SBML Model Report

Model name: "Yao2008_Rb_E2F_Switch"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by Kieran Smallbone[1] at February eighth 2011 at no o' clock in the morning. and last time modified at March 31st 2014 at 12:24 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	7
events	2	constraints	0
reactions	17	function definitions	0
global parameters	1	unit definitions	6
rules	0	initial assignments	0

Model Notes

This is the model described in the article:
A bistable Rb-E2F switch underlies the restriction point
Guang Yao, Tae Jun Lee, Seiichi Mori, Joseph R. Nevins, Lingchong You, *Nat Cell Biol* 2008 10:476-482; PMID: 18364697 ; DOI: 10.1038/ncb1711 .

Abstract:

The restriction point (R-point) marks the critical event when a mammalian cell commits to proliferation and becomes independent of growth stimulation. It is fundamental for normal differenti-

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ation and tissue homeostasis, and seems to be dysregulated in virtually all cancers. Although the R-point has been linked to various activities involved in the regulation of G1-S transition of the mammalian cell cycle, the underlying mechanism remains unclear. Using single-cell measurements, we show here that the Rb-E2F pathway functions as a bistable switch to convert graded serum inputs into all-or-none E2F responses. Once turned ON by sufficient serum stimulation, E2F can memorize and maintain this ON state independently of continuous serum stimulation. We further show that, at critical concentrations and duration of serum stimulation, bistable E2F activation correlates directly with the ability of a cell to traverse the R-point.

This model reproduces the serum-pulse stimulation-protocol in Figure 3(b).

2 Unit Definitions

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

2.1 Unit `substance`

Name micromole

Definition µmol

2.2 Unit `time`

Name hour

Definition 3600 s

2.3 Unit `uM_per_hr`

Name uM per hr

Definition $\mu\text{mol} \cdot 1^{-1} \cdot (3600\ \text{s})^{-1}$

2.4 Unit uM

Name uM

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

2.5 Unit per_hr

Name per hr

Definition $(3600\ \text{s})^{-1}$

2.6 Unit per_uM_per_hr

Name per_uM per hr

Definition $\mu\text{mol}^{-1} \cdot 1 \cdot (3600\ \text{s})^{-1}$

2.7 Unit volume

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

Definition l

2.8 Unit area

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

Definition m^2

2.9 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
`cell`	cell	0000290	3	1	litre	☑	

3.1 Compartment `cell`

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

Name cell

SBO:0000290 physical compartment

4 Species

This model contains seven 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
MC	Myc	cell	$\mu mol \cdot l^{-1}$	⊟	⊟
EF	E2F	cell	$\mu mol \cdot l^{-1}$	⊟	⊟
CD	CycD	cell	$\mu mol \cdot l^{-1}$	⊟	⊟
CE	CycE	cell	$\mu mol \cdot l^{-1}$	⊟	⊟
RB	Rb	cell	$\mu mol \cdot l^{-1}$	⊟	⊟
RE	Rb-E2F complex	cell	$\mu mol \cdot l^{-1}$	⊟	⊟
RP	phosphorylated Rb	cell	$\mu mol \cdot l^{-1}$	⊟	⊟

5 Parameter

This model contains one global parameter.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
S	S	0000472	1.0	dimensionless	⊟

6 Events

This is an overview of two 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 `e1`

Trigger condition

$$t > 0 \tag{1}$$

Assignment

$$S = 20 \tag{2}$$

6.2 Event `e2`

Trigger condition

$$t > 5 \tag{3}$$

Assignment

$$S = 1 \tag{4}$$

7 Reactions

This model contains 17 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	r1		$\emptyset \longrightarrow MC$	0000205
2	r2		$\emptyset \longrightarrow CD$	0000205
3	r3		$\emptyset \xrightarrow{MC} EF$	0000205
4	r4		$\emptyset \xrightarrow{EF} CE$	0000205
5	r5		$\emptyset \xrightarrow{MC} CD$	0000205
6	r6		$\emptyset \longrightarrow RB$	0000205
7	r7		$RE \xrightarrow{CD,\ CE} EF + RP$	0000180
8	r8		$EF + RB \longrightarrow RE$	0000177
9	r9		$RB \xrightarrow{CD,\ CE} RP$	0000216
10	r10		$RP \longrightarrow RB$	0000330
11	r11		$MC \longrightarrow \emptyset$	0000179
12	r12		$EF \longrightarrow \emptyset$	0000179
13	r13		$CE \longrightarrow \emptyset$	0000179
14	r14		$CD \longrightarrow \emptyset$	0000179
15	r15		$RB \longrightarrow \emptyset$	0000179
16	r16		$RP \longrightarrow \emptyset$	0000179
17	r17		$RE \longrightarrow \emptyset$	0000179

