SBML Model Report

Model name: "Eungdamrong2007_Ras_Activation"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by Harish Dharuri[1] at January 29th 2008 at 10:13 a. m. and last time modified at March 20th 2014 at 5:03 p. m. Table 1 gives an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	7
species types	0	species	46
events	0	constraints	0
reactions	43	function definitions	0
global parameters	26	unit definitions	21
rules	12	initial assignments	0

Model Notes

The model reproduces the time profiles of Golgi Ras-GTP and plasma membrane Ras-GTP, subjected to a palmitoylation rate of 0.00015849 second inverse. This is depicted in Fig 5a and 5b for various palmitolylation rates, however the value used in this model is not present in the figure in the paper but corresponds to Fig S2 of the supplement. Model successfully reproduced using MathSBML. Please note that the units of volumetric species in this model are

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molecules/micrometer cubed, to convert this to microMolar as given in the paper, multiply the simulation result by 1/602.

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 23 unit definitions of which two are predefined by SBML and not mentioned in the model.

2.1 Unit `substance`

Definition item

2.2 Unit `volume`

Definition μm^3

2.3 Unit `area`

Definition μm^2

2.4 Unit `molecules`

Definition item

2.5 Unit `umol_um3_litre_1`

Definition 10^{-21} mol

2.6 Unit `um2`

Definition μm^2

2.7 Unit uM_um3_molecules_1

Definition 10^{-21} dimensionless $\cdot$ item^{-1} $\cdot$ mol

2.8 Unit molecules_um_2_s_1

Definition 10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2} $\cdot$ s^{-1}

2.9 Unit pA_um_2

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

2.10 Unit s_1

Definition s^{-1}

2.11 Unit s

Definition s

2.12 Unit molecules_um_2

Definition 10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2}

2.13 Unit uM_s_1

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

2.14 Unit uM_1_s_1

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

2.15 Unit uM

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

2.16 Unit molecules_um_2_uM_1_s_1

Definition 10^{15} dimensionless $\cdot$ item $\cdot$ m $\cdot$ mol^{-1} $\cdot$ s^{-1}

2.17 Unit um2_molecules_1_s_1

Definition 10^{-12} dimensionless $\cdot$ item^{-1} $\cdot$ m^{2} $\cdot$ s^{-1}

2.18 Unit uM_um_s_1

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

2.19 Unit _one__0E_33_item_2_m2_mol_s_1

Definition 10^{-33} dimensionless $\cdot$ item$^{-2} \cdot$ m$^2 \cdot$ mol $\cdot$ s^{-1}

2.20 Unit _one__0E_30_item_2_m5_s_1

Definition 10^{-30} dimensionless $\cdot$ item$^{-2} \cdot$ m$^5 \cdot$ s^{-1}

2.21 Unit um3_molecules_1_s_1

Definition 10^{-18} dimensionless $\cdot$ item$^{-1} \cdot$ m$^3 \cdot$ s^{-1}

2.22 Unit length

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

Definition m

2.23 Unit time

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

Definition s

3 Compartments

This model contains seven compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
EC	EC		3	1	μm^3	☑	
cyt	cyt		3	0.976	μm^3	☑	PM
er	er		3	0.012	μm^3	☑	erMembrane
Golgi	Golgi		3	0.012	μm^3	☑	GM
PM	PM		2	0.6	μm^2	☑	EC
erMembrane	erMembrane		2	0.0456	μm^2	☑	cyt
GM	GM		2	0.048	μm^2	☑	cyt

3.1 Compartment EC

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

Name EC

3.2 Compartment `cyt`

This is a three dimensional compartment with a constant size of 0.976 μm^3, which is surrounded by `PM` (PM).

Name cyt

3.3 Compartment `er`

This is a three dimensional compartment with a constant size of 0.012 μm^3, which is surrounded by `erMembrane` (erMembrane).

Name er

3.4 Compartment `Golgi`

This is a three dimensional compartment with a constant size of 0.012 μm^3, which is surrounded by `GM` (GM).

Name Golgi

3.5 Compartment `PM`

This is a two dimensional compartment with a constant size of 0.6 μm^2, which is surrounded by `EC` (EC).

Name PM

3.6 Compartment `erMembrane`

This is a two dimensional compartment with a constant size of 0.0456 μm^2, which is surrounded by `cyt` (cyt).

Name erMembrane

3.7 Compartment `GM`

This is a two dimensional compartment with a constant size of 0.048 μm^2, which is surrounded by `cyt` (cyt).

Name GM

4 Species

This model contains 46 species. The boundary condition of three of these species is set to `true` so that these species' amount cannot be changed by any reaction. 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
RasGTP_Golgi_GM		GM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
EGF_EC		EC	$\text{item} \cdot \mu\text{m}^{-3}$	☐	☑
CAPRI_cyt		cyt	$\text{item} \cdot \mu\text{m}^{-3}$	☐	☐
serca		erMembrane	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
PIP_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
PI_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
Shc_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
CaCAPRI_PM_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
RactCa		erMembrane	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
Shc_star_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
EGFR_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
PLC_act_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
RasGTP_pal_cyt		cyt	$\text{item} \cdot \mu\text{m}^{-3}$	☐	☐
PLC_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
PIP2_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
Activated_EGFR_PM		PM	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
Ca		cyt	$\text{item} \cdot \mu\text{m}^{-3}$	☐	☐
Ract		erMembrane	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
Rinh		erMembrane	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
RinhCa		erMembrane	$\text{item} \cdot \mu\text{m}^{-2}$	☐	☐
IP3		cyt	$\text{item} \cdot \mu\text{m}^{-3}$	☐	☐

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
RasGDP_Golgi_GM		GM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
Ca_RasGRP_GM_GM		GM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
DAG_GM_GM		GM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
RasGRP_DAG_GM		GM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
CaCAPRI_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
DAG_PM		PM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
RasGTP_depal_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
RasGDP_depal_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
RasGDP_pal_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
Ca_PLCe_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
Ras_CaPLCe_GM		GM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
PIP2_GM_GM		GM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	☑
ER_erMembrane		erMembrane	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	☑
Ca_ER		er	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
Sos_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
Grb2_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
PLCe_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
buffer_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
ca_buffer_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
SosGrb2_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
SGS_PM		PM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
RasGTP_PM		PM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
RasGDP_PM		PM	$\mathrm{item} \cdot \mu\mathrm{m}^{-2}$	⊟	⊟
RasGRP_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟
CaRasGRP1_cyt		cyt	$\mathrm{item} \cdot \mu\mathrm{m}^{-3}$	⊟	⊟

5 Parameters

This model contains 26 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KMOLE			0.002	10^{-21} dimensionless $\cdot$ item^{-1} $\cdot$ mol	☑
kStimSynPIP2_PIP2_synthesis			0.010	s^{-1}	☑
tauPIP2syn_PIP2_synthesis			0.050	s	☑
PIP2syndecay_PIP2_synthesis			10.000	s	☑
PIP2_basal_PIP2_synthesis			1072.000	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2}	☑
kBasalSynPIP2_PIP2_synthesis			0.045	s^{-1}	☑
Rate_PIP2Synbasal_PIP2_synthesis			0.000	s^{-1}	⊟
Rate_PIP2SynStim_PIP2_synthesis			0.000	s^{-1}	⊟
Vmax_Shc_phosphorylation			0.000	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2} $\cdot$ s^{-1}	⊟
Vmax_RasGRP_DAG_GEF			0.000	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2} $\cdot$ s^{-1}	⊟
Vmax_CAPRI_GAP			0.000	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2} $\cdot$ s^{-1}	⊟
Vmax_CaRasGRP_act_RasGM			0.000	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2} $\cdot$ s^{-1}	⊟
PIP_basal_PIP_synthesis			2857.000	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2}	☑

Id	Name	SBO	Value	Unit	Constant
kBasalSynPIP-_PIP-_synthesis			0.002	s^{-1}	☑
kStimSynPIP-_PIP-_synthesis			0.010	s^{-1}	☑
tauPIPsyn-_PIP-_synthesis			0.050	s	☑
PIPsyndecay-_PIP-_synthesis			10.000	s	☑
Ratebasal-_PIPsyn_PIP-_synthesis			0.000	s^{-1}	⊟
Ratestim-_PIPsyn_PIP-_synthesis			0.000	s^{-1}	⊟
Kon-_reaction2			2.100	$1000\,\text{dimensionless} \cdot m^3 \cdot mol^{-1} \cdot s^{-1}$	☑
dinh-_reaction2			0.110	$0.0010\,\text{dimensionless} \cdot m^{-3} \cdot mol$	☑
Koff-_reaction2			0.000	s^{-1}	⊟
Vmax_EGF-_act_PLCgamma			0.000	$10^{12}\,\text{dimensionless} \cdot \text{item} \cdot m^{-2} \cdot s^{-1}$	⊟
dact_Ca-_binds_IP3R			0.200	s^{-1}	☑
Kr_Ca_binds-_IP3R			0.000	s^{-1}	⊟
Vmax_Sos-_act_RasPM			0.000	$10^{12}\,\text{dimensionless} \cdot \text{item} \cdot m^{-2} \cdot s^{-1}$	⊟

6 Rules

This is an overview of twelve rules.

