SBML Model Report

Model name: "ChenXF2008_CICR"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 3 format. This model was created by Harish Dharuri[1] at November 24th 2008 at 7:12 a. m. and last time modified at February 24th 2015 at 8:33 p. m. Table 1 provides an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	3
species types	0	species	9
events	0	constraints	0
reactions	15	function definitions	0
global parameters	38	unit definitions	5
rules	3	initial assignments	0

Model Notes

The model reproduces the plots in Figures 1 and 2. Note that the units of the time scale „A„ are not right in the paper, it was corrected by the curator. Model successfully tested on MathSBML.

2 Unit Definitions

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

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2.1 Unit substance

Name micromole

Definition $\mu\mathrm{mol}$

2.2 Unit uM

Name uM

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

2.3 Unit s_1

Name s_1

Definition s^{-1}

2.4 Unit uM_s_1

Name uM_s_1

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

2.5 Unit uM_1_s_1

Name uM_1_s_1

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

2.6 Unit volume

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

Definition l

2.7 Unit area

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

Definition m^2

2.8 Unit length

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

Definition m

2.9 Unit time

Notes Second is the predefined SBML unit for time.

Definition s

3 Compartments

This model contains three compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
Cytoplasm			3	1	litre	☑	
ER			3	0.185	l	☑	
PM			3	1	litre	☑	

3.1 Compartment Cytoplasm

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

3.2 Compartment ER

This is a three dimensional compartment with a constant size of 0.185 litre.

3.3 Compartment PM

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

4 Species

This model contains nine 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
Ca_Cyt		Cytoplasm	$\mu mol \cdot l^{-1}$	⊟	⊟
IP3_Cyt		Cytoplasm	$\mu mol \cdot l^{-1}$	⊟	⊟
Ca_ER		ER	$\mu mol \cdot l^{-1}$	⊟	⊟
S2		ER	$\mu mol \cdot l^{-1}$	⊟	⊟
S2a		ER	$\mu mol \cdot l^{-1}$	⊟	⊟
S4		ER	$\mu mol \cdot l^{-1}$	⊟	⊟
Oc		PM	$\mu mol \cdot l^{-1}$	⊟	⊟
O_o		PM	$\mu mol \cdot l^{-1}$	⊟	⊟
Orai1		PM	$\mu mol \cdot l^{-1}$	⊟	⊟

5 Parameters

This model contains 38 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
L			$9.3 \cdot 10^{-4}$	s^{-1}	☑
P_IP3R			66.600	s^{-1}	☑
Ki			1.000	$\mu mol \cdot l^{-1}$	☑
k_i			6.000	s^{-1}	☑
Ka			0.400	$\mu mol \cdot l^{-1}$	☑
V_SERCA			1.000	$\mu mol \cdot l^{-1} \cdot s^{-1}$	☑
p			2.000	dimensionless	☑
K_SERCA			0.150	$\mu mol \cdot l^{-1}$	☑
k_soc			2.300	$\mu mol^{-1} \cdot 1 \cdot s^{-1}$	☑
V_PMleak			$5 \cdot 10^{-7}$	s^{-1}	☑
Ca_ec			1500.000	$\mu mol \cdot l^{-1}$	☑
V_PMCA			1.000	$\mu mol \cdot l^{-1} \cdot s^{-1}$	☑
q			2.000	dimensionless	☑
K_PMCA			0.450	$\mu mol \cdot l^{-1}$	☑
V_PLC			0.500	$\mu mol \cdot l^{-1} \cdot s^{-1}$	☑
K_PLC			0.120	$\mu mol \cdot l^{-1}$	☑
kdeg			0.500	s^{-1}	☑
K_deg			0.100	$\mu mol \cdot l^{-1}$	☑
A			0.500	$\mu mol^{-1} \cdot 1 \cdot s^{-1}$	☑
Kd			0.400	$\mu mol \cdot l^{-1}$	☑
K1			5.000	$\mu mol \cdot l^{-1}$	☑
St			0.600	$\mu mol \cdot l^{-1}$	☑
k_a			4.000	s^{-1}	☑
Vs4			0.250	$\mu mol \cdot l^{-1} \cdot s^{-1}$	☑
K2			0.140	$\mu mol \cdot l^{-1}$	☑
kd_oligo			0.800	s^{-1}	☑
Vcp			$1.8 \cdot 10^{-4}$	$\mu mol \cdot l^{-1} \cdot s^{-1}$	☑
n_hill			3.000	dimensionless	☑
Kc			$2 \cdot 10^{-5}$	$\mu mol \cdot l^{-1}$	☑
kdc			0.500	s^{-1}	☑
kop			0.500	s^{-1}	☑
l_hill			1.000	dimensionless	☑
Ko			0.200	$\mu mol \cdot l^{-1}$	☑
kod			1.000	s^{-1}	☑
kdo			0.600	s^{-1}	☑
r_hill			4.000	dimensionless	☑
h			0.000	dimensionless	☐