7.1 Reaction r1

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

SBO:0000205 composite biochemical process

Notes Myc synthesis driven by growth signals (S)

Reaction equation

$$\emptyset \longrightarrow \mathrm{MC} \tag{5}$$

Product

Table 6: Properties of each product.

Id	Name	SBO
MC	Myc	

Kinetic Law

Derived unit $\mu\mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_1 = \mathrm{vol}(\mathrm{cell}) \cdot \frac{\mathrm{kM} \cdot \mathrm{S}}{\mathrm{KS} + \mathrm{S}} \tag{6}$$

Table 7: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KS		0000027	0.5	dimensionless	☑
kM		0000186	1.0	$\mu\mathrm{mol} \cdot 1^{-1} \cdot (3600\ \mathrm{s})^{-1}$	☑

7.2 Reaction r2

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

SBO:0000205 composite biochemical process

Notes CycD synthesis driven by growth signals

Reaction equation

$$\emptyset \longrightarrow \mathrm{CD} \tag{7}$$

Product

Table 8: Properties of each product.

Id	Name	SBO
CD	CycD	

Kinetic Law

Derived unit $\mu\text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_2 = \text{vol}(\text{cell}) \cdot \frac{\text{kkCDS} \cdot \text{S}}{\text{KS} + \text{S}} \tag{8}$$

Table 9: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KS		0000027	0.50	dimensionless	☑
kkCDS		0000186	0.45	$\mu\text{mol} \cdot 1^{-1} \cdot (3600\ \text{s})^{-1}$	☑

7.3 Reaction r3

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

SBO:0000205 composite biochemical process

Notes E2F synthesis by a synergy between Myc and E2F autocatalysis. Since neither Myc nor E2F forms a homodimer, we assumed no cooperativity in gene activation mediated by these factors, and used the Hill coefficient of 1.0. Using Hill coefficient greater than 1.0 will not change the qualitative behavior of system dynamics

Reaction equation

$$\emptyset \xrightarrow{\text{MC}} \text{EF} \tag{9}$$

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
MC	Myc	

Product

Table 11: Properties of each product.

Id	Name	SBO
EF	E2F	

Kinetic Law

Derived unit $1.0000000000000024 \cdot 10^{-6}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_3 = \mathrm{vol}\,(\mathrm{cell}) \cdot \left(\frac{\mathrm{kkEF} \cdot [\mathrm{MC}] \cdot [\mathrm{EF}]}{(\mathrm{KMC} + [\mathrm{MC}]) \cdot (\mathrm{KEF} + [\mathrm{EF}])} + \frac{\mathrm{kkb} \cdot [\mathrm{MC}]}{\mathrm{KMC} + [\mathrm{MC}]} \right) \tag{10}$$

Table 12: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KEF		0000027	0.150	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
KMC		0000027	0.150	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
kkEF		0000186	0.400	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1} \cdot (3600\ \mathrm{s})^{-1}$	☑
kkb		0000186	0.003	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1} \cdot (3600\ \mathrm{s})^{-1}$	☑

7.4 Reaction r4

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

SBO:0000205 composite biochemical process

Notes CycE synthesis driven by E2F

Reaction equation

$$\emptyset \xrightarrow{\mathrm{EF}} \mathrm{CE} \tag{11}$$

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
EF	E2F	

Id	Name	SBO

Product

Table 14: Properties of each product.

Id	Name	SBO
CE	CycE	

Kinetic Law

Derived unit $10^{-6}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_4 = \mathrm{vol}\,(\mathrm{cell}) \cdot \frac{\mathrm{kkCE} \cdot [\mathrm{EF}]}{\mathrm{KEF} + [\mathrm{EF}]} \tag{12}$$

Table 15: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KEF		0000027	0.15	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
kkCE		0000186	0.35	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1} \cdot (3600\ \mathrm{s})^{-1}$	☑

7.5 Reaction r5

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

SBO:0000205 composite biochemical process

Notes CycD synthesis driven by Myc

Reaction equation

$$\emptyset \xrightarrow{\mathrm{MC}} \mathrm{CD} \tag{13}$$

Modifier

Table 16: Properties of each modifier.