6.1 Rule Rate_PIP2Synbasal_PIP2_synthesis

Rule Rate_PIP2Synbasal_PIP2_synthesis is an assignment rule for parameter Rate_PIP2Synbasal_PIP2_synthesis:

$$\text{Rate\_PIP2Synbasal\_PIP2\_synthesis} \tag{1}$$
$$= \begin{cases} 0.581 \cdot \text{kBasalSynPIP2\_PIP2\_synthesis} \cdot \left(-1 + \exp\left((\text{PIP2\_basal\_PIP2\_synthesis} + ([\text{PIP2\_PM}])) \cdot \frac{}{\text{PIP2\_basa} \right. \right. \\ 0 \end{cases}$$

6.2 Rule Rate_PIP2SynStim_PIP2_synthesis

Rule Rate_PIP2SynStim_PIP2_synthesis is an assignment rule for parameter Rate_PIP2SynStim_PIP2_synthesis:

$$\text{Rate\_PIP2SynStim\_PIP2\_synthesis} \tag{2}$$
$$= \begin{cases} \text{kStimSynPIP2\_PIP2\_synthesis} \cdot \exp\left(\left((\text{t} + (\text{tauPIP2syn\_PIP2\_synthesis})) \cdot \frac{1}{\text{PIP2syndecay\_PIP2\_synthesis}} \right) \right) \\ 0 \end{cases}$$

6.3 Rule Vmax_Shc_phosphorylation

Rule Vmax_Shc_phosphorylation is an assignment rule for parameter Vmax_Shc_phosphorylation:

$$\text{Vmax\_Shc\_phosphorylation} = 0.2 \cdot [\text{Activated\_EGFR\_PM}] \tag{3}$$

6.4 Rule Vmax_RasGRP_DAG_GEF

Rule Vmax_RasGRP_DAG_GEF is an assignment rule for parameter Vmax_RasGRP_DAG_GEF:

$$\text{Vmax\_RasGRP\_DAG\_GEF} = 0.05 \cdot [\text{RasGRP\_DAG\_GM}] \tag{4}$$

6.5 Rule Vmax_CAPRI_GAP

Rule Vmax_CAPRI_GAP is an assignment rule for parameter Vmax_CAPRI_GAP:

$$\text{Vmax\_CAPRI\_GAP} = 10 \cdot [\text{CaCAPRI\_PM\_PM}] \tag{5}$$

6.6 Rule Vmax_CaRasGRP_act_RasGM

Rule Vmax_CaRasGRP_act_RasGM is an assignment rule for parameter Vmax_CaRasGRP_act_RasGM:

$$\text{Vmax\_CaRasGRP\_act\_RasGM} = 0.01 \cdot [\text{Ca\_RasGRP\_GM\_GM}] \tag{6}$$

6.7 Rule Ratebasal_PIPsyn_PIP_synthesis

Rule Ratebasal_PIPsyn_PIP_synthesis is an assignment rule for parameter Ratebasal_PIPsyn_PIP_synthesis:

$$\text{Ratebasal\_PIPsyn\_PIP\_synthesis} = \begin{cases} 0.581 \cdot \text{kBasalSynPIP\_PIP\_synthesis} \cdot \left(-1 + \exp\left((\text{PIP\_basal\_PIP\_synthesis} + ([\text{PIP\_PM}])) \cdot \frac{1}{\text{PIP\_basal\_PIP\_sy} \right. \right. \\ 0 \end{cases} \tag{7}$$

6.8 Rule Ratestim_PIPsyn_PIP_synthesis

Rule Ratestim_PIPsyn_PIP_synthesis is an assignment rule for parameter Ratestim_PIPsyn_PIP_synthesis:

$$\text{Ratestim\_PIPsyn\_PIP\_synthesis} = \begin{cases} \text{kStimSynPIP\_PIP\_synthesis} \cdot \exp\left(\left((t + (\text{tauPIPsyn\_PIP\_synthesis})) \cdot \frac{1}{\text{PIPsyndecay\_PIP\_synthesis}} \right) \right) & \text{if t} > \\ 0 & \text{otherv} \end{cases} \tag{8}$$

6.9 Rule Koff_reaction2

Rule Koff_reaction2 is an assignment rule for parameter Koff_reaction2:

$$\text{Koff\_reaction2} = \text{dinh\_reaction2} \cdot \text{Kon\_reaction2} \tag{9}$$

Derived unit s^{-1}

6.10 Rule Vmax_EGF_act_PLCgamma

Rule Vmax_EGF_act_PLCgamma is an assignment rule for parameter Vmax_EGF_act_PLCgamma:

$$\text{Vmax\_EGF\_act\_PLCgamma} = 0.3 \cdot [\text{Activated\_EGFR\_PM}] \tag{10}$$

6.11 Rule Kr_Ca_binds_IP3R

Rule Kr_Ca_binds_IP3R is an assignment rule for parameter Kr_Ca_binds_IP3R:

$$\text{Kr\_Ca\_binds\_IP3R} = 1000 \cdot \text{dact\_Ca\_binds\_IP3R} \tag{11}$$

6.12 Rule Vmax_Sos_act_RasPM

Rule Vmax_Sos_act_RasPM is an assignment rule for parameter Vmax_Sos_act_RasPM:

$$\text{Vmax\_Sos\_act\_RasPM} = 0.02 \cdot [\text{SGS\_PM}] \tag{12}$$

7 Reactions

This model contains 43 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	PIP2_synthesis	PIP2 synthesis	$\text{PIP\_PM} \rightleftharpoons \text{PIP2\_PM}$	
2	Shc_phosphorylation	Shc phosphorylation	$\text{Shc\_PM} \overset{\text{Activated\_EGFR\_PM}}{\rightleftharpoons} \text{Shc\_star\_PM}$	
3	Ca_bind_CAPRI	Ca bind CAPRI	$\text{Ca} + \text{CAPRI\_cyt} \rightleftharpoons \text{CaCAPRI\_cyt}$	
4	IP3_degradation	IP3 degradation	$\text{IP3} \rightleftharpoons \emptyset$	
5	RasGTP_depal_translocate	RasGTP depal translocate	$\text{RasGTP\_depal\_cyt} \rightleftharpoons \text{RasGTP\_Golgi\_GM}$	
6	ca_bind_rasGRP	ca bind rasGRP	$\text{Ca} + \text{RasGRP\_cyt} \rightleftharpoons \text{CaRasGRP1\_cyt}$	
7	RasGRP_DAG_GEF	RasGRP_DAG GEF	$\text{RasGDP\_Golgi\_GM} \overset{\text{RasGRP\_DAG\_GM}}{\rightleftharpoons} \text{RasGTP\_Golgi\_GM}$	
8	rasGTP_pal_translocation	rasGTP pal translocation	$\text{RasGTP\_pal\_cyt} \rightleftharpoons \text{RasGTP\_PM}$	
9	PLCg_dephos	PLCg dephos	$\text{PLC\_act\_PM} \rightleftharpoons \text{PLC\_PM}$	
10	basal_GAP	basal GAP	$\text{RasGTP\_PM} \rightleftharpoons \text{RasGDP\_PM}$	
11	CAPRI_translocation	CAPRI translocation	$\text{CaCAPRI\_cyt} \rightleftharpoons \text{CaCAPRI\_PM\_PM}$	
12	reaction5	reaction5	$\text{DAG\_GM\_GM} + \text{RasGRP\_cyt} \rightleftharpoons \text{RasGRP\_DAG\_GM}$	
13	RasGDP_pal	RasGDP pal	$\text{RasGDP\_Golgi\_GM} \rightleftharpoons \text{RasGDP\_pal\_cyt}$	
14	CAPRI_GAP	CAPRI GAP	$\text{RasGTP\_PM} \overset{\text{CaCAPRI\_PM\_PM}}{\rightleftharpoons} \text{RasGDP\_PM}$	
15	RasGDPpal_translocation	RasGDPpal translocation	$\text{RasGDP\_pal\_cyt} \rightleftharpoons \text{RasGDP\_PM}$	
16	sos_grb2_binding	sos grb2 binding	$\text{Sos\_cyt} + \text{Grb2\_cyt} \rightleftharpoons \text{SosGrb2\_cyt}$	

