SBML Model Report

Model name: "Chen2000 - Budding yeast cell cycle"

May 17, 2018

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Matthew Grant Roberts[1] and Catherine Lloyd[2] at June 25th 2010 at 12:06 a. m. and last time modified at February 20th 2018 at 9:06 a. 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	1
species types	0	species	0
events	4	constraints	0
reactions	0	function definitions	0
global parameters	102	unit definitions	1
rules	29	initial assignments	0

Model Notes

This a model from the article:
Kinetic analysis of a molecular model of the budding yeast cell cycle.
Chen KC, Csikasz-Nagy A, Gyorffy B, Val J, Novak B, Tyson JJ. Mol Biol Cell 2000 Jan;11(1):369-91 10637314 ,

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Abstract:
The molecular machinery of cell cycle control is known in more detail forbudding yeast, Saccharomyces cerevisiae, than for any other eukaryotic organism.In recent years, many elegant experiments on budding yeast have dissected theroles of cyclin molecules (Cln1-3 and Clb1-6) in coordinating the events of DNAsynthesis, bud emergence, spindle formation, nuclear division, and cellseparation. These experimental clues suggest a mechanism for the principalmolecular interactions controlling cyclin synthesis and degradation. Usingstandard techniques of biochemical kinetics, we convert the mechanism into a setof differential equations, which describe the time courses of three majorclasses of cyclin-dependent kinase activities. Model in hand, we examine themolecular events controlling „Start„ (the commitment step to a new round ofchromosome replication, bud formation, and mitosis) and „Finish„ (the transitionfrom metaphase to anaphase, when sister chromatids are pulled apart and the budseparates from the mother cell) in wild-type cells and 50 mutants. The modelaccounts for many details of the physiology, biochemistry, and genetics of cellcycle control in budding yeast.

This model was taken from the CellML repository and automatically converted to SBML.
The original model was: **Chen KC, Csikasz-Nagy A, Gyorffy B, Val J, Novak B, Tyson JJ. (2000) - version=1.0**
The original CellML model was created by:
Catherine Lloyd
c.lloyd@auckland.ac.nz
The University of Auckland

2 Unit Definitions

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

2.1 Unit `time`

Name time

Definition 60 s

2.2 Unit `substance`

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

Definition mol

2.3 Unit `volume`

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

Definition l

2.4 Unit `area`

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

Definition m^2

2.5 Unit `length`

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

Definition m

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`COMpartment`	Yeast Cell		3	1	litre	☑	

3.1 Compartment `COMpartment`

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

Name Yeast Cell

4 Parameters

This model contains 102 global parameters.

Table 3: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Cln2	Cln2		0.008		⊟
ks_n2	ks_n2_prime		0.000		☑
ks_n2_	ks_n2_2prime		0.050		☑
kd_n2	kd_n2		0.100		☑
Clb2_T	Clb2_T		0.234		⊟
Hct1_T	Hct1_T		1.000		☑
ks_b2	ks_b2_prime		0.002		☑
ks_b2_	ks_b2_2prime		0.050		☑
kd_b2	kd_b2_prime		0.010		☑
kd_b2_	kd_b2_2prime		2.000		☑
kd_b2__	kd_b2_3prime		0.050		☑
Vd_b2	Vd_b2		2.023		⊟
Clb2	Clb2		0.155		⊟
Clb5	Clb5		0.041		⊟
Sic1	Sic1		0.023		⊟
Clb5_T	Clb5_T		0.061		⊟
ks_b5	ks_b5_prime		0.006		☑
ks_b5_	ks_b5_2prime		0.020		☑
kd_b5	kd_b5_prime		0.100		☑
kd_b5_	kd_b5_2prime		0.250		☑
Vd_b5	Vd_b5		0.271		⊟
Bck2	Bck2		0.002		⊟
Bck2_0	Bck2_0		0.003		☑
Cln3	Cln3		0.002		⊟
Jn3	Jn3		6.000		☑
Dn3	Dn3		1.000		☑
Cln3_max	Cln3_max		0.020		☑
Sic1_T	Sic1_T		0.123		⊟
ks_c1	ks_c1		0.020		☑
ks_c1_	ks_c1_2prime		0.100		☑
Clb2_Sic1	Clb2_Sic1		0.079		⊟
kas_b2	kas_b2		50.000		☑
kdi_b2	kdi_b2		0.050		☑
Clb5_Sic1	Clb5_Sic1		0.021		⊟
kas_b5	kas_b5		50.000		☑
kdi_b5	kdi_b5		0.050		☑