Id	Name	SBO
MC	Myc	

Product

Table 17: Properties of each product.

Id	Name	SBO
CD	CycD	

Kinetic Law

Derived unit $10^{-6}\,\mathrm{mol}\cdot(3600\,\mathrm{s})^{-1}$

$$v_5 = \mathrm{vol}\,(\mathrm{cell}) \cdot \frac{\mathrm{kkCD}\cdot[\mathrm{MC}]}{\mathrm{KMC}+[\mathrm{MC}]} \tag{14}$$

Table 18: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KMC		0000027	0.15	$\mu\mathrm{mol}\cdot\mathrm{l}^{-1}$	☑
kkCD		0000186	0.03	$\mu\mathrm{mol}\cdot\mathrm{l}^{-1}\cdot(3600\,\mathrm{s})^{-1}$	☑

7.6 Reaction r6

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

SBO:0000205 composite biochemical process

Notes Constitutive Rb synthesis

Reaction equation

$$\emptyset \longrightarrow \mathrm{RB} \tag{15}$$

Product

Table 19: Properties of each product.

Id	Name	SBO
RB	Rb	

Kinetic Law

Derived unit $\mu\text{mol} \cdot (3600\ \text{s})^{-1}$

$$v_6 = \text{vol}(\text{cell}) \cdot \text{kkRB} \tag{16}$$

Table 20: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kkRB		0000048	0.18	$\mu\text{mol} \cdot 1^{-1} \cdot (3600\ \text{s})^{-1}$	☑

7.7 Reaction r7

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

SBO:0000180 dissociation

Notes E2F dissociation from Rb-E2F complex by CycD- and CycE-mediated phosphorylation

Reaction equation

$$\text{RE} \xrightarrow{\text{CD, CE}} \text{EF} + \text{RP} \tag{17}$$

Reactant

Table 21: Properties of each reactant.

Id	Name	SBO
RE	Rb-E2F complex	

Modifiers

Table 22: Properties of each modifier.

Id	Name	SBO
CD	CycD	
CE	CycE	

Products

Table 23: Properties of each product.

Id	Name	SBO
EF	E2F	
RP	phosphorylated Rb	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot 10^{-6}\ \mathrm{mol}$

$$v_7 = \mathrm{vol}\,(\mathrm{cell}) \cdot \left(\frac{\mathrm{kkRBPP} \cdot [\mathrm{CD}] \cdot [\mathrm{RE}]}{\mathrm{KD} + [\mathrm{RE}]} + \frac{\mathrm{kkRBPP} \cdot [\mathrm{CE}] \cdot [\mathrm{RE}]}{\mathrm{KE} + [\mathrm{RE}]} \right) \tag{18}$$

Table 24: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KD		0000027	0.92	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
KE		0000027	0.92	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
kkRBPP		0000025	18.00	$(3600\ \mathrm{s})^{-1}$	☑

7.8 Reaction r8

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

SBO:0000177 non-covalent binding

Notes E2F titration by Rb via E2F-Rb complex formation

Reaction equation

$$\mathrm{EF} + \mathrm{RB} \longrightarrow \mathrm{RE} \tag{19}$$

Reactants

Table 25: Properties of each reactant.

Id	Name	SBO
EF	E2F	
RB	Rb	

Product

Table 26: Properties of each product.

Id	Name	SBO
RE	Rb-E2F complex	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_8 = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{kkRE} \cdot [\mathrm{RB}] \cdot [\mathrm{EF}] \tag{20}$$

Table 27: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
kkRE		0000339	180.0	$\mu\mathrm{mol}^{-1} \cdot 1 \cdot (3600\ \mathrm{s})^{-1}$	☑

7.9 Reaction r9

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

SBO:0000216 phosphorylation

Notes Rb phosphorylation by CycD and CycE

Reaction equation

$$\mathrm{RB} \xrightarrow{\mathrm{CD,\ CE}} \mathrm{RP} \tag{21}$$

Reactant

Table 28: Properties of each reactant.

Id	Name	SBO
RB	Rb	

Modifiers

Table 29: Properties of each modifier.

Id	Name	SBO
CD	CycD	
CE	CycE	

Product

Table 30: Properties of each product.