№	Id	Name	Reaction Equation	SBO
17	RasGDP_depal_translocate	RasGDP depal translocate	$\text{RasGDP\_depal\_cyt} \rightleftharpoons \text{RasGDP\_Golgi\_GM}$	
18	Ras_GTP_palm1	Ras GTP palm1	$\text{RasGTP\_Golgi\_GM} \rightleftharpoons \text{RasGTP\_pal\_cyt}$	
19	RasPal_basal_GAP	RasPal basal GAP	$\text{RasGTP\_pal\_cyt} \rightleftharpoons \text{RasGDP\_pal\_cyt}$	
20	basal_cyt_depal_GEF	basal cyt depal GEF	$\text{RasGTP\_depal\_cyt} \rightleftharpoons \text{RasGDP\_depal\_cyt}$	
21	caPLCe_gen_DAG	caPLCe gen DAG	$\text{PIP2\_GM\_GM} \xrightleftharpoons{\text{Ras\_CaPLCe\_GM}} \text{DAG\_GM\_GM} + \text{IP3}$	
22	CaRasGRP_act_RasGM	CaRasGRP act RasGM	$\text{RasGDP\_Golgi\_GM} \xrightleftharpoons{\text{Ca\_RasGRP\_GM\_GM}} \text{RasGTP\_Golgi\_GM}$	
23	PIP2_hydrolysis	PIP2 hydrolysis	$\text{PIP2\_PM} \xrightleftharpoons{\text{PLC\_act\_PM}} \text{DAG\_PM} + \text{IP3}$	
24	Sos_activation	Sos activation	$\text{SosGrb2\_cyt} + \text{Shc\_star\_PM} \rightleftharpoons \text{SGS\_PM}$	
25	PIP_synthesis	PIP synthesis	$\text{PI\_PM} \rightleftharpoons \text{PIP\_PM}$	
26	EGF_internalization	EGF_internalization	$\text{Activated\_EGFR\_PM} \rightleftharpoons \emptyset$	
27	calcium_buffer	calcium buffer	$\text{buffer\_cyt} + \text{Ca} \rightleftharpoons \text{ca\_buffer\_cyt}$	
28	RasGM_basal_GAP	RasGM basal GAP	$\text{RasGTP\_Golgi\_GM} \rightleftharpoons \text{RasGDP\_Golgi\_GM}$	
29	reaction0	reaction0	$\text{Shc\_star\_PM} \rightleftharpoons \text{Shc\_PM}$	
30	EGFR_binding	EGFR_binding	$\text{EGF\_EC} + \text{EGFR\_PM} \rightleftharpoons \text{Activated\_EGFR\_PM}$	
31	ca_act_PLCe	ca act PLCe	$\text{Ca} + \text{PLCe\_cyt} \rightleftharpoons \text{Ca\_PLCe\_cyt}$	
32	ras_act_PLCe	ras_act_PLCe	$\text{RasGTP\_Golgi\_GM} + \text{Ca\_PLCe\_cyt} \rightleftharpoons \text{Ras\_CaPLCe\_GM}$	
33	RasGDP_depal2	RasGDP depal2	$\text{RasGDP\_PM} \rightleftharpoons \text{RasGDP\_depal\_cyt}$	
34	CaRasGRP_translocation	CaRasGRP translocation	$\text{CaRasGRP1\_cyt} \rightleftharpoons \text{Ca\_RasGRP\_GM\_GM}$	
35	reaction2	reaction2	$\text{Rinh} + \text{Ca} \rightleftharpoons \text{RinhCa}$	

№	Id	Name	Reaction Equation	SBO
36	EGF_act-_PLCgamma	EGF act PLCgamma	$\mathrm{PLC\_PM} \overset{\mathrm{Activated\_EGFR\_PM}}{\rightleftharpoons} \mathrm{PLC\_act\_PM}$	
37	Ca_binds_IP3R	Ca_binds_IP3R	$\mathrm{Ract} + \mathrm{Ca} \rightleftharpoons \mathrm{RactCa}$	
38	reaction7	reaction7	$\mathrm{DAG\_GM\_GM} \rightleftharpoons \emptyset$	
39	Sos_act_RasPM	Sos act RasPM	$\mathrm{RasGDP\_PM} \overset{\mathrm{SGS\_PM}}{\rightleftharpoons} \mathrm{RasGTP\_PM}$	
40	flux1	flux1	$\mathrm{Ca} \overset{\mathrm{ER\_erMembrane,\ serca}}{\rightleftharpoons} \mathrm{Ca\_ER}$	
41	flux0	flux0	$\mathrm{Ca} \overset{\mathrm{ER\_erMembrane,\ RactCa,\ Ract,\ IP3,\ Rinh,\ RinhCa}}{\rightleftharpoons} \mathrm{Ca\_ER}$	
42	flux2	flux2	$\mathrm{Ca} \overset{\mathrm{ER\_erMembrane}}{\rightleftharpoons} \mathrm{Ca\_ER}$	
43	Ras_PM_depal1	Ras PM depal1	$\mathrm{RasGTP\_PM} \rightleftharpoons \mathrm{RasGTP\_depal\_cyt}$	

7.1 Reaction PIP2_synthesis

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

Name PIP2 synthesis

Reaction equation

$$\text{PIP\_PM} \rightleftharpoons \text{PIP2\_PM} \tag{13}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
PIP_PM		

Product

Table 7: Properties of each product.

Id	Name	SBO
PIP2_PM		

Kinetic Law

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

$$v_1 = (\text{Rate\_PIP2Synbasal\_PIP2\_synthesis} + \text{Rate\_PIP2SynStim\_PIP2\_synthesis}) \cdot [\text{PIP\_PM}] \cdot \text{area}(\text{PM}) \tag{14}$$

Table 8: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑

7.2 Reaction Shc_phosphorylation

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

Name Shc phosphorylation

Reaction equation

$$\text{Shc\_PM} \xrightleftharpoons{\text{Activated\_EGFR\_PM}} \text{Shc\_star\_PM} \tag{15}$$

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
Shc_PM		

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
Activated_EGFR_PM		

Product

Table 11: Properties of each product.

Id	Name	SBO
Shc_star_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{Vmax\_Shc\_phosphorylation} \cdot [\text{Shc\_PM}] \cdot \frac{1}{\text{Km} + [\text{Shc\_PM}]} \cdot \text{area}\,(\text{PM}) \tag{16}$$

Table 12: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Km			1032.0	10^{12} dimensionless · item · m^{-2}	☑

7.3 Reaction Ca_bind_CAPRI

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

Name Ca bind CAPRI

Reaction equation

$$\mathrm{Ca} + \mathrm{CAPRI\_cyt} \rightleftharpoons \mathrm{CaCAPRI\_cyt} \tag{17}$$

Reactants

Table 13: Properties of each reactant.

Id	Name	SBO
Ca		
CAPRI_cyt		

Product

Table 14: Properties of each product.

Id	Name	SBO
CaCAPRI_cyt		

Kinetic Law

Derived unit contains undeclared units

$$\begin{aligned} v_3 = {} & (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{Ca}] \cdot 0.00166112956810631 \cdot [\mathrm{CAPRI\_cyt}] \\ & + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{CaCAPRI\_cyt}]))) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \end{aligned} \tag{18}$$

Table 15: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			0.1	$1000\,\mathrm{dimensionless} \cdot \mathrm{m}^3 \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑
Kr			0.5	s^{-1}	☑

7.4 Reaction IP3_degradation

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

Name IP3 degradation

Reaction equation

$$\mathrm{IP3} \rightleftharpoons \emptyset \tag{19}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
IP3		

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{kIP3deg} \cdot (0.00166112956810631 \cdot [\mathrm{IP3}] + (\mathrm{IP3\_basal})) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \tag{20}$$

Table 17: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kIP3deg			0.5	s^{-1}	☑
IP3_basal			0.0	$0.0010\,\mathrm{dimensionless} \cdot \mathrm{m}^{-3} \cdot \mathrm{mol}$	☑

7.5 Reaction RasGTP_depal_translocate

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

Name RasGTP depal translocate

Reaction equation

$$\mathrm{RasGTP\_depal\_cyt} \rightleftharpoons \mathrm{RasGTP\_Golgi\_GM} \tag{21}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
RasGTP_depal_cyt		

Product

Table 19: Properties of each product.

Id	Name	SBO
RasGTP_Golgi_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_5 = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{RasGTP\_depal\_cyt}] + ((\mathrm{Kr} \cdot [\mathrm{RasGTP\_Golgi\_GM}]))) \cdot \mathrm{area}\,(\mathrm{GM}) \quad (22)$$

Table 20: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless · A · m^{-2}	☑
Kf			120.00	10^{15} dimensionless · item · m · mol^{-1} · s^{-1}	☑
Kr			0.01	s^{-1}	☑

7.6 Reaction ca_bind_rasGRP

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

Name ca bind rasGRP

Reaction equation

$$\mathrm{Ca} + \mathrm{RasGRP\_cyt} \rightleftharpoons \mathrm{CaRasGRP1\_cyt} \quad (23)$$

Reactants

Table 21: Properties of each reactant.

Id	Name	SBO
Ca		
RasGRP_cyt		

Product

Table 22: Properties of each product.

Id	Name	SBO
CaRasGRP1_cyt		

Kinetic Law

Derived unit contains undeclared units

$$v_6 = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{Ca}] \cdot 0.00166112956810631 \cdot [\mathrm{RasGRP\_cyt}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{CaRasGRP1\_cyt}]))) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \quad (24)$$

Table 23: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			0.1	$1000\,\mathrm{dimensionless} \cdot \mathrm{m}^3 \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑
Kr			0.5	s^{-1}	☑

7.7 Reaction RasGRP_DAG_GEF

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

Name RasGRP_DAG GEF

Reaction equation

$$\mathrm{RasGDP\_Golgi\_GM} \xrightleftharpoons{\mathrm{RasGRP\_DAG\_GM}} \mathrm{RasGTP\_Golgi\_GM} \quad (25)$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
RasGDP_Golgi_GM		

Modifier

Table 25: Properties of each modifier.