Id	Name	SBO	Value	Unit	Constant
Vd2_c1	Vd2_c1		0.031		☐
kd2_c1	kd2_c1		0.300		☑
epsilonc1_n3	epsilonc1_n3		20.000		☑
epsilonc1_k2	epsilonc1_k2		2.000		☑
epsilonc1_b5	epsilonc1_b5		1.000		☑
epsilonc1_b2	epsilonc1_b2		0.067		☑
Cdc20_T	Cdc20_T		0.833		☐
ks_20	ks_20_prime		0.005		☑
ks_20_	ks_20_2prime		0.060		☑
Cdc20	Cdc20		0.685		☐
ka_20	ka_20		1.000		☑
ki_20	ki_20_prime		0.100		☑
ki_20_	ki_20_2prime		10.000		☑
Vi_20	Vi_20		0.100		☐
Hct1	Hct1		0.995		☐
ka_t1	ka_t1_prime		0.040		☑
ka_t1_	ka_t1_2prime		2.000		☑
ki_t1	ki_t1_prime		0.000		☑
ki_t1_	ki_t1_2prime		0.640		☑
Vi_t1	Vi_t1		0.119		☐
Ji_t1	Ji_t1		0.050		☑
Ja_t1	Ja_t1		0.050		☑
epsiloni_t1_n2	epsiloni_t1_n2		1.000		☑
epsiloni_t1_b5	epsiloni_t1_b5		0.500		☑
epsiloni_t1_b2	epsiloni_t1_b2		1.000		☑
mass	mass		0.661		☐
mu	mu		0.006		☑
ORI	ORI		0.000		☐
ks_ori	ks_ori		2.000		☑
kd_ori	kd_ori		0.060		☑
epsilonori_b2	epsilonori_b2		0.400		☑
BUD	BUD		0.000		☐
ks_bud	ks_bud		0.300		☑
kd_bud	kd_bud		0.060		☑
epsilonbud_b5	epsilonbud_b5		1.000		☑
SPN	SPN		0.000		☐
ks_spn	ks_spn		0.080		☑

Id	Name	SBO	Value	Unit	Constant
kd_spn	kd_spn		0.060		☑
J_spn	J_spn		0.200		☑
SBF	SBF		0.003		☐
ka_sbf	ka_sbf		1.000		☑
ki_sbf	ki_sbf_prime		0.500		☑
ki_sbf_	ki_sbf_2prime		6.000		☑
Va_sbf	Va_sbf		0.311		☐
Ji_sbf	Ji_sbf		0.010		☑
Ja_sbf	Ja_sbf		0.010		☑
epsilonsbf_n3	epsilonsbf_n3		75.000		☑
epsilonsbf_b5	epsilonsbf_b5		0.500		☑
MBF	MBF		0.003		☐
Mcm1	Mcm1		0.513		☐
ka_mcm	ka_mcm		1.000		☑
ki_mcm	ki_mcm		0.150		☑
Ji_mcm	Ji_mcm		1.000		☑
Ja_mcm	Ja_mcm		1.000		☑
Swi5	Swi5		0.923		☐
ka_swi	ka_swi		1.000		☑
ki_swi	ki_swi_prime		0.300		☑
ki_swi_	ki_swi_2prime		0.200		☑
Ji_swi	Ji_swi		0.100		☑
Ja_swi	Ja_swi		0.100		☑
kd1_c1	kd1_c1		0.010		☑
kd_20	kd_20		0.080		☑
Jd2_c1	Jd2_c1		0.050		☑
END_M	END_M		2000.000		☐
START_S	START_S		1000.000		☐
D	D		145.632		☐

5 Rules

This is an overview of 29 rules.

