trimeric Gt into alpha and beta-gamma subunits

### Reaction equation

$$\text{G\_GTP} \longrightarrow \text{Ga\_GTP} + \text{Gbg} \tag{178}$$

### Reactant

Table 150: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| G_GTP | G_GTP | |

### Products

Table 151: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP | Ga_GTP | |
| Gbg | Gbg | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{73} = \text{kG7} \cdot [\text{G\_GTP}] \tag{179}$$

## 7.74 Reaction v_r18

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

**Name** v_r18

**Notes** PDE activation. Here we have the following assumptions on the effector 1) Each PDE subunit may bind Ga_Gtp and become active independently from the other one and with no cooperativity, 2) A PDE hetero-tetramer can hence bind up to 2 different Ga_GTP and

thus it works with its in vivo kcat (the reversible reaction is assumed to be possibly present but in this model its rate is set to zero)

### Reaction equation

$$\text{Ga\_GTP} + \text{PDE} \rightleftharpoons \text{PDE\_Ga\_GTP} \tag{180}$$

### Reactants

Table 152: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP | Ga_GTP | |
| PDE | PDE | |

### Product

Table 153: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| PDE_Ga_GTP | PDE_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{74} = \text{kP1} \cdot [\text{PDE}] \cdot [\text{Ga\_GTP}] - \text{kP1\_rev} \cdot [\text{PDE\_Ga\_GTP}] \tag{181}$$

## 7.75 Reaction v_r19

This is an irreversible reaction of one reactant forming one product.

**Name** v_r19

### Reaction equation

$$\text{PDE\_Ga\_GTP} \longrightarrow \text{PDE\_a\_Ga\_GTP} \tag{182}$$

### Reactant

Table 154: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| PDE_Ga_GTP | PDE_Ga_GTP | |

### Product

Table 155: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{75} = \text{kP2} \cdot [\text{PDE\_Ga\_GTP}] \tag{183}$$

## 7.76 Reaction v_r20

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

**Name** v_r20

**Notes** Here PDE has two Ga bound but only one active subunit

### Reaction equation

$$\text{Ga\_GTP} + \text{PDE\_a\_Ga\_GTP} \longrightarrow \text{Ga\_GTP\_PDE\_a\_Ga\_GTP} \tag{184}$$

### Reactants

Table 156: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP | Ga_GTP | |
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |

### Product

Table 157: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP_PDE_a_Ga_GTP | Ga_GTP_PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{76} = \text{kP3} \cdot [\text{PDE\_a\_Ga\_GTP}] \cdot [\text{Ga\_GTP}] \tag{185}$$

## 7.77 Reaction v_r21

This is an irreversible reaction of one reactant forming one product.

**Name** v_r21

**Notes** Here PDE has two Ga bound and both its subunits are active

### Reaction equation

$$\text{Ga\_GTP\_PDE\_a\_Ga\_GTP} \longrightarrow \text{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} \tag{186}$$

### Reactant

Table 158: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP_PDE_a_Ga_GTP | Ga_GTP_PDE_a_Ga_GTP | |

### Product

Table 159: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP_a_PDE_a_Ga_GTP | Ga_GTP_a_PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{77} = \text{kP4} \cdot [\text{Ga\_GTP\_PDE\_a\_Ga\_GTP}] \tag{187}$$

## 7.78 Reaction v_r22

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

**Name** v_r22

**Notes** RGS binds to a PDE-Ga complex with both active subunits to form a complex

### Reaction equation

$$\text{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} + \text{RGS} \longrightarrow \text{RGS\_Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} \tag{188}$$

### Reactants

Table 160: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP_a_PDE_a_Ga_GTP | Ga_GTP_a_PDE_a_Ga_GTP | |
| RGS | RGS | |

### Product

Table 161: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| RGS_Ga_GTP_a_PDE_a_Ga_GTP | RGS_Ga_GTP_a_PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{78} = \text{kRGS1} \cdot [\text{RGS}] \cdot [\text{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP}] \tag{189}$$