Id	Name	SBO
RasGRP_DAG_GM		

Product

Table 26: Properties of each product.

Id	Name	SBO
RasGTP_Golgi_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{Vmax\_RasGRP\_DAG\_GEF} \cdot [\mathrm{RasGDP\_Golgi\_GM}] \cdot \frac{1}{\mathrm{Km} + [\mathrm{RasGDP\_Golgi\_GM}]} \cdot \mathrm{area}\,(\mathrm{GM}) \tag{26}$$

Table 27: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Km			600.0	10^{12} dimensionless · item · m^{-2}	☑

7.8 Reaction rasGTP_pal_translocation

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

Name rasGTP pal translocation

Reaction equation

$$\text{RasGTP\_pal\_cyt} \rightleftharpoons \text{RasGTP\_PM} \tag{27}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
RasGTP_pal_cyt		

Product

Table 29: Properties of each product.

Id	Name	SBO
RasGTP_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_8 = (\text{Kf} \cdot 0.00166112956810631 \cdot [\text{RasGTP\_pal\_cyt}] + ((\text{Kr} \cdot [\text{RasGTP\_PM}]))) \cdot \text{area}(\text{PM}) \tag{28}$$

Table 30: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless · A · m^{-2}	☑
Kf			120.00	10^{15} dimensionless · item · m · mol^{-1} · s^{-1}	☑
Kr			0.01	s^{-1}	☑

7.9 Reaction PLCg_dephos

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

Name PLCg dephos

Reaction equation

$$\text{PLC\_act\_PM} \rightleftharpoons \text{PLC\_PM} \tag{29}$$

Reactant

Table 31: Properties of each reactant.

Id	Name	SBO
PLC_act_PM		

Product

Table 32: Properties of each product.

Id	Name	SBO
PLC_PM		

Kinetic Law

Derived unit $\text{s}^{-1} \cdot \text{item}$

$$v_9 = (\text{Kf} \cdot [\text{PLC\_act\_PM}] + ((\text{Kr} \cdot [\text{PLC\_PM}]))) \cdot \text{area}(\text{PM}) \tag{30}$$

Table 33: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			0.2	s^{-1}	☑
Kr			0.0	s^{-1}	☑

7.10 Reaction basal_GAP

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

Name basal GAP

Reaction equation

$$\text{RasGTP\_PM} \rightleftharpoons \text{RasGDP\_PM} \tag{31}$$

Reactant

Table 34: Properties of each reactant.

Id	Name	SBO
RasGTP_PM		

Product

Table 35: Properties of each product.

Id	Name	SBO
RasGDP_PM		

Kinetic Law

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

$$v_{10} = (\mathrm{Kf} \cdot [\mathrm{RasGTP\_PM}] + ((\mathrm{Kr} \cdot [\mathrm{RasGDP\_PM}]))) \cdot \mathrm{area}\,(\mathrm{PM}) \tag{32}$$

Table 36: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m^{-2}	☑
Kf			10^{-4}	s^{-1}	☑
Kr			0.000	s^{-1}	☑

7.11 Reaction CAPRI_translocation

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

Name CAPRI translocation

Reaction equation

$$\mathrm{CaCAPRI\_cyt} \rightleftharpoons \mathrm{CaCAPRI\_PM\_PM} \tag{33}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
CaCAPRI_cyt		

Product

Table 38: Properties of each product.

Id	Name	SBO
CaCAPRI_PM_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{CaCAPRI\_cyt}] + ((\mathrm{Kr} \cdot [\mathrm{CaCAPRI\_PM\_PM}]))) \cdot \mathrm{area}(\mathrm{PM}) \tag{34}$$

Table 39: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			120.0	10^{15} dimensionless · item · m · $mol^{-1} \cdot s^{-1}$	☑
Kr			0.1	s^{-1}	☑

7.12 Reaction reaction5

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

Name reaction5

Reaction equation

$$\mathrm{DAG\_GM\_GM} + \mathrm{RasGRP\_cyt} \rightleftharpoons \mathrm{RasGRP\_DAG\_GM} \tag{35}$$

Reactants

Table 40: Properties of each reactant.

Id	Name	SBO
DAG_GM_GM		
RasGRP_cyt		

Product

Table 41: Properties of each product.

Id	Name	SBO
RasGRP_DAG_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = (\mathrm{Kf} \cdot [\mathrm{DAG\_GM\_GM}] \cdot 0.001661129568106 31 \cdot [\mathrm{RasGRP\_cyt}] + ((\mathrm{Kr} \cdot [\mathrm{RasGRP\_DAG\_GM}]))) \cdot \mathrm{area}(\mathrm{GM}) \quad (36)$$

Table 42: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			0.5	1000 dimensionless · $m^3 \cdot mol^{-1} \cdot s^{-1}$	☑
Kr			0.1	s^{-1}	☑

7.13 Reaction RasGDP_pal

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

Name RasGDP pal

Reaction equation

$$\mathrm{RasGDP\_Golgi\_GM} \rightleftharpoons \mathrm{RasGDP\_pal\_cyt} \quad (37)$$

Reactant

Table 43: Properties of each reactant.

Id	Name	SBO
RasGDP_Golgi_GM		

Product

Table 44: Properties of each product.

Id	Name	SBO
RasGDP_pal_cyt		

Kinetic Law

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

$$v_{13} = (\mathrm{Kf} \cdot [\mathrm{RasGDP\_Golgi\_GM}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{RasGDP\_pal\_cyt}]))) \cdot \mathrm{area}(\mathrm{GM}) \quad (38)$$

Table 45: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m^{-2}	☑
Kf			0.015	s^{-1}	☑
Kr			10^{-5}	10^{15} dimensionless · item · m · $\mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑

7.14 Reaction CAPRI_GAP

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

Name CAPRI GAP

Reaction equation

$$\mathrm{RasGTP\_PM} \xrightleftharpoons{\mathrm{CaCAPRI\_PM\_PM}} \mathrm{RasGDP\_PM} \quad (39)$$

Reactant

Table 46: Properties of each reactant.

Id	Name	SBO
RasGTP_PM		

Modifier

Table 47: Properties of each modifier.

Id	Name	SBO
CaCAPRI_PM_PM		

Product

Table 48: Properties of each product.

Id	Name	SBO
RasGDP_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{Vmax\_CAPRI\_GAP} \cdot [\text{RasGTP\_PM}] \cdot \frac{1}{\text{Km} + [\text{RasGTP\_PM}]} \cdot \text{area}\,(\text{PM}) \qquad (40)$$

Table 49: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Km			1200.0	10^{12} dimensionless · item · m^{-2}	☑

7.15 Reaction RasGDPpal_translocation

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

Name RasGDPpal translocation

Reaction equation

$$\text{RasGDP\_pal\_cyt} \rightleftharpoons \text{RasGDP\_PM} \tag{41}$$

Reactant

Table 50: Properties of each reactant.

Id	Name	SBO
RasGDP_pal_cyt		

Product

Table 51: Properties of each product.

Id	Name	SBO
RasGDP_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = (\text{Kf} \cdot 0.00166112956810631 \cdot [\text{RasGDP\_pal\_cyt}] + ((\text{Kr} \cdot [\text{RasGDP\_PM}]))) \cdot \text{area}(\text{PM}) \tag{42}$$

Table 52: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Kf			120.00	10^{15} dimensionless$\cdot$ item$\cdot$m$\cdot$mol$^{-1}\cdot$s^{-1}	☑
Kr			0.01	s^{-1}	☑

7.16 Reaction sos_grb2_binding

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

Name sos grb2 binding

Reaction equation

$$\mathrm{Sos\_cyt} + \mathrm{Grb2\_cyt} \rightleftharpoons \mathrm{SosGrb2\_cyt} \tag{43}$$

Reactants

Table 53: Properties of each reactant.

Id	Name	SBO
Sos_cyt		
Grb2_cyt		

Product

Table 54: Properties of each product.

Id	Name	SBO
SosGrb2_cyt		

Kinetic Law

Derived unit contains undeclared units

$$\begin{aligned} v_{16} = (&\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{Sos\_cyt}] \cdot 0.00166112956810631 \cdot [\mathrm{Grb2\_cyt}] \\ &+ ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{SosGrb2\_cyt}]))) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \end{aligned} \tag{44}$$

Table 55: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			0.025	$1000\,\mathrm{dimensionless} \cdot \mathrm{m}^3 \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑
Kr			0.017	s^{-1}	☑

7.17 Reaction RasGDP_depal_translocate

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

Name RasGDP depal translocate

Reaction equation

$$\text{RasGDP\_depal\_cyt} \rightleftharpoons \text{RasGDP\_Golgi\_GM} \tag{45}$$

Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
RasGDP_depal_cyt		

Product

Table 57: Properties of each product.