5.1 Rule Vd_b2

Rule Vd_b2 is an assignment rule for parameter Vd_b2:

$$\mathrm{Vd\_b2} = \mathrm{kd\_b2} \cdot (\mathrm{Hct1\_T} - \mathrm{Hct1}) + \mathrm{kd\_b2\_} \cdot \mathrm{Hct1} + \mathrm{kd\_b2\_\_} \cdot \mathrm{Cdc20} \tag{1}$$

5.2 Rule Clb2

Rule Clb2 is an assignment rule for parameter Clb2:

$$\mathrm{Clb2} = \mathrm{Clb2\_T} - \mathrm{Clb2\_Sic1} \tag{2}$$

5.3 Rule Clb5

Rule Clb5 is an assignment rule for parameter Clb5:

$$\mathrm{Clb5} = \mathrm{Clb5\_T} - \mathrm{Clb5\_Sic1} \tag{3}$$

5.4 Rule Sic1

Rule Sic1 is an assignment rule for parameter Sic1:

$$\mathrm{Sic1} = \mathrm{Sic1\_T} - (\mathrm{Clb2\_Sic1} + \mathrm{Clb5\_Sic1}) \tag{4}$$

5.5 Rule Vd_b5

Rule Vd_b5 is an assignment rule for parameter Vd_b5:

$$\mathrm{Vd\_b5} = \mathrm{kd\_b5} + \mathrm{kd\_b5\_} \cdot \mathrm{Cdc20} \tag{5}$$

5.6 Rule Bck2

Rule Bck2 is an assignment rule for parameter Bck2:

$$\mathrm{Bck2} = \mathrm{Bck2\_0} \cdot \mathrm{mass} \tag{6}$$

5.7 Rule Cln3

Rule Cln3 is an assignment rule for parameter Cln3:

$$\mathrm{Cln3} = \frac{\mathrm{Cln3\_max} \cdot \mathrm{Dn3} \cdot \mathrm{mass}}{\mathrm{Jn3} + \mathrm{Dn3} \cdot \mathrm{mass}} \tag{7}$$

5.8 Rule Va_sbf

Rule Va_sbf is an assignment rule for parameter Va_sbf:

$$\mathrm{Va\_sbf} = \mathrm{ka\_sbf} \cdot (\mathrm{Cln2} + \mathrm{epsilonsbf\_n3} \cdot (\mathrm{Cln3} + \mathrm{Bck2}) + \mathrm{epsilonsbf\_b5} \cdot \mathrm{Clb5}) \tag{8}$$

5.9 Rule Vd2_c1

Rule Vd2_c1 is an assignment rule for parameter Vd2_c1:

$$\begin{aligned}\mathrm{Vd2\_c1} = \mathrm{kd2\_c1} \cdot (&\mathrm{epsilonc1\_n3} \cdot \mathrm{Cln3} + \mathrm{epsilonc1\_k2} \cdot \mathrm{Bck2} + \mathrm{Cln2} + \mathrm{epsilonc1\_b5} \\ &\cdot \mathrm{Clb5} + \mathrm{epsilonc1\_b2} \cdot \mathrm{Clb2})\end{aligned} \tag{9}$$

5.10 Rule Vi_20

Rule Vi_20 is an assignment rule for parameter Vi_20:

$$\mathrm{Vi\_20} = \begin{cases} 10 & \text{if } (\mathrm{time} \geq \mathrm{START\_S}) \wedge (\mathrm{time} \\ \begin{cases} 10 - 9.9 \cdot \frac{\mathrm{time} - \mathrm{END\_M}}{12} & \text{if } (\mathrm{time} \geq \mathrm{END\_M}) \wedge (\mathrm{time} < \mathrm{END\_M} + 12) \\ 0.1 & \text{otherwise} \end{cases} & \text{otherwise} \end{cases} \quad (10)$$

5.11 Rule Vi_t1

Rule Vi_t1 is an assignment rule for parameter Vi_t1:

$$\mathrm{Vi\_t1} = \mathrm{ki\_t1} + \mathrm{ki\_t1\_} \cdot (\mathrm{Cln3} + \mathrm{epsiloni\_t1\_n2} \cdot \mathrm{Cln2} + \mathrm{epsiloni\_t1\_b5} \cdot \mathrm{Clb5} + \mathrm{epsiloni\_t1\_b2} \cdot \mathrm{Clb2}) \quad (11)$$

5.12 Rule SBF

Rule SBF is an assignment rule for parameter SBF:

$$\mathrm{SBF} = \frac{2 \cdot \mathrm{V}}{\mathrm{ki\_sbf} + \mathrm{ki\_sbf\_} \cdot \mathrm{Clb2} + \mathrm{Va\_sbf} \cdot \mathrm{Ji\_sbf} + (\mathrm{ki\_sbf} + \mathrm{ki\_sbf\_} \cdot \mathrm{Clb2}) \cdot \mathrm{Ja\_sbf} - \mathrm{Va\_sbf} + \Big((\mathrm{ki\_sbf} + \mathrm{ki\_sbf\_} \cdot \mathrm{Clb2}} \quad (12)$$