## 7.79 Reaction v_r23

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

**Name** v_r23

**Notes** One out of two PDE subunits is deactivated and one GTP is hydrolyzed

### Reaction equation

$$\text{RGS\_Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} \longrightarrow \text{Ga\_GDP} + \text{PDE\_a\_Ga\_GTP} + \text{RGS} \tag{190}$$

### Reactant

Table 162: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| RGS_Ga_GTP_a_PDE_a_Ga_GTP | RGS_Ga_GTP_a_PDE_a_Ga_GTP | |

### Products

Table 163: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GDP | Ga_GDP | |
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |
| RGS | RGS | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{79} = \text{kRGS2} \cdot [\text{RGS\_Ga\_GTP\_a\_PDE\_a\_Ga\_GTP}] \tag{191}$$

## 7.80 Reaction v_r24

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

**Name** v_r24

**Notes** RGS binds to a PDE-Ga complex with one active subunit to form a complex. Here we assume that the association rate constant is the same as in v_r22

### Reaction equation

$$\text{PDE\_a\_Ga\_GTP} + \text{RGS} \longrightarrow \text{RGS\_PDE\_a\_Ga\_GTP} \tag{192}$$

### Reactants

Table 164: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |
| RGS | RGS | |

### Product

Table 165: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| RGS_PDE_a_Ga_GTP | RGS_PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{80} = \text{kRGS1} \cdot [\text{RGS}] \cdot [\text{PDE\_a\_Ga\_GTP}] \tag{193}$$

## 7.81 Reaction v_r25

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

**Name** v_r25

**Notes** The PDE subunit is deactivated and GTP is hydrolyzed. Here we assume that the deactivation/dissociation rate constant is the same as in v_r23

### Reaction equation

$$\text{RGS\_PDE\_a\_Ga\_GTP} \longrightarrow \text{Ga\_GDP} + \text{PDE} + \text{RGS} \tag{194}$$

### Reactant

Table 166: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| RGS_PDE_a_Ga_GTP | RGS_PDE_a_Ga_GTP | |

### Products

Table 167: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GDP | Ga_GDP | |
| PDE | PDE | |
| RGS | RGS | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{81} = \text{kRGS2} \cdot [\text{RGS\_PDE\_a\_Ga\_GTP}] \tag{195}$$

## 7.82 Reaction v_r26

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

**Name** v_r26

**Notes** Inactivation of the PDEa complex by Ga's GTPase capability

### Reaction equation

$$\text{PDE\_a\_Ga\_GTP} \longrightarrow \text{Ga\_GDP} + \text{PDE} \tag{196}$$

### Reactant

Table 168: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |

### Products

Table 169: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GDP | Ga_GDP | |
| PDE | PDE | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{82} = \text{kPDEshutoff} \cdot [\text{PDE\_a\_Ga\_GTP}] \tag{197}$$

## 7.83 Reaction v_r27

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

**Name** v_r27

**Notes** Inactivation of the aPDEa complex by Ga's GTPase capability; here we assume that the same rate constant as above applies

### Reaction equation

$$\text{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} \longrightarrow \text{Ga\_GDP} + \text{PDE\_a\_Ga\_GTP} \tag{198}$$

### Reactant

Table 170: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP_a_PDE_a_Ga_GTP | Ga_GTP_a_PDE_a_Ga_GTP | |

### Products

Table 171: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GDP | Ga_GDP | |
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{83} = \text{kPDEshutoff} \cdot [\text{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP}] \tag{199}$$

## 7.84 Reaction v_r28

This is an irreversible reaction of one reactant forming one product.