Id	Name	SBO
RasGDP_Golgi_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = (\text{Kf} \cdot 0.00166112956810631 \cdot [\text{RasGDP\_depal\_cyt}] + ((\text{Kr} \cdot [\text{RasGDP\_Golgi\_GM}]))) \cdot \text{area}(\text{GM}) \tag{46}$$

Table 58: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Kf			120.00	10^{15} dimensionless $\cdot$ item $\cdot$ m $\cdot$ $mol^{-1} \cdot s^{-1}$	☑
Kr			0.01	s^{-1}	☑

7.18 Reaction Ras_GTP_palm1

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

Name Ras GTP palm1

Reaction equation

$$\text{RasGTP\_Golgi\_GM} \rightleftharpoons \text{RasGTP\_pal\_cyt} \tag{47}$$

Reactant

Table 59: Properties of each reactant.

Id	Name	SBO
RasGTP_Golgi_GM		

Product

Table 60: Properties of each product.

Id	Name	SBO
RasGTP_pal_cyt		

Kinetic Law

Derived unit $\text{s}^{-1} \cdot \text{item}$

$$v_{18} = (\text{Kf} \cdot [\text{RasGTP\_Golgi\_GM}] + ((\text{Kr} \cdot 0.00166112956810631 \cdot [\text{RasGTP\_pal\_cyt}]))) \cdot \text{area} \tag{48}$$

Table 61: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m^{-2}	☑
Kf			$1.58489319246111 \cdot 10^{-4}$	s^{-1}	☑
Kr			10^{-5}	10^{15} dimensionless · item · m · $\text{mol}^{-1} \cdot \text{s}^{-1}$	☑

7.19 Reaction RasPal_basal_GAP

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

Name RasPal basal GAP

Reaction equation

$$\text{RasGTP\_pal\_cyt} \rightleftharpoons \text{RasGDP\_pal\_cyt} \tag{49}$$

Reactant

Table 62: Properties of each reactant.

Id	Name	SBO
RasGTP_pal_cyt		

Product

Table 63: Properties of each product.

Id	Name	SBO
RasGDP_pal_cyt		

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{RasGTP\_pal\_cyt}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{RasGDP\_pal\_cyt}]))) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \quad (50)$$

Table 64: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			10^{-4}	s^{-1}	☑
Kr			0.000	s^{-1}	☑

7.20 Reaction basal_cyt_depal_GEF

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

Name basal cyt depal GEF

Reaction equation

$$\mathrm{RasGTP\_depal\_cyt} \rightleftharpoons \mathrm{RasGDP\_depal\_cyt} \quad (51)$$

Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
RasGTP_depal_cyt		

Product

Table 66: Properties of each product.

Id	Name	SBO
RasGDP_depal_cyt		

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{RasGTP\_depal\_cyt}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{RasGDP\_depal\_cyt}]))) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \quad (52)$$

Table 67: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			10^{-4}	s^{-1}	☑
Kr			0.000	s^{-1}	☑

7.21 Reaction caPLCe_gen_DAG

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

Name caPLCe gen DAG

Reaction equation

$$\mathrm{PIP2\_GM\_GM} \xrightleftharpoons{\mathrm{Ras\_CaPLCe\_GM}} \mathrm{DAG\_GM\_GM} + \mathrm{IP3} \quad (53)$$

Reactant

Table 68: Properties of each reactant.

Id	Name	SBO
PIP2_GM_GM		

Modifier

Table 69: Properties of each modifier.

Id	Name	SBO
Ras_CaPLCe_GM		

Products

Table 70: Properties of each product.

Id	Name	SBO
DAG_GM_GM		
IP3		

Kinetic Law

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

$$v_{21} = \mathrm{kact} \cdot [\mathrm{PIP2\_GM\_GM}] \cdot [\mathrm{Ras\_CaPLCe\_GM}] \cdot \mathrm{area}\,(\mathrm{GM}) \tag{54}$$

Table 71: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
kact			1.18	10^{-12} dimensionless $\cdot$ $\mathrm{item}^{-1} \cdot \mathrm{m}^2 \cdot \mathrm{s}^{-1}$	☑

7.22 Reaction CaRasGRP_act_RasGM

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

Name CaRasGRP act RasGM

Reaction equation

$$\text{RasGDP\_Golgi\_GM} \xrightleftharpoons{\text{Ca\_RasGRP\_GM\_GM}} \text{RasGTP\_Golgi\_GM} \tag{55}$$

Reactant

Table 72: Properties of each reactant.

Id	Name	SBO
RasGDP_Golgi_GM		

Modifier

Table 73: Properties of each modifier.

Id	Name	SBO
Ca_RasGRP_GM_GM		

Product

Table 74: Properties of each product.

Id	Name	SBO
RasGTP_Golgi_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \text{Vmax\_CaRasGRP\_act\_RasGM} \cdot [\text{RasGDP\_Golgi\_GM}] \cdot \frac{1}{\text{Km} + [\text{RasGDP\_Golgi\_GM}]} \cdot \text{area}\,(\text{GM}) \tag{56}$$

Table 75: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Km			1200.0	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2}	☑

7.23 Reaction PIP2_hydrolysis

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

Name PIP2 hydrolysis

Reaction equation

$$\mathrm{PIP2\_PM} \overset{\mathrm{PLC\_act\_PM}}{\rightleftharpoons} \mathrm{DAG\_PM} + \mathrm{IP3} \tag{57}$$

Reactant

Table 76: Properties of each reactant.

Id	Name	SBO
PIP2_PM		

Modifier

Table 77: Properties of each modifier.

Id	Name	SBO
PLC_act_PM		

Products

Table 78: Properties of each product.

Id	Name	SBO
DAG_PM		
IP3		

Kinetic Law

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

$$v_{23} = \mathrm{k\_PIP2hyd} \cdot [\mathrm{PIP2\_PM}] \cdot [\mathrm{PLC\_act\_PM}] \cdot \mathrm{area}\,(\mathrm{PM}) \tag{58}$$

Table 79: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m^{-2}	☑
k_PIP2hyd			1.188	10^{-12} dimensionless · $item^{-1} \cdot m^2 \cdot s^{-1}$	☑

7.24 Reaction Sos_activation

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

Name Sos activation

Reaction equation

$$\text{SosGrb2\_cyt} + \text{Shc\_star\_PM} \rightleftharpoons \text{SGS\_PM} \tag{59}$$

Reactants

Table 80: Properties of each reactant.

Id	Name	SBO
SosGrb2_cyt		
Shc_star_PM		

Product

Table 81: Properties of each product.

Id	Name	SBO
SGS_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = (\text{Kf} \cdot 0.00166112956810631 \cdot [\text{SosGrb2\_cyt}] \cdot [\text{Shc\_star\_PM}] + ((\text{Kr} \cdot [\text{SGS\_PM}]))) \cdot \text{area}(\text{PM}) \tag{60}$$

Table 82: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			90.0	1000 dimensionless · $m^3 \cdot mol^{-1} \cdot s^{-1}$	☑
Kr			0.1	s^{-1}	☑

7.25 Reaction PIP_synthesis

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

Name PIP synthesis

Reaction equation

$$\text{PI\_PM} \rightleftharpoons \text{PIP\_PM} \tag{61}$$

Reactant

Table 83: Properties of each reactant.

Id	Name	SBO
PI_PM		

Product

Table 84: Properties of each product.

Id	Name	SBO
PIP_PM		

Kinetic Law

Derived unit $s^{-1} \cdot \text{item}$

$$v_{25} = (\text{Ratebasal\_PIPsyn\_PIP\_synthesis} + \text{Ratestim\_PIPsyn\_PIP\_synthesis}) \cdot [\text{PI\_PM}] \cdot \text{area}(\text{PM}) \tag{62}$$

Table 85: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑

7.26 Reaction EGF_internalization

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

Name EGF_internalization

Reaction equation

$$\text{Activated\_EGFR\_PM} \rightleftharpoons \emptyset \tag{63}$$

Reactant

Table 86: Properties of each reactant.

Id	Name	SBO
Activated_EGFR_PM		

Kinetic Law

Derived unit $s^{-1} \cdot \text{item}$

$$v_{26} = \text{Kf} \cdot [\text{Activated\_EGFR\_PM}] \cdot \text{area}(\text{PM}) \tag{64}$$

Table 87: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless · A · m^{-2}	☑
Kf			0.002	s^{-1}	☑
Kr			0.000	10^{12} dimensionless · item · $m^{-2} \cdot s^{-1}$	☑

7.27 Reaction calcium_buffer

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

Name calcium buffer

Reaction equation

$$\text{buffer\_cyt} + \text{Ca} \rightleftharpoons \text{ca\_buffer\_cyt} \tag{65}$$

Reactants

Table 88: Properties of each reactant.

Id	Name	SBO
buffer_cyt		
Ca		

Product

Table 89: Properties of each product.