5.13 Rule MBF

Rule MBF is an assignment rule for parameter MBF:

$$\mathrm{MBF} = \mathrm{SBF} \quad (13)$$

5.14 Rule Mcm1

Rule Mcm1 is an assignment rule for parameter Mcm1:

$$\mathrm{Mcm1} = \frac{2 \cdot \mathrm{ka\_mcm} \cdot \mathrm{Clb2}}{\mathrm{ki\_mcm} + \mathrm{ka\_mcm} \cdot \mathrm{Clb2} \cdot \mathrm{Ji\_mcm} + \mathrm{ki\_mcm} \cdot \mathrm{Ja\_mcm} - \mathrm{ka\_mcm} \cdot \mathrm{Clb2} + \Big((\mathrm{ki\_mcm} + \mathrm{ka\_mcm} \cdot \mathrm{Clb2} \cdot \mathrm{Ji\_mcm}} \quad (14)$$

5.15 Rule Swi5

Rule Swi5 is an assignment rule for parameter Swi5:

$$\mathrm{Swi5} = \frac{}{\mathrm{ki\_swi} + \mathrm{ki\_swi\_} \cdot \mathrm{Clb2} + \mathrm{ka\_swi} \cdot \mathrm{Cdc20} \cdot \mathrm{Ji\_swi} + (\mathrm{ki\_swi} + \mathrm{ki\_swi\_} \cdot \mathrm{Clb2}) \cdot \mathrm{Ja\_swi} - \mathrm{ka\_swi} \cdot \mathrm{Cdc20} + \Big((\mathrm{ki\_s}} \quad (15)$$

5.16 Rule D

Rule D is an assignment rule for parameter D:

$$D = \frac{1.026}{mu} - 32 \tag{16}$$

5.17 Rule Cln2

Rule Cln2 is a rate rule for parameter Cln2:

$$\frac{d}{dt}\text{Cln2} = \text{mass} \cdot (\text{ks\_n2} + \text{ks\_n2\_} \cdot \text{SBF}) - \text{kd\_n2} \cdot \text{Cln2} \tag{17}$$

5.18 Rule Clb2_T

Rule Clb2_T is a rate rule for parameter Clb2_T:

$$\frac{d}{dt}\text{Clb2\_T} = \text{mass} \cdot (\text{ks\_b2} + \text{ks\_b2\_} \cdot \text{Mcm1}) - \text{Vd\_b2} \cdot \text{Clb2\_T} \tag{18}$$

5.19 Rule Clb5_T

Rule Clb5_T is a rate rule for parameter Clb5_T:

$$\frac{d}{dt}\text{Clb5\_T} = \text{mass} \cdot (\text{ks\_b5} + \text{ks\_b5\_} \cdot \text{MBF}) - \text{Vd\_b5} \cdot \text{Clb5\_T} \tag{19}$$

5.20 Rule Sic1_T

Rule Sic1_T is a rate rule for parameter Sic1_T:

$$\frac{d}{dt}\text{Sic1\_T} = \text{ks\_c1} + \text{ks\_c1\_} \cdot \text{Swi5} - \text{Sic1\_T} \cdot \left(\text{kd1\_c1} + \frac{\text{Vd2\_c1}}{\text{Jd2\_c1} + \text{Sic1\_T}}\right) \tag{20}$$

5.21 Rule Clb2_Sic1

Rule Clb2_Sic1 is a rate rule for parameter Clb2_Sic1:

$$\begin{aligned}\frac{d}{dt}\text{Clb2\_Sic1} = {} & \text{kas\_b2} \cdot \text{Clb2} \cdot \text{Sic1} - \text{Clb2\_Sic1} \\ & \cdot \left(\text{kdi\_b2} + \text{Vd\_b2} + \text{kd1\_c1} + \frac{\text{Vd2\_c1}}{\text{Jd2\_c1} + \text{Sic1\_T}}\right)\end{aligned} \tag{21}$$