**Name** v_r28

**Notes** Here we assume, according to Felber et al. (1996) that Gt may hydrolize GTP to GDP, and hence inactivate

### Reaction equation

$$\text{Ga\_GTP} \longrightarrow \text{Ga\_GDP} \tag{200}$$

### Reactant

Table 172: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP | Ga_GTP | |

### Product

Table 173: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ga_GDP | Ga_GDP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{84} = \text{kGshutoff} \cdot [\text{Ga\_GTP}] \tag{201}$$

## 7.85 Reaction v_r29

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

**Name** v_r29

**Notes** Gt recycling... heterotrimer reconstitution

### Reaction equation

$$\text{Ga\_GDP} + \text{Gbg} \longrightarrow \text{Gt} \tag{202}$$

### Reactants

Table 174: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ga_GDP | Ga_GDP | |
| Gbg | Gbg | |

### Product

Table 175: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Gt | Gt | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{85} = \text{kGrecyc} \cdot [\text{Gbg}] \cdot [\text{Ga\_GDP}] \tag{203}$$

## 7.86 Reaction v_r30

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

**Name** v_r30

**Notes** RK inhibition by Rec_2Ca (Rec_wCa2 is determined using QSSA and not directly)

### Reaction equation

$$\text{RK} \overset{\text{Ca2\_free}}{\rightleftharpoons} \text{Rec\_wCa2\_RK} \tag{204}$$

### Reactant

Table 176: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| RK | RK | |

### Modifier

Table 177: Properties of each modifier.

| Id | Name | SBO |
|---|---|---|
| Ca2_free | Ca2_free | |

### Product

Table 178: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Rec_wCa2_RK | Rec_wCa2_RK | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{86} = \text{kRec3} \cdot \text{Rec\_wCa2} \cdot [\text{RK}] - \text{kRec4} \cdot [\text{Rec\_wCa2\_RK}] \tag{205}$$

## 7.87 Reaction v_r31

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

**Name** v_r31

**Notes** Ca2+ association and dissociation from intracellular buffers, with total concentration eT

### Reaction equation

$$\text{Ca2\_free} \rightleftharpoons \text{Ca2\_buff} \tag{206}$$

### Reactant

Table 179: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ca2_free | Ca2_free | |

### Product

Table 180: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ca2_buff | Ca2_buff | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{87} = \text{k1} \cdot (\text{eT} - [\text{Ca2\_buff}]) \cdot [\text{Ca2\_free}] - \text{k2} \cdot [\text{Ca2\_buff}] \tag{207}$$

## 7.88 Reaction v_r32

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

**Name** v_r32

**Notes** Efflux of Ca2+ via the Na+/Ca2+ - K+ exchanger. Note that intracellular Ca2 cannot be lower than Ca2_0

### Reaction equation

$$\text{Ca2\_free} \longrightarrow \emptyset \tag{208}$$

### Reactant

Table 181: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| Ca2_free | Ca2_free | |

### Kinetic Law

**Derived unit** not available

$$v_{88} = \text{gammaCa} \cdot ([\text{Ca2\_free}] - \text{Ca2\_0}) \tag{209}$$

## 7.89 Reaction v_r33

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

**Name** v_r33

**Notes** Influx of extracellular Ca2+ through cGMP-gated cation channels

### Reaction equation

$$\emptyset \xrightarrow{\text{cGMP}} \text{Ca2\_free} \tag{210}$$

### Modifier

Table 182: Properties of each modifier.

| Id | Name | SBO |
|---|---|---|
| cGMP | cGMP | |

### Product

Table 183: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| Ca2_free | Ca2_free | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{89} = \frac{1000000.0 \cdot \mathrm{fCa} \cdot \mathrm{Jdark}}{(2 + \mathrm{fCa}) \cdot \mathrm{F} \cdot \mathrm{Vcyto}} \cdot \left( \frac{[\mathrm{cGMP}]}{\mathrm{cGMPdark}} \right)^{\mathrm{ncg}} \tag{211}$$