Id	Name	SBO
ca_buffer_cyt		

Kinetic Law

Derived unit contains undeclared units

$$\begin{aligned} v_{27} = &(\text{Kf} \cdot 0.00166112956810631 \cdot [\text{buffer\_cyt}] \cdot 0.00166112956810631 \cdot [\text{Ca}] \\ &+ ((\text{Kr} \cdot 0.00166112956810631 \cdot [\text{ca\_buffer\_cyt}]))) \cdot \text{vol}(\text{cyt}) \cdot 1 \cdot \frac{1}{\text{KMOLE}} \end{aligned} \tag{66}$$

Table 90: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			50.0	$1000\,\text{dimensionless} \cdot \text{m}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$	☑
Kr			10.0	s^{-1}	☑

7.28 Reaction RasGM_basal_GAP

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

Name RasGM basal GAP

Reaction equation

$$\text{RasGTP\_Golgi\_GM} \rightleftharpoons \text{RasGDP\_Golgi\_GM} \tag{67}$$

Reactant

Table 91: Properties of each reactant.

Id	Name	SBO
RasGTP_Golgi_GM		

Product

Table 92: Properties of each product.

Id	Name	SBO
RasGDP_Golgi_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = \text{Vmax} \cdot [\text{RasGTP\_Golgi\_GM}] \cdot \frac{1}{\text{Km} + [\text{RasGTP\_Golgi\_GM}]} \cdot \text{area}\,(\text{GM}) \tag{68}$$

Table 93: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Km			600.0	10^{12} dimensionless · item · m^{-2}	☑
Vmax			1.0	10^{12} dimensionless · item · $\text{m}^{-2} \cdot \text{s}^{-1}$	☑

7.29 Reaction reaction0

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

Name reaction0

Reaction equation

$$\text{Shc\_star\_PM} \rightleftharpoons \text{Shc\_PM} \tag{69}$$

Reactant

Table 94: Properties of each reactant.

Id	Name	SBO
Shc_star_PM		

Product

Table 95: Properties of each product.

Id	Name	SBO
Shc_PM		

Kinetic Law

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

$$v_{29} = (\mathrm{Kf} \cdot [\text{Shc\_star\_PM}] + ((\mathrm{Kr} \cdot [\text{Shc\_PM}]))) \cdot \mathrm{area}(\mathrm{PM}) \tag{70}$$

Table 96: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			0.5	s^{-1}	☑
Kr			0.0	s^{-1}	☑

7.30 Reaction EGFR_binding

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

Name EGFR_binding

Reaction equation

$$\text{EGF\_EC} + \text{EGFR\_PM} \rightleftharpoons \text{Activated\_EGFR\_PM} \tag{71}$$

Reactants

Table 97: Properties of each reactant.

Id	Name	SBO
EGF_EC		
EGFR_PM		

Product

Table 98: Properties of each product.

Id	Name	SBO
Activated_EGFR_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = (\mathrm{Kf} \cdot 0.001661129568106 31 \cdot [\mathrm{EGF\_EC}] \cdot [\mathrm{EGFR\_PM}] + ((\mathrm{Kr} \cdot [\mathrm{Activated\_EGFR\_PM}]))) \cdot \mathrm{area}(\mathrm{PM}) \quad (72)$$

Table 99: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless · A · m^{-2}	☑
Kf			1.00	1000 dimensionless · $m^3 \cdot mol^{-1} \cdot s^{-1}$	☑
Kr			0.01	s^{-1}	☑

7.31 Reaction ca_act_PLCe

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

Name ca act PLCe

Reaction equation

$$\mathrm{Ca} + \mathrm{PLCe\_cyt} \rightleftharpoons \mathrm{Ca\_PLCe\_cyt} \quad (73)$$

Reactants

Table 100: Properties of each reactant.

Id	Name	SBO
Ca		
PLCe_cyt		

Product

Table 101: Properties of each product.

Id	Name	SBO
Ca_PLCe_cyt		

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{Ca}] \cdot 0.00166112956810631 \cdot [\mathrm{PLCe\_cyt}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{Ca\_PLCe\_cyt}]))) \cdot \mathrm{vol}(\mathrm{cyt}) \cdot 1 \cdot \frac{1}{\mathrm{KMOLE}} \quad (74)$$

Table 102: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kf			3.0	$1000\,\mathrm{dimensionless} \cdot \mathrm{m}^3 \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑
Kr			1.0	s^{-1}	☑

7.32 Reaction ras_act_PLCe

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

Name ras_act_PLCe

Reaction equation

$$\mathrm{RasGTP\_Golgi\_GM} + \mathrm{Ca\_PLCe\_cyt} \rightleftharpoons \mathrm{Ras\_CaPLCe\_GM} \quad (75)$$

Reactants

Table 103: Properties of each reactant.

Id	Name	SBO
RasGTP_Golgi_GM		
Ca_PLCe_cyt		

Product

Table 104: Properties of each product.

Id	Name	SBO
Ras_CaPLCe_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = (\mathrm{Kf} \cdot [\mathrm{RasGTP\_Golgi\_GM}] \cdot 0.00166112956810631 \cdot [\mathrm{Ca\_PLCe\_cyt}] + ((\mathrm{Kr} \cdot [\mathrm{Ras\_CaPLCe\_GM}]))) \cdot \mathrm{area}(\mathrm{GM}) \quad (76)$$

Table 105: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			15.0	1000 dimensionless · $m^3 \cdot mol^{-1} \cdot s^{-1}$	☑
Kr			1.0	s^{-1}	☑

7.33 Reaction RasGDP_depal2

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

Name RasGDP depal2

Reaction equation

$$\mathrm{RasGDP\_PM} \rightleftharpoons \mathrm{RasGDP\_depal\_cyt} \quad (77)$$

Reactant

Table 106: Properties of each reactant.

Id	Name	SBO
RasGDP_PM		

Product

Table 107: Properties of each product.

Id	Name	SBO
RasGDP_depal_cyt		

Kinetic Law

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

$$v_{33} = (\mathrm{Kf} \cdot [\mathrm{RasGDP\_PM}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{RasGDP\_depal\_cyt}]))) \cdot \mathrm{area}(\mathrm{PM}) \quad (78)$$

Table 108: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Kf			10^{-4}	s^{-1}	☑
Kr			0.000	10^{15} dimensionless $\cdot$ item $\cdot \mathrm{m} \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑

7.34 Reaction CaRasGRP_translocation

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

Name CaRasGRP translocation

Reaction equation

$$\mathrm{CaRasGRP1\_cyt} \rightleftharpoons \mathrm{Ca\_RasGRP\_GM\_GM} \quad (79)$$

Reactant

Table 109: Properties of each reactant.

Id	Name	SBO
CaRasGRP1_cyt		

Product

Table 110: Properties of each product.

Id	Name	SBO
Ca_RasGRP_GM_GM		

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = (\mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{CaRasGRP1\_cyt}] + ((\mathrm{Kr} \cdot [\mathrm{Ca\_RasGRP\_GM\_GM}]))) \cdot \mathrm{area}(\mathrm{GM}) \quad (80)$$

Table 111: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑
Kf			10.0	10^{15} dimensionless · item · m · mol^{-1} · s^{-1}	☑
Kr			5.0	s^{-1}	☑

7.35 Reaction reaction2

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

Name reaction2

Reaction equation

$$\mathrm{Rinh} + \mathrm{Ca} \rightleftharpoons \mathrm{RinhCa} \quad (81)$$

Reactants

Table 112: Properties of each reactant.

Id	Name	SBO
Rinh		
Ca		

Product

Table 113: Properties of each product.

Id	Name	SBO
RinhCa		

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = (\text{Kon\_reaction2} \cdot [\text{Rinh}] \cdot 0.00166112956810631 \cdot [\text{Ca}] + ((\text{Koff\_reaction2} \cdot [\text{RinhCa}]))) \cdot \text{area}(\text{erMembrane}) \quad (82)$$

Table 114: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless · A · m^{-2}	☑

7.36 Reaction EGF_act_PLCgamma

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

Name EGF act PLCgamma

Reaction equation

$$\text{PLC\_PM} \overset{\text{Activated\_EGFR\_PM}}{\rightleftharpoons} \text{PLC\_act\_PM} \quad (83)$$

Reactant

Table 115: Properties of each reactant.

Id	Name	SBO
PLC_PM		

Modifier

Table 116: Properties of each modifier.

Id	Name	SBO
Activated_EGFR_PM		

Product

Table 117: Properties of each product.

Id	Name	SBO
PLC_act_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \text{Vmax\_EGF\_act\_PLCgamma} \cdot [\text{PLC\_PM}] \cdot \frac{1}{\text{Km} + [\text{PLC\_PM}]} \cdot \text{area}\,(\text{PM}) \qquad (84)$$

Table 118: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Km			410.0	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2}	☑

7.37 Reaction Ca_binds_IP3R

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

Name Ca_binds_IP3R

Reaction equation

$$\mathrm{Ract} + \mathrm{Ca} \rightleftharpoons \mathrm{RactCa} \tag{85}$$

Reactants

Table 119: Properties of each reactant.

Id	Name	SBO
Ract		
Ca		

Product

Table 120: Properties of each product.

Id	Name	SBO
RactCa		

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = ([\mathrm{Ract}] \cdot \mathrm{Kf} \cdot 0.00166112956810631 \cdot [\mathrm{Ca}] + ((\mathrm{Kr\_Ca\_binds\_IP3R} \cdot [\mathrm{RactCa}]))) \cdot \mathrm{area}(\mathrm{erMembrane}) \tag{86}$$

Table 121: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Kf			1000.0	1000 dimensionless $\cdot$ $\mathrm{m}^3 \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑

7.38 Reaction reaction7

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

Name reaction7

Reaction equation

$$\text{DAG\_GM\_GM} \rightleftharpoons \emptyset \tag{87}$$

Reactant

Table 122: Properties of each reactant.