Id	Name	SBO	Value	Unit	Constant
Orai1_t			0.001	$\mu mol \cdot l^{-1}$	☑

6 Rules

This is an overview of three rules.

6.1 Rule Orai1

Rule Orai1 is an assignment rule for species Orai1:

$$Orai1 = Orai1\_t - (r\_hill \cdot [Oc] + r\_hill \cdot [O\_o]) \tag{1}$$

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

6.2 Rule S2

Rule S2 is an assignment rule for species S2:

$$S2 = \frac{K1^2}{[Ca\_ER]^2 + K1^2} \cdot (St - [S2a]) \tag{2}$$

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

6.3 Rule h

Rule h is a rate rule for parameter h:

$$\frac{d}{dt}h = A \cdot (Kd - ([Ca\_Cyt] + Kd) \cdot h) \tag{3}$$

Derived unit s^{-1}

7 Reactions

This model contains 15 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	ER_Channel		$Ca\_ER \xrightarrow{IP3\_Cyt} Ca\_Cyt$	
2	SERCA		$Ca\_Cyt \longrightarrow Ca\_ER$	
3	PM_Channel		$\emptyset \xrightarrow{O\_o} Ca\_Cyt$	
4	PMCA		$Ca\_Cyt \longrightarrow \emptyset$	
5	PLC		$\emptyset \xrightarrow{Ca\_Cyt} IP3\_Cyt$	
6	deg		$IP3\_Cyt \xrightarrow{Ca\_Cyt} \emptyset$	
7	act_apoSTIM1_syn		$\emptyset \xrightarrow{S2} S2a$	
8	act_apoSTIM1_deg		$S2a \longrightarrow \emptyset$	
9	apoSTIM1_oligo_syn		$\emptyset \xrightarrow{S2} S4$	
10	apoSTIM1_oligo_deg		$S4 \longrightarrow \emptyset$	
11	close_CRAC_prod		$\emptyset \xrightarrow{Orai1} Oc$	
12	closed_CRAC_channel_deg		$Oc \longrightarrow \emptyset$	
13	open_CRAC_channel_prod		$Oc \xrightarrow{S2a} O\_o$	

№	Id	Name	Reaction Equation	SBO
14	open_to_closed		O_o ⟶ Oc	
15	open_CRAC-_channel_deg		O_o ⟶ ∅	

7.1 Reaction ER_Channel

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

Reaction equation

$$\mathrm{Ca\_ER} \xrightarrow{\mathrm{IP3\_Cyt}} \mathrm{Ca\_Cyt} \tag{4}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
Ca_ER		

Modifier

Table 7: Properties of each modifier.

Id	Name	SBO
IP3_Cyt		

Product

Table 8: Properties of each product.