## 7.90 Reaction v_r34

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

**Name** v_r34

**Notes** Synthesis by means of Guanylyl cyclase

### Reaction equation

$$\emptyset \xrightarrow{\mathrm{Ca2\_free}} \mathrm{cGMP} \tag{212}$$

### Modifier

Table 184: Properties of each modifier.

| Id | Name | SBO |
|---|---|---|
| Ca2_free | Ca2_free | |

### Product

Table 185: Properties of each product.

| Id | Name | SBO |
|---|---|---|
| cGMP | cGMP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{90} = \frac{\text{alfamax}}{1 + \left(\frac{[\text{Ca2\_free}]}{\text{Kc}}\right)^{\text{m}}} \tag{213}$$

## 7.91 Reaction v_r35

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

**Name** v_r35

**Notes** Hydrolysis by means of PDE

### Reaction equation

$$\text{cGMP} \xrightarrow{\text{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP, PDE\_a\_Ga\_GTP}} \emptyset \tag{214}$$

### Reactant

Table 186: Properties of each reactant.

| Id | Name | SBO |
|---|---|---|
| cGMP | cGMP | |

### Modifiers

Table 187: Properties of each modifier.

| Id | Name | SBO |
|---|---|---|
| Ga_GTP_a_PDE_a_Ga_GTP | Ga_GTP_a_PDE_a_Ga_GTP | |
| PDE_a_Ga_GTP | PDE_a_Ga_GTP | |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{91} = (\text{betadark} + \text{betasub} \cdot \text{E}) \cdot [\text{cGMP}] \tag{215}$$

# 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 `Arr`

**Name** Arr

**SBO:0000252** polypeptide chain

**Initial concentration** $3.13 \cdot 10^{7}\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in twelve reactions (as a reactant in `v_r5_1`, `v_r5_2`, `v_r5_3`, `v_r5_4`, `v_r5_5`, `v_r5_6` and as a product in `v_r6_1`, `v_r6_2`, `v_r6_3`, `v_r6_4`, `v_r6_5`, `v_r6_6`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Arr} = v_{27} + v_{28} + v_{29} + v_{30} + v_{31} + v_{32} - v_{21} - v_{22} - v_{23} - v_{24} - v_{25} - v_{26} \tag{216}$$

## 8.2 Species `Ca2_buff`

**Name** Ca2_buff

**SBO:0000247** simple chemical

**Initial concentration** $42.857\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in one reaction (as a product in `v_r31`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ca2\_buff} = v_{87} \tag{217}$$

## 8.3 Species `Ca2_free`

**Name** Ca2_free

**SBO:0000247** simple chemical

**Initial concentration** $0.6\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in five reactions (as a reactant in v_r31, v_r32 and as a product in v_r33 and as a modifier in v_r30, v_r34).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ca2\_free} = v_{89} - v_{87} - v_{88} \tag{218}$$

## 8.4 Species G_GTP

**Name** G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in nine reactions (as a reactant in v_r17 and as a product in v_r11, v_r16_0, v_r16_1, v_r16_2, v_r16_3, v_r16_4, v_r16_5, v_r16_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{G\_GTP} = v_{43} + v_{66} + v_{67} + v_{68} + v_{69} + v_{70} + v_{71} + v_{72} - v_{73} \tag{219}$$

## 8.5 Species Ga_GDP

**Name** Ga_GDP

**SBO:0000296** macromolecular complex

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

This species takes part in six reactions (as a reactant in v_r29 and as a product in v_r23, v_r25, v_r26, v_r27, v_r28).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ga\_GDP} = v_{79} + v_{81} + v_{82} + v_{83} + v_{84} - v_{85} \tag{220}$$

## 8.6 Species Ga_GTP

**Name** Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in four reactions (as a reactant in v_r18, v_r20, v_r28 and as a product in v_r17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ga\_GTP} = v_{73} - v_{74} - v_{76} - v_{84} \tag{221}$$