5.22 Rule Clb5_Sic1

Rule Clb5_Sic1 is a rate rule for parameter Clb5_Sic1:

$$\begin{aligned}\frac{d}{dt}\text{Clb5\_Sic1} = {} & \text{kas\_b5} \cdot \text{Clb5} \cdot \text{Sic1} - \text{Clb5\_Sic1} \\ & \cdot \left(\text{kdi\_b5} + \text{Vd\_b5} + \text{kd1\_c1} + \frac{\text{Vd2\_c1}}{\text{Jd2\_c1} + \text{Sic1\_T}}\right)\end{aligned} \tag{22}$$

5.23 Rule Cdc20_T

Rule Cdc20_T is a rate rule for parameter Cdc20_T:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Cdc20\_T} = \mathrm{ks\_20} + \mathrm{ks\_20\_} \cdot \mathrm{Clb2} - \mathrm{kd\_20} \cdot \mathrm{Cdc20\_T} \tag{23}$$

5.24 Rule Cdc20

Rule Cdc20 is a rate rule for parameter Cdc20:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Cdc20} = \mathrm{ka\_20} \cdot (\mathrm{Cdc20\_T} - \mathrm{Cdc20}) - \mathrm{Cdc20} \cdot (\mathrm{Vi\_20} + \mathrm{kd\_20}) \tag{24}$$

5.25 Rule Hct1

Rule Hct1 is a rate rule for parameter Hct1:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Hct1} = \frac{(\mathrm{ka\_t1} + \mathrm{ka\_t1\_} \cdot \mathrm{Cdc20}) \cdot (\mathrm{Hct1\_T} - \mathrm{Hct1})}{\mathrm{Ja\_t1} + \mathrm{Hct1\_T} - \mathrm{Hct1}} - \frac{\mathrm{Vi\_t1} \cdot \mathrm{Hct1}}{\mathrm{Ji\_t1} + \mathrm{Hct1}} \tag{25}$$

5.26 Rule mass

Rule mass is a rate rule for parameter mass:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{mass} = \mathrm{mu} \cdot \mathrm{mass} \tag{26}$$

5.27 Rule ORI

Rule ORI is a rate rule for parameter ORI:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ORI} = \mathrm{ks\_ori} \cdot (\mathrm{Clb5} + \mathrm{epsilonori\_b2} \cdot \mathrm{Clb2}) - \mathrm{kd\_ori} \cdot \mathrm{ORI} \tag{27}$$

5.28 Rule BUD

Rule BUD is a rate rule for parameter BUD:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{BUD} = \mathrm{ks\_bud} \cdot (\mathrm{Cln2} + \mathrm{Cln3} + \mathrm{epsilonbud\_b5} \cdot \mathrm{Clb5}) - \mathrm{kd\_bud} \cdot \mathrm{BUD} \tag{28}$$

5.29 Rule SPN

Rule SPN is a rate rule for parameter SPN:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{SPN} = \frac{\mathrm{ks\_spn} \cdot \mathrm{Clb2}}{\mathrm{J\_spn} + \mathrm{Clb2}} - \mathrm{kd\_spn} \cdot \mathrm{SPN} \tag{29}$$

6 Events

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

6.1 Event `Event_detection_for_END_M`

Name Event detection for END_M

Trigger condition

$$\mathrm{SPN} \geq 1 \tag{30}$$

Assignment

$$\mathrm{END\_M} = \mathrm{time} \tag{31}$$

6.2 Event `Event_detection_for_Cell_Division_and_BUD_SPN_reset`

Name Event detection for Cell Division and BUD/SPN reset

Trigger condition

$$\mathrm{Clb2} < 0.3 \tag{32}$$

Assignments

$$\mathrm{mass} = \exp\left(1 \cdot \mathrm{mu} \cdot \mathrm{D}\right) \cdot \mathrm{mass} \tag{33}$$

$$\mathrm{BUD} = 0 \tag{34}$$

$$\mathrm{SPN} = 0 \tag{35}$$

6.3 Event `Event_detection_for_START_S`

Name Event detection for START_S

Trigger condition

$$\mathrm{ORI} > 1 \tag{36}$$

Assignments

$$\mathrm{START\_S} = \mathrm{time} \tag{37}$$

$$\mathrm{END\_M} = \mathrm{time} + 1000 \tag{38}$$

6.4 Event `Event_detection_for_ORI_reset`

Name Event detection for ORI reset

Trigger condition

$$\mathrm{Clb2} + \mathrm{Clb5} < 0.2 \tag{39}$$

Assignment

$$\mathrm{ORI} = 0 \tag{40}$$

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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