Id	Name	SBO
DAG_GM_GM		

Kinetic Law

Derived unit $\text{s}^{-1} \cdot \text{item}$

$$v_{38} = \text{Kf} \cdot [\text{DAG\_GM\_GM}] \cdot \text{area}(\text{GM}) \tag{88}$$

Table 123: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	$\text{dimensionless} \cdot \text{A} \cdot \text{m}^{-2}$	☑
Kf			0.25	s^{-1}	☑
Kr			0.00	$10^{12}\ \text{dimensionless} \cdot \text{item} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$	☑

7.39 Reaction Sos_act_RasPM

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

Name Sos act RasPM

Reaction equation

$$\text{RasGDP\_PM} \overset{\text{SGS\_PM}}{\rightleftharpoons} \text{RasGTP\_PM} \tag{89}$$

Reactant

Table 124: Properties of each reactant.

Id	Name	SBO
RasGDP_PM		

Modifier

Table 125: Properties of each modifier.

Id	Name	SBO
SGS_PM		

Product

Table 126: Properties of each product.

Id	Name	SBO
RasGTP_PM		

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \text{Vmax\_Sos\_act\_RasPM} \cdot [\text{RasGDP\_PM}] \cdot \frac{1}{\text{Km} + [\text{RasGDP\_PM}]} \cdot \text{area}\,(\text{PM}) \qquad (90)$$

Table 127: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.0	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Km			600.0	10^{12} dimensionless $\cdot$ item $\cdot$ m^{-2}	☑

7.40 Reaction flux1

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

Name flux1

Reaction equation

$$\text{Ca} \xrightleftharpoons{\text{ER\_erMembrane, serca}} \text{Ca\_ER} \qquad (91)$$

Reactant

Table 128: Properties of each reactant.

Id	Name	SBO
Ca		

Modifiers

Table 129: Properties of each modifier.

Id	Name	SBO
ER_erMembrane		
serca		

Product

Table 130: Properties of each product.

Id	Name	SBO
Ca_ER		

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = [\text{ER\_erMembrane}] \cdot [\text{serca}] \cdot \text{vP} \cdot 0.00166112956810631 \cdot [\text{Ca}] \cdot 0.00166112956810631 \cdot [\text{Ca}] \cdot \frac{1}{\text{kP} \cdot \text{kP} + 0.00166112956810631 \cdot [\text{Ca}] \cdot 0.00166112956810631 \cdot [\text{Ca}]} \cdot \text{area}\left(\text{erMembrane}\right) \cdot 1 \cdot \frac{1}{\text{KMOLE}} \tag{92}$$

Table 131: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
vP			0.066	10^{-33} dimensionless $\cdot$ $\text{item}^{-2} \cdot \text{m}^2 \cdot \text{mol} \cdot \text{s}^{-1}$	☑
kP			0.270		☑

7.41 Reaction `flux0`

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

Name flux0

Reaction equation

$$\mathrm{Ca} \xrightleftharpoons{\text{ER\_erMembrane, RactCa, Ract, IP3, Rinh, RinhCa}} \mathrm{Ca\_ER} \tag{93}$$

Reactant

Table 132: Properties of each reactant.

Id	Name	SBO
Ca		

Modifiers

Table 133: Properties of each modifier.

Id	Name	SBO
ER_erMembrane		
RactCa		
Ract		
IP3		
Rinh		
RinhCa		

Product

Table 134: Properties of each product.

Id	Name	SBO
Ca_ER		

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \Bigg(0.25 \cdot [\text{ER\_erMembrane}] \cdot ([\text{RactCa}] + [\text{Ract}]) \cdot (0.00166112956810631 \cdot [\text{Ca\_ER}] + ((0.00166112956810631 \cdot [\text{Ca}]))) \cdot \Bigg(0.00166112956810631 \cdot [\text{IP3}] \cdot [\text{RactCa}] \cdot [\text{Rinh}] \cdot \frac{1}{0.00166112956810631 \cdot [\text{IP3}] + \text{dI}} \cdot \frac{1}{[\text{RactCa}] + [\text{Ract}]} \cdot \frac{1}{[\text{RinhCa}] + [\text{Rinh}]}\Bigg)^3 \cdot \text{singleChanFlux}\Bigg) \cdot \text{area}(\text{erMembrane}) \cdot 1 \cdot \frac{1}{\text{KMOLE}} \tag{94}$$

Table 135: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.00	dimensionless · A · m^{-2}	☑
dI			0.80	0.0010 dimensionless · m^{-3} · mol	☑
singleChanFlux			4.69	10^{-30} dimensionless · $item^{-2} \cdot m^5 \cdot s^{-1}$	☑

7.42 Reaction flux2

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

Name flux2

Reaction equation

$$\text{Ca} \overset{\text{ER\_erMembrane}}{\rightleftharpoons} \text{Ca\_ER} \tag{95}$$

Reactant

Table 136: Properties of each reactant.

Id	Name	SBO
Ca		

Modifier

Table 137: Properties of each modifier.

Id	Name	SBO
ER_erMembrane		

Product

Table 138: Properties of each product.

Id	Name	SBO
Ca_ER		

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = ([\text{ER\_erMembrane}] \cdot (0.00166112956810631 \cdot [\text{Ca\_ER}] + ((0.00166112956810631 \cdot [\text{Ca}]))) \cdot \text{vL}) \cdot \text{area}(\text{erMembrane}) \cdot 1 \cdot \frac{1}{\text{KMOLE}} \quad (96)$$

Table 139: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
vL			$3.16 \cdot 10^{-5}$	10^{-18} dimensionless $\cdot$ item$^{-1} \cdot m^3 \cdot s^{-1}$	☑

7.43 Reaction Ras_PM_depal1

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

Name Ras PM depal1

Reaction equation

$$\text{RasGTP\_PM} \rightleftharpoons \text{RasGTP\_depal\_cyt} \quad (97)$$

Reactant

Table 140: Properties of each reactant.

Id	Name	SBO
RasGTP_PM		

Product

Table 141: Properties of each product.

Id	Name	SBO
RasGTP_depal_cyt		

Kinetic Law

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

$$v_{43} = (\mathrm{Kf} \cdot [\mathrm{RasGTP\_PM}] + ((\mathrm{Kr} \cdot 0.00166112956810631 \cdot [\mathrm{RasGTP\_depal\_cyt}]))) \cdot \mathrm{area}\,(\mathrm{PM}) \tag{98}$$

Table 142: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
I			0.000	dimensionless $\cdot$ A $\cdot$ m^{-2}	☑
Kf			10^{-4}	s^{-1}	☑
Kr			0.000	10^{15} dimensionless $\cdot$ item $\cdot \mathrm{m} \cdot \mathrm{mol}^{-1} \cdot \mathrm{s}^{-1}$	☑

8 Derived Rate Equations

When interpreted as an ordinary differential equation framework, this model implies the following set of equations for the rates of change of each species.

Identifiers for kinetic laws highlighted in gray cannot be verified to evaluate to units of SBML `substance` per `time`. As a result, some SBML interpreters may not be able to verify the consistency of the units on quantities in the model. Please check if

- parameters without an unit definition are involved or
- volume correction is necessary because the `hasOnlySubstanceUnits` flag may be set to `false` and `spacialDimensions`> 0 for certain species.

8.1 Species RasGTP_Golgi_GM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in six reactions (as a reactant in Ras_GTP_palm1, RasGM_basal_GAP, ras_act_PLCe and as a product in RasGTP_depal_translocate, RasGRP_DAG_GEF, CaRasGRP_act_RasGM).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGTP\_Golgi\_GM} = v_5 + v_7 + v_{22} - v_{18} - v_{28} - v_{32} \tag{99}$$

8.2 Species EGF_EC

Initial concentration $4.02136\ \text{item} \cdot \mu\text{m}^{-3}$

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{EGF\_EC} = 0 \tag{100}$$

8.3 Species CAPRI_cyt

Initial concentration $30.1\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in one reaction (as a reactant in Ca_bind_CAPRI).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{CAPRI\_cyt} = -v_3 \tag{101}$$

8.4 Species serca

Initial concentration $45\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in one reaction (as a modifier in flux1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{serca} = 0 \tag{102}$$

8.5 Species PIP_PM

Initial concentration $2857\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a reactant in PIP2_synthesis and as a product in PIP_synthesis).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PIP\_PM} = v_{25} - v_1 \tag{103}$$

8.6 Species PI_PM

Initial concentration $142857\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in one reaction (as a reactant in PIP_synthesis).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PI\_PM} = -v_{25} \tag{104}$$

8.7 Species Shc_PM

Initial concentration $186\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a reactant in Shc_phosphorylation and as a product in reaction0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Shc\_PM} = v_{29} - v_2 \tag{105}$$