## 8.7 Species Ga_GTP_PDE_a_Ga_GTP

**Name** Ga_GTP_PDE_a_Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r21 and as a product in v_r20).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ga\_GTP\_PDE\_a\_Ga\_GTP} = v_{76} - v_{77} \tag{222}$$

## 8.8 Species Ga_GTP_a_PDE_a_Ga_GTP

**Name** Ga_GTP_a_PDE_a_Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in four reactions (as a reactant in v_r22, v_r27 and as a product in v_r21 and as a modifier in v_r35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} = v_{77} - v_{78} - v_{83} \tag{223}$$

## 8.9 Species Gbg

**Name** Gbg

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r29 and as a product in v_r17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gbg} = v_{73} - v_{85} \tag{224}$$

## 8.10 Species Gt

**Name** Gt

**SBO:0000252** polypeptide chain

**Initial concentration** $3.6\cdot 10^{8}\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in nine reactions (as a reactant in v_r8, v_r13_0, v_r13_1, v_r13_2, v_r13_3, v_r13_4, v_r13_5, v_r13_6 and as a product in v_r29).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Gt} = v_{85} - v_{40} - v_{45} - v_{46} - v_{47} - v_{48} - v_{49} - v_{50} - v_{51} \tag{225}$$

## 8.11 Species Ops

**Name** Ops

**SBO:0000252** polypeptide chain

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

This species takes part in 16 reactions (as a reactant in v_r8, v_r12 and as a product in v_r6_1, v_r6_2, v_r6_3, v_r6_4, v_r6_5, v_r6_6, v_r7_0, v_r7_1, v_r7_2, v_r7_3, v_r7_4, v_r7_5, v_r7_6, v_r11).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ops} = {} & v_{27} + v_{28} + v_{29} + v_{30} + v_{31} + v_{32} + v_{33} + v_{34} \\ & + v_{35} + v_{36} + v_{37} + v_{38} + v_{39} + v_{43} - v_{40} - v_{44}\end{aligned} \tag{226}$$

## 8.12 Species Ops_G

**Name** Ops_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r10 and as a product in v_r9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ops\_G} = v_{41} - v_{42} \tag{227}$$

## 8.13 Species Ops_G_GTP

**Name** Ops_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r11 and as a product in v_r10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ops\_G\_GTP} = v_{42} - v_{43} \tag{228}$$

## 8.14 Species Ops_Gt

**Name** Ops_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r9 and as a product in v_r8).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ops\_Gt} = v_{40} - v_{41} \tag{229}$$

## 8.15 Species PDE

**Name** PDE

**SBO:0000252** polypeptide chain

**Initial concentration** $1.335 \cdot 10^{7}\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v_r18 and as a product in v_r25, v_r26).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PDE} = v_{81} + v_{82} - v_{74} \tag{230}$$

## 8.16 Species PDE_Ga_GTP

**Name** PDE_Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r19 and as a product in v_r18).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PDE\_Ga\_GTP} = v_{74} - v_{75} \tag{231}$$

## 8.17 Species PDE_a_Ga_GTP

**Name** PDE_a_Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in seven reactions (as a reactant in v_r20, v_r24, v_r26 and as a product in v_r19, v_r23, v_r27 and as a modifier in v_r35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PDE\_a\_Ga\_GTP} = v_{75} + v_{79} + v_{83} - v_{76} - v_{80} - v_{82} \tag{232}$$

## 8.18 Species R

**Name** R

**SBO:0000252** polypeptide chain

**Initial concentration** $3.6 \cdot 10^{9}\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in v_r1 and as a product in v_r12).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R} = v_{44} - v_{1} \tag{233}$$

## 8.19 Species R0

**Name** R0

**SBO:0000252** polypeptide chain

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

This species takes part in five reactions (as a reactant in v_r2_0, v_r7_0, v_r13_0 and as a product in v_r1, v_r16_0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R0} = v_1 + v_{66} - v_2 - v_{33} - v_{45} \tag{234}$$

