SBML Model Report

Model name: “Tyson1991 - Cell Cycle 6 var”

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: Bruce Shapiro[1] and Vijayalakshmi Chelliah[2] at February eighth 2005 at 6:28 p. m. and last time modified at May 16th 2013 at 2:40 p. m. Table 1 gives an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	9
events	0	constraints	0
reactions	9	function definitions	0
global parameters	0	unit definitions	0
rules	2	initial assignments	0

Model Notes

Tyson1991 - Cell Cycle 6 var

Mathematical model of the interactions of cdc2 and cyclin.

This model is described in the article:Modeling the cell division cycle: cdc2 and cyclin interactions.Tyson JJ.Proc. Natl. Acad. Sci. U.S.A. 1991; 88(16); 7328-32

Abstract:

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The proteins cdc2 and cyclin form a heterodimer (maturation promoting factor) that controls the major events of the cell cycle. A mathematical model for the interactions of cdc2 and cyclin is constructed. Simulation and analysis of the model show that the control system can operate in three modes: as a steady state with high maturation promoting factor activity, as a spontaneous oscillator, or as an excitable switch. We associate the steady state with metaphase arrest in unfertilized eggs, the spontaneous oscillations with rapid division cycles in early embryos, and the excitable switch with growth-controlled division cycles typical of nonembryonic cells.

This model is hosted on BioModels Database and identified by: BIOMD0000000005 .

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

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
`cell`			3	1	litre	☑	

3.1 Compartment `cell`

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

4 Species

This model contains nine 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 7 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
`EmptySet`		`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	☑
`C2`	cdc2k	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`CP`	cdc2k-P	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`M`	p-cyclin_cdc2	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`pM`	p-cyclin_cdc2-p	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`Y`	cyclin	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`YP`	p-cyclin	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	⊟
`YT`	total_cyclin	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	☑
`CT`	total_cdc2	`cell`	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	⊟	☑

5 Rules

This is an overview of two rules.

5.1 Rule YT

Rule YT is an assignment rule for species YT:

$$\mathrm{YT} = [\mathrm{Y}] + [\mathrm{YP}] + [\mathrm{M}] + [\mathrm{pM}] \tag{1}$$

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

5.2 Rule CT

Rule CT is an assignment rule for species CT:

$$\mathrm{CT} = [\mathrm{C2}] + [\mathrm{CP}] + [\mathrm{M}] + [\mathrm{pM}] \tag{2}$$

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

6 Reactions

This model contains nine 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 4: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	`Reaction1`	cyclin_cdc2k dissociation	$M \longrightarrow C2 + YP$	
2	`Reaction2`	cdc2k phosphorylation	$C2 \longrightarrow CP$	
3	`Reaction3`	cdc2k dephosphorylation	$CP \longrightarrow C2$	
4	`Reaction4`	cyclin cdc2k-p association	$CP + Y \longrightarrow pM$	
5	`Reaction5`	deactivation of cdc2 kinase	$M \longrightarrow pM$	
6	`Reaction6`	cyclin biosynthesis	$EmptySet \longrightarrow Y$	
7	`Reaction7`	default degradation of cyclin	$Y \longrightarrow EmptySet$	
8	`Reaction8`	cdc2 kinase triggered degration of cyclin	$YP \longrightarrow EmptySet$	
9	`Reaction9`	activation of cdc2 kinase	$pM \xrightarrow{CT} M$	

6.1 Reaction Reaction1

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

Name cyclin_cdc2k dissociation

Reaction equation

$$\mathrm{M} \longrightarrow \mathrm{C2} + \mathrm{YP} \tag{3}$$

Reactant

Table 5: Properties of each reactant.

Id	Name	SBO
M	p-cyclin_cdc2	

Products

Table 6: Properties of each product.

Id	Name	SBO
C2	cdc2k	
YP	p-cyclin	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{k6} \cdot [\mathrm{M}] \tag{4}$$

Table 7: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k6			1.0		☑

6.2 Reaction Reaction2

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

Name cdc2k phosphorylation

Reaction equation

$$\mathrm{C2} \longrightarrow \mathrm{CP} \tag{5}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
C2	cdc2k	

Product

Table 9: Properties of each product.

Id	Name	SBO
CP	cdc2k-P	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\,(\mathrm{cell}) \cdot [\mathrm{C2}] \cdot \mathrm{k8notP} \tag{6}$$

Table 10: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k8notP			1000000.0		☑

6.3 Reaction Reaction3

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

Name cdc2k dephosphorylation

Reaction equation

$$\mathrm{CP} \longrightarrow \mathrm{C2} \tag{7}$$

Reactant

Table 11: Properties of each reactant.

Id	Name	SBO
CP	cdc2k-P	

Product

Table 12: Properties of each product.

Id	Name	SBO
C2	cdc2k	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\,(\mathrm{cell}) \cdot [\mathrm{CP}] \cdot \mathrm{k9} \tag{8}$$

Table 13: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k9			1000.0		☑

6.4 Reaction Reaction4

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

Name cyclin cdc2k-p association

Reaction equation

$$\mathrm{CP} + \mathrm{Y} \longrightarrow \mathrm{pM} \tag{9}$$

Reactants

Table 14: Properties of each reactant.