Id	Name	SBO
Ca_Cyt		

Kinetic Law

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

$$v_1 = \mathrm{vol}\left(\mathrm{Cytoplasm}\right) \cdot \left(\mathrm{L} + \frac{\mathrm{P\_IP3R} \cdot \left[\mathrm{IP3\_Cyt}\right]^3 \cdot \left[\mathrm{Ca\_Cyt}\right]^3 \cdot \mathrm{h}^3}{\left(\left[\mathrm{IP3\_Cyt}\right] + \mathrm{Ki}\right)^3 \cdot \left(\left[\mathrm{Ca\_Cyt}\right] + \mathrm{Ka}\right)^3}\right) \cdot \left(\left[\mathrm{Ca\_ER}\right] - \left[\mathrm{Ca\_Cyt}\right]\right) \tag{5}$$

7.2 Reaction SERCA

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

Reaction equation

$$\text{Ca\_Cyt} \longrightarrow \text{Ca\_ER} \tag{6}$$

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
Ca_Cyt		

Product

Table 10: Properties of each product.

Id	Name	SBO
Ca_ER		

Kinetic Law

Derived unit $1.0000000000000024 \cdot 10^{-6}\ \text{mol} \cdot \text{s}^{-1}$

$$v_2 = \text{vol}\,(\text{Cytoplasm}) \cdot \frac{\text{V\_SERCA} \cdot [\text{Ca\_Cyt}]^{\text{p}}}{\text{K\_SERCA}^{\text{p}} + [\text{Ca\_Cyt}]^{\text{p}}} \tag{7}$$

7.3 Reaction PM_Channel

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

Reaction equation

$$\emptyset \xrightarrow{\text{O\_o}} \text{Ca\_Cyt} \tag{8}$$

Modifier

Table 11: Properties of each modifier.

Id	Name	SBO
O_o		

Product

Table 12: Properties of each product.

Id	Name	SBO
Ca_Cyt		

Kinetic Law

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

$$v_3 = \mathrm{vol}\,(\mathrm{Cytoplasm}) \cdot (\mathrm{k\_soc} \cdot [\mathrm{O\_o}] + \mathrm{V\_PMleak}) \cdot (\mathrm{Ca\_ec} - [\mathrm{Ca\_Cyt}]) \tag{9}$$

7.4 Reaction PMCA

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

Reaction equation

$$\mathrm{Ca\_Cyt} \longrightarrow \emptyset \tag{10}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
Ca_Cyt		

Kinetic Law

Derived unit $1.0000000000000024 \cdot 10^{-6}\ \mathrm{mol} \cdot \mathrm{s}^{-1}$

$$v_4 = \mathrm{vol}\,(\mathrm{Cytoplasm}) \cdot \frac{\mathrm{V\_PMCA} \cdot [\mathrm{Ca\_Cyt}]^{\mathrm{q}}}{\mathrm{K\_PMCA}^{\mathrm{q}} + [\mathrm{Ca\_Cyt}]^{\mathrm{q}}} \tag{11}$$

7.5 Reaction PLC

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

Reaction equation

$$\emptyset \xrightarrow{\mathrm{Ca\_Cyt}} \mathrm{IP3\_Cyt} \tag{12}$$

Modifier

Table 14: Properties of each modifier.

Id	Name	SBO
Ca_Cyt		

Product

Table 15: Properties of each product.

Id	Name	SBO
IP3_Cyt		

Kinetic Law

Derived unit $1.0000000000000024 \cdot 10^{-6}\ \mathrm{mol} \cdot \mathrm{s}^{-1}$

$$v_5 = \mathrm{vol}\,(\mathrm{Cytoplasm}) \cdot \frac{\mathrm{V\_PLC} \cdot [\mathrm{Ca\_Cyt}]^2}{\mathrm{K\_PLC}^2 + [\mathrm{Ca\_Cyt}]^2} \tag{13}$$

7.6 Reaction deg

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

Reaction equation

$$\mathrm{IP3\_Cyt} \xrightarrow{\mathrm{Ca\_Cyt}} \emptyset \tag{14}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
IP3_Cyt		

Modifier

Table 17: Properties of each modifier.

Id	Name	SBO
Ca_Cyt		

Kinetic Law

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

$$v_6 = \mathrm{vol}\,(\mathrm{Cytoplasm}) \cdot \frac{\mathrm{kdeg} \cdot [\mathrm{Ca\_Cyt}]^2}{\mathrm{K\_deg}^2 + [\mathrm{Ca\_Cyt}]^2} \cdot [\mathrm{IP3\_Cyt}] \tag{15}$$

7.7 Reaction act_apoSTIM1_syn

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

Reaction equation

$$\emptyset \xrightarrow{\mathrm{S2}} \mathrm{S2a} \tag{16}$$

Modifier

Table 18: Properties of each modifier.