## 8.20 Species R0_G

**Name** R0_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_0 and as a product in v_r14_0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R0\_G} = v_{52} - v_{59} \tag{235}$$

## 8.21 Species R0_G_GTP

**Name** R0_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_0 and as a product in v_r15_0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R0\_G\_GTP} = v_{59} - v_{66} \tag{236}$$

## 8.22 Species R0_Gt

**Name** R0_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_0 and as a product in v_r13_0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R0\_Gt} = v_{45} - v_{52} \tag{237}$$

## 8.23 Species R0_RKpre

**Name** R0_RKpre

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r3_0 and as a product in v_r2_0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R0\_RKpre} = v_2 - v_9 \tag{238}$$

## 8.24 Species R1

**Name** R1

**SBO:0000252** polypeptide chain

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

This species takes part in six reactions (as a reactant in v_r2_1, v_r5_1, v_r7_1, v_r13_1 and as a product in v_r4_1, v_r16_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1} = v_{15} + v_{67} - v_3 - v_{21} - v_{34} - v_{46} \tag{239}$$

## 8.25 Species R1_Arr

**Name** R1_Arr

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r6_1 and as a product in v_r5_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1\_Arr} = v_{21} - v_{27} \tag{240}$$

## 8.26 Species R1_G

**Name** R1_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_1 and as a product in v_r14_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1\_G} = v_{53} - v_{60} \tag{241}$$

## 8.27 Species R1_G_GTP

**Name** R1_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_1 and as a product in v_r15_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1\_G\_GTP} = v_{60} - v_{67} \tag{242}$$

## 8.28 Species R1_Gt

**Name** R1_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_1 and as a product in v_r13_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1\_Gt} = v_{46} - v_{53} \tag{243}$$

## 8.29 Species R1_RKpost

**Name** R1_RKpost

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r4_1 and as a product in v_r3_0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1\_RKpost} = v_{9} - v_{15} \tag{244}$$

## 8.30 Species R1_RKpre

**Name** R1_RKpre

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r3_1 and as a product in v_r2_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R1\_RKpre} = v_{3} - v_{10} \tag{245}$$

## 8.31 Species R2

**Name** R2

**SBO:0000252** polypeptide chain

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

This species takes part in six reactions (as a reactant in v_r2_2, v_r5_2, v_r7_2, v_r13_2 and as a product in v_r4_2, v_r16_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2} = v_{16} + v_{68} - v_4 - v_{22} - v_{35} - v_{47} \tag{246}$$

## 8.32 Species R2_Arr

**Name** R2_Arr

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r6_2 and as a product in v_r5_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2\_Arr} = v_{22} - v_{28} \tag{247}$$

## 8.33 Species R2_G

**Name** R2_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_2 and as a product in v_r14_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2\_G} = v_{54} - v_{61} \tag{248}$$

## 8.34 Species R2_G_GTP

**Name** R2_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_2 and as a product in v_r15_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2\_G\_GTP} = v_{61} - v_{68} \tag{249}$$

## 8.35 Species R2_Gt

**Name** R2_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_2 and as a product in v_r13_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2\_Gt} = v_{47} - v_{54} \tag{250}$$

## 8.36 Species R2_RKpost

**Name** R2_RKpost

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r4_2 and as a product in v_r3_1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2\_RKpost} = v_{10} - v_{16} \tag{251}$$

## 8.37 Species R2_RKpre

**Name** R2_RKpre

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r3_2 and as a product in v_r2_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R2\_RKpre} = v_{4} - v_{11} \tag{252}$$

## 8.38 Species R3

**Name** R3

**SBO:0000252** polypeptide chain

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

This species takes part in six reactions (as a reactant in v_r2_3, v_r5_3, v_r7_3, v_r13_3 and as a product in v_r4_3, v_r16_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3} = v_{17} + v_{69} - v_{5} - v_{23} - v_{36} - v_{48} \tag{253}$$