Id	Name	SBO
CP	cdc2k-P	
Y	cyclin	

Product

Table 15: Properties of each product.

Id	Name	SBO
pM	p-cyclin_cdc2-p	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\,(\mathrm{cell}) \cdot [\mathrm{CP}] \cdot \mathrm{k3} \cdot [\mathrm{Y}] \tag{10}$$

Table 16: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k3			200.0		☑

6.5 Reaction Reaction5

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

Name deactivation of cdc2 kinase

Reaction equation

$$\mathrm{M} \longrightarrow \mathrm{pM} \tag{11}$$

Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
M	p-cyclin_cdc2	

Product

Table 18: Properties of each product.

Id	Name	SBO
pM	p-cyclin_cdc2-p	

Id	Name	SBO

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{k5notP} \cdot [\mathrm{M}] \tag{12}$$

Table 19: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k5notP			0.0		☑

6.6 Reaction Reaction6

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

Name cyclin biosynthesis

Reaction equation

$$\mathrm{EmptySet} \longrightarrow \mathrm{Y} \tag{13}$$

Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
EmptySet		

Product

Table 21: Properties of each product.

Id	Name	SBO
Y	cyclin	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{k1aa} \tag{14}$$

Table 22: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1aa			0.015		☑

6.7 Reaction Reaction7

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

Name default degradation of cyclin

Reaction equation

$$\mathrm{Y} \longrightarrow \mathrm{EmptySet} \tag{15}$$

Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
Y	cyclin	

Product

Table 24: Properties of each product.

Id	Name	SBO
EmptySet		

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{k2} \cdot [\mathrm{Y}] \tag{16}$$

Table 25: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k2			0.0		☑

6.8 Reaction Reaction8

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

Name cdc2 kinase triggered degration of cyclin

Reaction equation

$$\mathrm{YP} \longrightarrow \mathrm{EmptySet} \tag{17}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
YP	p-cyclin	

Product

Table 27: Properties of each product.

Id	Name	SBO
EmptySet		

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{k7} \cdot [\mathrm{YP}] \tag{18}$$

Table 28: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k7			0.6		☑

6.9 Reaction Reaction9

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

Name activation of cdc2 kinase

Reaction equation

$$\mathrm{pM} \xrightarrow{\mathrm{CT}} \mathrm{M} \tag{19}$$

Reactant

Table 29: Properties of each reactant.

Id	Name	SBO
pM	p-cyclin_cdc2-p	

Modifier

Table 30: Properties of each modifier.

Id	Name	SBO
CT	total_cdc2	

Product

Table 31: Properties of each product.

Id	Name	SBO
M	p-cyclin_cdc2	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\,(\mathrm{cell}) \cdot [\mathrm{pM}] \cdot \left(\mathrm{k4prime} + \mathrm{k4} \cdot \left(\frac{[\mathrm{M}]}{[\mathrm{CT}]} \right)^2 \right) \tag{20}$$

Table 32: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k4			180.000		☑
k4prime			0.018		☑

7 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.

7.1 Species `EmptySet`

Initial amount 0 mol

This species takes part in three reactions (as a reactant in `Reaction6` and as a product in `Reaction7`, `Reaction8`), which do not influence its rate of change because this species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{EmptySet} = 0 \tag{21}$$

7.2 Species `C2`

Name cdc2k

Initial amount 0 mol

This species takes part in three reactions (as a reactant in `Reaction2` and as a product in `Reaction1`, `Reaction3`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{C2} = v_1 + v_3 - v_2 \tag{22}$$

7.3 Species `CP`

Name cdc2k-P

Initial amount 0.75 mol

This species takes part in three reactions (as a reactant in `Reaction3`, `Reaction4` and as a product in `Reaction2`).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{CP} = v_2 - v_3 - v_4 \tag{23}$$

7.4 Species M

Name p-cyclin_cdc2

Initial amount 0 mol

This species takes part in three reactions (as a reactant in Reaction1, Reaction5 and as a product in Reaction9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{M} = v_9 - v_1 - v_5 \tag{24}$$

7.5 Species pM

Name p-cyclin_cdc2-p

Initial amount 0.25 mol

This species takes part in three reactions (as a reactant in Reaction9 and as a product in Reaction4, Reaction5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{pM} = v_4 + v_5 - v_9 \tag{25}$$

7.6 Species Y

Name cyclin

Initial amount 0 mol

This species takes part in three reactions (as a reactant in Reaction4, Reaction7 and as a product in Reaction6).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Y} = v_6 - v_4 - v_7 \tag{26}$$

7.7 Species YP

Name p-cyclin

Initial amount 0 mol

This species takes part in two reactions (as a reactant in Reaction8 and as a product in Reaction1).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{YP} = v_1 - v_8 \tag{27}$$

7.8 Species YT

Name total_cyclin

Involved in rule YT

One rule determines the species' quantity.

7.9 Species CT

Name total_cdc2

Involved in rule CT

This species takes part in one reaction (as a modifier in Reaction9). Not this but one rule determines the species' quantity because this species is on the boundary of the reaction system.

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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