8.8 Species CaCAPRI_PM_PM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in CAPRI_translocation and as a modifier in CAPRI_GAP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{CaCAPRI\_PM\_PM} = v_{11} \tag{106}$$

8.9 Species RactCa

Initial concentration $2.264\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in Ca_binds_IP3R and as a modifier in flux0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RactCa} = v_{37} \tag{107}$$

8.10 Species Shc_star_PM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in three reactions (as a reactant in Sos_activation, reaction0 and as a product in Shc_phosphorylation).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Shc\_star\_PM} = v_2 - v_{24} - v_{29} \tag{108}$$

8.11 Species EGFR_PM

Initial concentration $21\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in one reaction (as a reactant in EGFR_binding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{EGFR\_PM} = -v_{30} \tag{109}$$

8.12 Species PLC_act_PM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in three reactions (as a reactant in PLCg_dephos and as a product in EGF_act_PLCgamma and as a modifier in PIP2_hydrolysis).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PLC\_act\_PM} = v_{36} - v_9 \tag{110}$$

8.13 Species RasGTP_pal_cyt

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

This species takes part in three reactions (as a reactant in rasGTP_pal_translocation, RasPal-_basal_GAP and as a product in Ras_GTP_palm1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGTP\_pal\_cyt} = v_{18} - v_8 - v_{19} \tag{111}$$

8.14 Species PLC_PM

Initial concentration $100\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a reactant in EGF_act_PLCgamma and as a product in PLCg_dephos).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PLC\_PM} = v_9 - v_{36} \tag{112}$$

8.15 Species PIP2_PM

Initial concentration $1072\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a reactant in PIP2_hydrolysis and as a product in PIP2_synthesis).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PIP2\_PM} = v_1 - v_{23} \tag{113}$$

8.16 Species Activated_EGFR_PM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in four reactions (as a reactant in EGF_internalization and as a product in EGFR_binding and as a modifier in Shc_phosphorylation, EGF_act_PLCgamma).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Activated\_EGFR\_PM} = v_{30} - v_{26} \tag{114}$$

8.17 Species Ca

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

This species takes part in nine reactions (as a reactant in Ca_bind_CAPRI, ca_bind_rasGRP, calcium_buffer, ca_act_PLCe, reaction2, Ca_binds_IP3R, flux1, flux0, flux2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Ca} = -v_3 - v_6 - v_{27} - v_{31} - v_{35} - v_{37} - v_{40} - v_{41} - v_{42} \tag{115}$$

8.18 Species Ract

Initial concentration $9.056\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a reactant in Ca_binds_IP3R and as a modifier in flux0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Ract} = -v_{37} \tag{116}$$

8.19 Species Rinh

Initial concentration $7.7825\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a reactant in reaction2 and as a modifier in flux0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Rinh} = -v_{35} \tag{117}$$

8.20 Species RinhCa

Initial concentration $3.5375\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in reaction2 and as a modifier in flux0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RinhCa} = v_{35} \tag{118}$$

8.21 Species IP3

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

This species takes part in four reactions (as a reactant in IP3_degradation and as a product in caPLCe_gen_DAG, PIP2_hydrolysis and as a modifier in flux0).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IP3} = v_{21} + v_{23} - v_4 \tag{119}$$

8.22 Species RasGDP_Golgi_GM

Initial concentration $50\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in five reactions (as a reactant in RasGRP_DAG_GEF, RasGDP_pal, CaRasGRP-_act_RasGM and as a product in RasGDP_depal_translocate, RasGM_basal_GAP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RasGDP\_Golgi\_GM} = v_{17} + v_{28} - v_7 - v_{13} - v_{22} \tag{120}$$

8.23 Species Ca_RasGRP_GM_GM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in CaRasGRP_translocation and as a modifier in CaRasGRP_act_RasGM).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ca\_RasGRP\_GM\_GM} = v_{34} \tag{121}$$

8.24 Species DAG_GM_GM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in three reactions (as a reactant in reaction5, reaction7 and as a product in caPLCe_gen_DAG).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{DAG\_GM\_GM} = v_{21} - v_{12} - v_{38} \tag{122}$$

8.25 Species RasGRP_DAG_GM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in reaction5 and as a modifier in RasGRP-_DAG_GEF).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RasGRP\_DAG\_GM} = v_{12} \tag{123}$$

8.26 Species CaCAPRI_cyt

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

This species takes part in two reactions (as a reactant in CAPRI_translocation and as a product in Ca_bind_CAPRI).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{CaCAPRI\_cyt} = v_3 - v_{11} \tag{124}$$

8.27 Species DAG_PM

Initial concentration $2000\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in one reaction (as a product in PIP2_hydrolysis).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{DAG\_PM} = v_{23} \tag{125}$$

8.28 Species RasGTP_depal_cyt

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

This species takes part in three reactions (as a reactant in RasGTP_depal_translocate, basal_cyt_depal_GEF and as a product in Ras_PM_depal1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGTP\_depal\_cyt} = v_{43} - v_5 - v_{20} \tag{126}$$

8.29 Species RasGDP_depal_cyt

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

This species takes part in three reactions (as a reactant in RasGDP_depal_translocate and as a product in basal_cyt_depal_GEF, RasGDP_depal2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGDP\_depal\_cyt} = v_{20} + v_{33} - v_{17} \tag{127}$$

8.30 Species RasGDP_pal_cyt

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

This species takes part in three reactions (as a reactant in RasGDPpal_translocation and as a product in RasGDP_pal, RasPal_basal_GAP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGDP\_pal\_cyt} = v_{13} + v_{19} - v_{15} \tag{128}$$

8.31 Species Ca_PLCe_cyt

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

This species takes part in two reactions (as a reactant in ras_act_PLCe and as a product in ca_act_PLCe).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Ca\_PLCe\_cyt} = v_{31} - v_{32} \tag{129}$$

8.32 Species Ras_CaPLCe_GM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in ras_act_PLCe and as a modifier in caPLCe_gen_DAG).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Ras\_CaPLCe\_GM} = v_{32} \tag{130}$$

8.33 Species PIP2_GM_GM

Initial concentration $250\ \text{item} \cdot \mu\text{m}^{-2}$

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PIP2\_GM\_GM} = 0 \tag{131}$$

8.34 Species ER_erMembrane

Initial concentration $2\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in three reactions (as a modifier in flux1, flux0, flux2), which do not influence its rate of change because this species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{ER\_erMembrane} = 0 \tag{132}$$

8.35 Species Ca_ER

Initial concentration $120400\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in three reactions (as a product in flux1, flux0, flux2).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Ca\_ER} = v_{40} + v_{41} + v_{42} \tag{133}$$

8.36 Species Sos_cyt

Initial concentration $81.27\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in one reaction (as a reactant in sos_grb2_binding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Sos\_cyt} = -v_{16} \tag{134}$$

8.37 Species Grb2_cyt

Initial concentration $502.67\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in one reaction (as a reactant in sos_grb2_binding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{Grb2\_cyt} = -v_{16} \tag{135}$$

8.38 Species PLCe_cyt

Initial concentration $12.04\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in one reaction (as a reactant in ca_act_PLCe).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{PLCe\_cyt} = -v_{31} \tag{136}$$

8.39 Species buffer_cyt

Initial concentration $120.4\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in one reaction (as a reactant in calcium_buffer).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{buffer\_cyt} = -v_{27} \tag{137}$$

8.40 Species ca_buffer_cyt

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

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{ca\_buffer\_cyt} = v_{27} \tag{138}$$

8.41 Species SosGrb2_cyt

Initial concentration $99.33\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a reactant in Sos_activation and as a product in sos_grb2_binding).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{SosGrb2\_cyt} = v_{16} - v_{24} \tag{139}$$

8.42 Species SGS_PM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in two reactions (as a product in Sos_activation and as a modifier in Sos_act_RasPM).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{SGS\_PM} = v_{24} \tag{140}$$

8.43 Species RasGTP_PM

Initial concentration $0\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in five reactions (as a reactant in basal_GAP, CAPRI_GAP, Ras_PM-_depal1 and as a product in rasGTP_pal_translocation, Sos_act_RasPM).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGTP\_PM} = v_8 + v_{39} - v_{10} - v_{14} - v_{43} \tag{141}$$

8.44 Species RasGDP_PM

Initial concentration $400\ \text{item} \cdot \mu\text{m}^{-2}$

This species takes part in five reactions (as a reactant in RasGDP_depal2, Sos_act_RasPM and as a product in basal_GAP, CAPRI_GAP, RasGDPpal_translocation).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGDP\_PM} = v_{10} + v_{14} + v_{15} - v_{33} - v_{39} \tag{142}$$

8.45 Species RasGRP_cyt

Initial concentration $30.1\ \text{item} \cdot \mu\text{m}^{-3}$

This species takes part in two reactions (as a reactant in ca_bind_rasGRP, reaction5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{RasGRP\_cyt} = -v_6 - v_{12} \tag{143}$$

8.46 Species CaRasGRP1_cyt

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

This species takes part in two reactions (as a reactant in CaRasGRP_translocation and as a product in ca_bind_rasGRP).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{CaRasGRP1\_cyt} = v_6 - v_{34} \tag{144}$$

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