## 8.39 Species R3_Arr

**Name** R3_Arr

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r6_3 and as a product in v_r5_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3\_Arr} = v_{23} - v_{29} \tag{254}$$

## 8.40 Species R3_G

**Name** R3_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_3 and as a product in v_r14_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3\_G} = v_{55} - v_{62} \tag{255}$$

## 8.41 Species R3_G_GTP

**Name** R3_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_3 and as a product in v_r15_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3\_G\_GTP} = v_{62} - v_{69} \tag{256}$$

## 8.42 Species R3_Gt

**Name** R3_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_3 and as a product in v_r13_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3\_Gt} = v_{48} - v_{55} \tag{257}$$

## 8.43 Species R3_RKpost

**Name** R3_RKpost

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r4_3 and as a product in v_r3_2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3\_RKpost} = v_{11} - v_{17} \tag{258}$$

## 8.44 Species R3_RKpre

**Name** R3_RKpre

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r3_3 and as a product in v_r2_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R3\_RKpre} = v_{5} - v_{12} \tag{259}$$

## 8.45 Species R4

**Name** R4

**SBO:0000252** polypeptide chain

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

This species takes part in six reactions (as a reactant in v_r2_4, v_r5_4, v_r7_4, v_r13_4 and as a product in v_r4_4, v_r16_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4} = v_{18} + v_{70} - v_{6} - v_{24} - v_{37} - v_{49} \tag{260}$$

## 8.46 Species R4_Arr

**Name** R4_Arr

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r6_4 and as a product in v_r5_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4\_Arr} = v_{24} - v_{30} \tag{261}$$

## 8.47 Species R4_G

**Name** R4_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_4 and as a product in v_r14_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4\_G} = v_{56} - v_{63} \tag{262}$$

## 8.48 Species R4_G_GTP

**Name** R4_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_4 and as a product in v_r15_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4\_G\_GTP} = v_{63} - v_{70} \tag{263}$$

## 8.49 Species R4_Gt

**Name** R4_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_4 and as a product in v_r13_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4\_Gt} = v_{49} - v_{56} \tag{264}$$

## 8.50 Species R4_RKpost

**Name** R4_RKpost

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r4_4 and as a product in v_r3_3).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4\_RKpost} = v_{12} - v_{18} \tag{265}$$

## 8.51 Species R4_RKpre

**Name** R4_RKpre

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r3_4 and as a product in v_r2_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R4\_RKpre} = v_6 - v_{13} \tag{266}$$

## 8.52 Species R5

**Name** R5

**SBO:0000252** polypeptide chain

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

This species takes part in six reactions (as a reactant in v_r2_5, v_r5_5, v_r7_5, v_r13_5 and as a product in v_r4_5, v_r16_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5} = v_{19} + v_{71} - v_7 - v_{25} - v_{38} - v_{50} \tag{267}$$

## 8.53 Species R5_Arr

**Name** R5_Arr

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r6_5 and as a product in v_r5_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5\_Arr} = v_{25} - v_{31} \tag{268}$$

## 8.54 Species R5_G

**Name** R5_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_5 and as a product in v_r14_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5\_G} = v_{57} - v_{64} \tag{269}$$

## 8.55 Species R5_G_GTP

**Name** R5_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_5 and as a product in v_r15_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5\_G\_GTP} = v_{64} - v_{71} \tag{270}$$

## 8.56 Species R5_Gt

**Name** R5_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_5 and as a product in v_r13_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5\_Gt} = v_{50} - v_{57} \tag{271}$$

## 8.57 Species R5_RKpost

**Name** R5_RKpost

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r4_5 and as a product in v_r3_4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5\_RKpost} = v_{13} - v_{19} \tag{272}$$

## 8.58 Species R5_RKpre

**Name** R5_RKpre

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r3_5 and as a product in v_r2_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R5\_RKpre} = v_{7} - v_{14} \tag{273}$$