Id	Name	SBO
S2		

Product

Table 19: Properties of each product.

Id	Name	SBO
S2a		

Kinetic Law

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

$$v_7 = \mathrm{vol}\,(\mathrm{ER}) \cdot \mathrm{k\_a} \cdot [\mathrm{S2}] \tag{17}$$

7.8 Reaction act_apoSTIM1_deg

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

Reaction equation

$$\mathrm{S2a} \longrightarrow \emptyset \tag{18}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
S2a		

Kinetic Law

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

$$v_8 = \mathrm{vol}\,(\mathrm{ER}) \cdot \mathrm{k\_i} \cdot [\mathrm{S2a}] \tag{19}$$

7.9 Reaction apoSTIM1_oligo_syn

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

Reaction equation

$$\emptyset \xrightarrow{\mathrm{S2}} \mathrm{S4} \tag{20}$$

Modifier

Table 21: Properties of each modifier.

Id	Name	SBO
S2		

Product

Table 22: Properties of each product.

Id	Name	SBO
S4		

Kinetic Law

Derived unit $1.0000000000000024 \cdot 10^{-6}\ \mathrm{mol} \cdot \mathrm{s}^{-1}$

$$v_9 = \mathrm{vol}\,(\mathrm{ER}) \cdot \frac{\mathrm{Vs4} \cdot [\mathrm{S2}]^2}{[\mathrm{S2}]^2 + \mathrm{K2}^2} \tag{21}$$

7.10 Reaction apoSTIM1_oligo_deg

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

Reaction equation

$$\mathrm{S4} \longrightarrow \emptyset \tag{22}$$

Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
S4		

Kinetic Law

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

$$v_{10} = \mathrm{vol}\,(\mathrm{ER}) \cdot \mathrm{kd\_oligo} \cdot [\mathrm{S4}] \tag{23}$$

7.11 Reaction close_CRAC_prod

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

Reaction equation

$$\emptyset \xrightarrow{\mathrm{Orai1}} \mathrm{Oc} \tag{24}$$

Modifier

Table 24: Properties of each modifier.

Id	Name	SBO
Orai1		

Product

Table 25: Properties of each product.

Id	Name	SBO
Oc		

Kinetic Law

Derived unit $10^{-6}\,\mathrm{mol}\cdot\mathrm{s}^{-1}$

$$v_{11} = \mathrm{vol}\,(\mathrm{PM}) \cdot \frac{\mathrm{Vcp} \cdot [\mathrm{Orai1}]^{\mathrm{n\_hill}}}{\mathrm{Kc}^{\mathrm{n\_hill}} + [\mathrm{Orai1}]^{\mathrm{n\_hill}}} \tag{25}$$

7.12 Reaction `closed_CRAC_channel_deg`

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

Reaction equation

$$\mathrm{Oc} \longrightarrow \emptyset \tag{26}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
Oc		

Kinetic Law

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

$$v_{12} = \mathrm{vol}\,(\mathrm{PM}) \cdot \mathrm{kdc} \cdot [\mathrm{Oc}] \tag{27}$$

7.13 Reaction `open_CRAC_channel_prod`

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

Reaction equation

$$\mathrm{Oc} \xrightarrow{\mathrm{S2a}} \mathrm{O\_o} \tag{28}$$

Reactant

Table 27: Properties of each reactant.

Id	Name	SBO
Oc		

Modifier

Table 28: Properties of each modifier.

Id	Name	SBO
S2a		

Product

Table 29: Properties of each product.