Id	Name	SBO
RP	phosphorylated Rb	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot 10^{-6}\ \mathrm{mol}$

$$v_9 = \mathrm{vol}\,(\mathrm{cell}) \cdot \left(\frac{\mathrm{kkRBP} \cdot [\mathrm{CD}] \cdot [\mathrm{RB}]}{\mathrm{KD} + [\mathrm{RB}]} + \frac{\mathrm{kkRBP2} \cdot [\mathrm{CE}] \cdot [\mathrm{RB}]}{\mathrm{KE} + [\mathrm{RB}]} \right) \tag{22}$$

Table 31: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
KD		0000027	0.92	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
KE		0000027	0.92	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
kkRBP		0000025	18.00	$(3600\ \mathrm{s})^{-1}$	☑
kkRBP2		0000025	18.00	$(3600\ \mathrm{s})^{-1}$	☑

7.10 Reaction r10

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

SBO:0000330 dephosphorylation

Notes Rb dephosphorylation

Reaction equation

$$\mathrm{RP} \longrightarrow \mathrm{RB} \tag{23}$$

Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
RP	phosphorylated Rb	

Product

Table 33: Properties of each product.

Id	Name	SBO
RB	Rb	

Kinetic Law

Derived unit $10^{-6}\ \mathrm{mol} \cdot (3600\ \mathrm{s})^{-1}$

$$v_{10} = \mathrm{vol}\,(\mathrm{cell}) \cdot \frac{\mathrm{kkRBUP} \cdot [\mathrm{RP}]}{\mathrm{Kp} + [\mathrm{RP}]} \tag{24}$$

Table 34: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Kp		0000027	0.01	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$	☑
kkRBUP		0000186	3.60	$\mu\mathrm{mol} \cdot \mathrm{l}^{-1} \cdot (3600\ \mathrm{s})^{-1}$	☑

7.11 Reaction r11

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

SBO:0000179 degradation

Notes Myc decay

Reaction equation

$$\mathrm{MC} \longrightarrow \emptyset \tag{25}$$

Reactant

Table 35: Properties of each reactant.

Id	Name	SBO
MC	Myc	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{11} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dMC} \cdot [\mathrm{MC}] \tag{26}$$

Table 36: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dMC		0000356	0.7	$(3600\ \mathrm{s})^{-1}$	☑

7.12 Reaction r12

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

SBO:0000179 degradation

Notes E2F decay

Reaction equation

$$\mathrm{EF} \longrightarrow \emptyset \tag{27}$$

Reactant

Table 37: Properties of each reactant.

Id	Name	SBO
EF	E2F	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{12} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dEF} \cdot [\mathrm{EF}] \tag{28}$$

Table 38: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dEF		0000356	0.25	$(3600\ \mathrm{s})^{-1}$	☑

7.13 Reaction r13

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

SBO:0000179 degradation

Notes CycE decay

Reaction equation

$$\mathrm{CE} \longrightarrow \emptyset \tag{29}$$

Reactant

Table 39: Properties of each reactant.

Id	Name	SBO
CE	CycE	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{13} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dCE} \cdot [\mathrm{CE}] \tag{30}$$

Table 40: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dCE		0000356	1.5	$(3600\ \mathrm{s})^{-1}$	☑

7.14 Reaction r14

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

SBO:0000179 degradation

Notes CycD decay

Reaction equation

$$\mathrm{CD} \longrightarrow \emptyset \tag{31}$$

Reactant

Table 41: Properties of each reactant.

Id	Name	SBO
CD	CycD	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{14} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dCD} \cdot [\mathrm{CD}] \tag{32}$$

Table 42: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dCD		0000356	1.5	$(3600\ \mathrm{s})^{-1}$	☑

7.15 Reaction r15

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

SBO:0000179 degradation

Notes Rb decay

Reaction equation

$$\mathrm{RB} \longrightarrow \emptyset \tag{33}$$

Reactant

Table 43: Properties of each reactant.