## 8.59 Species R6

**Name** R6

**SBO:0000252** polypeptide chain

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

This species takes part in six reactions (as a reactant in v_r2_6, v_r5_6, v_r7_6, v_r13_6 and as a product in v_r4_6, v_r16_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6} = v_{20} + v_{72} - v_{8} - v_{26} - v_{39} - v_{51} \tag{274}$$

## 8.60 Species R6_Arr

**Name** R6_Arr

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r6_6 and as a product in v_r5_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6\_Arr} = v_{26} - v_{32} \tag{275}$$

## 8.61 Species R6_G

**Name** R6_G

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r15_6 and as a product in v_r14_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6\_G} = v_{58} - v_{65} \tag{276}$$

## 8.62 Species R6_G_GTP

**Name** R6_G_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r16_6 and as a product in v_r15_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6\_G\_GTP} = v_{65} - v_{72} \tag{277}$$

## 8.63 Species R6_Gt

**Name** R6_Gt

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r14_6 and as a product in v_r13_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6\_Gt} = v_{51} - v_{58} \tag{278}$$

## 8.64 Species R6_RKpost

**Name** R6_RKpost

**SBO:0000297** protein complex

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

This species takes part in two reactions (as a reactant in v_r4_6 and as a product in v_r3_5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6\_RKpost} = v_{14} - v_{20} \tag{279}$$

## 8.65 Species R6_RKpre

**Name** R6_RKpre

**SBO:0000297** protein complex

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

This species takes part in one reaction (as a product in v_r2_6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R6\_RKpre} = v_{8} \tag{280}$$

## 8.66 Species RGS

**Name** RGS

**SBO:0000252** polypeptide chain

**Initial concentration** $3000000\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in four reactions (as a reactant in v_r22, v_r24 and as a product in v_r23, v_r25).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGS} = v_{79} + v_{81} - v_{78} - v_{80} \tag{281}$$

## 8.67 Species RGS_Ga_GTP_a_PDE_a_Ga_GTP

**Name** RGS_Ga_GTP_a_PDE_a_Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r23 and as a product in v_r22).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGS\_Ga\_GTP\_a\_PDE\_a\_Ga\_GTP} = v_{78} - v_{79} \tag{282}$$

## 8.68 Species RGS_PDE_a_Ga_GTP

**Name** RGS_PDE_a_Ga_GTP

**SBO:0000296** macromolecular complex

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

This species takes part in two reactions (as a reactant in v_r25 and as a product in v_r24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RGS\_PDE\_a\_Ga\_GTP} = v_{80} - v_{81} \tag{283}$$

## 8.69 Species RK

**Name** RK

**SBO:0000252** polypeptide chain

**Initial concentration** $10838\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in 14 reactions (as a reactant in v_r2_0, v_r2_1, v_r2_2, v_r2_3, v_r2_4, v_r2_5, v_r2_6, v_r30 and as a product in v_r4_1, v_r4_2, v_r4_3, v_r4_4, v_r4_5, v_r4_6).

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RK} = {} & v_{15} + v_{16} + v_{17} + v_{18} + v_{19} + v_{20} - v_2 \\ & - v_3 - v_4 - v_5 - v_6 - v_7 - v_8 - v_{86}\end{aligned} \tag{284}$$

## 8.70 Species Rec_wCa2_RK

**Name** Rec_wCa2_RK

**SBO:0000296** macromolecular complex

**Initial concentration** $4204560\ \mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in one reaction (as a product in v_r30).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Rec\_wCa2\_RK} = v_{86} \tag{285}$$

### 8.71 Species cGMP

**Name** cGMP

**SBO:0000247** simple chemical

**Initial concentration** $4\ \mathrm{mol} \cdot \mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in v_r35 and as a product in v_r34 and as a modifier in v_r33).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{cGMP} = v_{90} - v_{91} \tag{286}$$

## A Glossary of Systems Biology Ontology Terms

**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: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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