Id	Name	SBO
O_o		

Kinetic Law

Derived unit $\mathrm{s}^{-1} \cdot 10^{-6}\,\mathrm{mol}$

$$v_{13} = \mathrm{vol}\,(\mathrm{PM}) \cdot \frac{\mathrm{kop} \cdot [\mathrm{S2a}]^{\mathrm{l\_hill}} \cdot [\mathrm{Oc}]}{\mathrm{Ko}^{\mathrm{l\_hill}} + [\mathrm{S2a}]^{\mathrm{l\_hill}}} \tag{29}$$

7.14 Reaction open_to_closed

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

Reaction equation

$$\mathrm{O\_o} \longrightarrow \mathrm{Oc} \tag{30}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
O_o		

Product

Table 31: Properties of each product.

Id	Name	SBO
Oc		

Kinetic Law

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

$$v_{14} = \mathrm{vol}(\mathrm{PM}) \cdot \mathrm{kod} \cdot [\mathrm{O\_o}] \tag{31}$$

7.15 Reaction open_CRAC_channel_deg

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

Reaction equation

$$\mathrm{O\_o} \longrightarrow \emptyset \tag{32}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
O_o		

Kinetic Law

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

$$v_{15} = \mathrm{vol}(\mathrm{PM}) \cdot \mathrm{kdo} \cdot [\mathrm{O\_o}] \tag{33}$$

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.

8.1 Species Ca_Cyt

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

This species takes part in six reactions (as a reactant in SERCA, PMCA and as a product in ER_Channel, PM_Channel and as a modifier in PLC, deg).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ca\_Cyt} = v_1 + v_3 - v_2 - v_4 \tag{34}$$

8.2 Species IP3_Cyt

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

This species takes part in three reactions (as a reactant in deg and as a product in PLC and as a modifier in ER_Channel).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{IP3\_Cyt} = v_5 - v_6 \tag{35}$$

8.3 Species Ca_ER

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

This species takes part in two reactions (as a reactant in ER_Channel and as a product in SERCA).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Ca\_ER} = v_2 - v_1 \tag{36}$$

8.4 Species S2

Initial concentration $0.54\ \mu\mathrm{mol}\cdot\mathrm{l}^{-1}$

Involved in rule S2

This species takes part in two reactions (as a modifier in act_apoSTIM1_syn, apoSTIM1_oligo_syn) and is also involved in one rule which determines this species' quantity.

8.5 Species S2a

Initial concentration $0.06\ \mu\mathrm{mol}\cdot\mathrm{l}^{-1}$

This species takes part in three reactions (as a reactant in act_apoSTIM1_deg and as a product in act_apoSTIM1_syn and as a modifier in open_CRAC_channel_prod).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S2a} = v_7 - v_8 \tag{37}$$

8.6 Species S4

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

This species takes part in two reactions (as a reactant in apoSTIM1_oligo_deg and as a product in apoSTIM1_oligo_syn).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S4} = v_9 - v_{10} \tag{38}$$

8.7 Species Oc

Initial concentration $0\ \mu\text{mol} \cdot \text{l}^{-1}$

This species takes part in four reactions (as a reactant in closed_CRAC_channel_deg, open_CRAC_channel_prod and as a product in close_CRAC_prod, open_to_closed).

$$\frac{\text{d}}{\text{d}t}\text{Oc} = v_{11} + v_{14} - v_{12} - v_{13} \tag{39}$$

8.8 Species O_o

Initial concentration $0\ \mu\text{mol} \cdot \text{l}^{-1}$

This species takes part in four reactions (as a reactant in open_to_closed, open_CRAC_channel_deg and as a product in open_CRAC_channel_prod and as a modifier in PM_Channel).

$$\frac{\text{d}}{\text{d}t}\text{O\_o} = v_{13} - v_{14} - v_{15} \tag{40}$$

8.9 Species Orai1

Initial concentration $0.0010\ \mu\text{mol} \cdot \text{l}^{-1}$

Involved in rule Orai1

This species takes part in one reaction (as a modifier in close_CRAC_prod) and is also involved in one rule which determines this species' quantity.

SBML2LaTeX was developed by Andreas Dräger[a], Hannes Planatscher[a], Dieudonné M Wouamba[a], Adrian Schröder[a], Michael Hucka[b], Lukas Endler[c], Martin Golebiewski[d] and Andreas Zell[a]. Please see http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX for more information.

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