Id	Name	SBO
RB	Rb	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{15} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dRB} \cdot [\mathrm{RB}] \tag{34}$$

Table 44: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dRB		0000356	0.06	$(3600\ \mathrm{s})^{-1}$	☑

7.16 Reaction r16

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

SBO:0000179 degradation

Notes Phosphorylated Rb decay

Reaction equation

$$\mathrm{RP} \longrightarrow \emptyset \tag{35}$$

Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
RP	phosphorylated Rb	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{16} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dRP} \cdot [\mathrm{RP}] \tag{36}$$

Table 46: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dRP		0000356	0.06	$(3600\ \mathrm{s})^{-1}$	☑

7.17 Reaction r17

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

SBO:0000179 degradation

Notes Rb-E2F complex decay

Reaction equation

$$\mathrm{RE} \longrightarrow \emptyset \tag{37}$$

Reactant

Table 47: Properties of each reactant.

Id	Name	SBO
RE	Rb-E2F complex	

Kinetic Law

Derived unit $(3600\ \mathrm{s})^{-1} \cdot \mu\mathrm{mol}$

$$v_{17} = \mathrm{vol}\,(\mathrm{cell}) \cdot \mathrm{dRE} \cdot [\mathrm{RE}] \tag{38}$$

Table 48: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
dRE		0000356	0.03	$(3600\ \mathrm{s})^{-1}$	☑

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.

8.1 Species MC

Name Myc

SBO:0000252 polypeptide chain

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

This species takes part in four reactions (as a reactant in r11 and as a product in r1 and as a modifier in r3, r5).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{MC} = v_1 - v_{11} \tag{39}$$

8.2 Species EF

Name E2F

SBO:0000252 polypeptide chain

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

This species takes part in five reactions (as a reactant in r8, r12 and as a product in r3, r7 and as a modifier in r4).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{EF} = v_3 + v_7 - v_8 - v_{12} \tag{40}$$

8.3 Species CD

Name CycD

SBO:0000252 polypeptide chain

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

This species takes part in five reactions (as a reactant in r14 and as a product in r2, r5 and as a modifier in r7, r9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{CD} = v_2 + v_5 - v_{14} \tag{41}$$

8.4 Species CE

Name CycE

SBO:0000252 polypeptide chain

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

This species takes part in four reactions (as a reactant in r13 and as a product in r4 and as a modifier in r7, r9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{CE} = v_4 - v_{13} \tag{42}$$

8.5 Species RB

Name Rb

SBO:0000252 polypeptide chain

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

This species takes part in five reactions (as a reactant in r8, r9, r15 and as a product in r6, r10).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RB} = v_6 + v_{10} - v_8 - v_9 - v_{15} \tag{43}$$

8.6 Species RE

Name Rb-E2F complex

SBO:0000297 protein complex

Initial concentration $0.55\ \mu\text{mol}\cdot\text{l}^{-1}$

This species takes part in three reactions (as a reactant in r7, r17 and as a product in r8).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RE} = v_8 - v_7 - v_{17} \tag{44}$$

8.7 Species RP

Name phosphorylated Rb

SBO:0000252 polypeptide chain

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

This species takes part in four reactions (as a reactant in r10, r16 and as a product in r7, r9).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{RP} = v_7 + v_9 - v_{10} - v_{16} \tag{45}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000025 **catalytic rate constant:** Numerical parameter that quantifies the velocity of an enzymatic reaction

SBO:0000027 **Michaelis constant:** Substrate concentration at which the velocity of reaction is half its maximum. Michaelis constant is an experimental parameter. According to the underlying molecular mechanism it can be interpreted differently in terms of microscopic constants

SBO:0000048 forward zeroth order rate constant, continuous case: Numerical parameter that quantifies the forward velocity of a chemical reaction independant of the reactant quantities. This parameter encompasses all the contributions to the velocity. It is to be used in a reaction modelled using a continuous framework.

SBO:0000177 non-covalent binding: Interaction between several biochemical entities that results in the formation of a non-covalent comple

SBO:0000179 degradation: Complete disappearance of a physical entity

SBO:0000180 dissociation: Transformation of a non-covalent complex that results in the formation of several independent biochemical entitie

SBO:0000186 maximal velocity: Limiting maximal velocity of an enzymatic reaction, reached when the substrate is in large excess and all the enzyme is complexed.

SBO:0000205 composite biochemical process: Process that involves the participation of chemical or biological entities and is composed of several elementary steps or reactions.

SBO:0000216 phosphorylation: Addition of a phosphate group (-H2PO4) to a chemical entity

SBO:0000252 polypeptide chain: Naturally occurring macromolecule formed by the repetition of amino-acid residues linked by peptidic bonds. A polypeptide chain is synthesized by the ribosome. CHEBI:1654

SBO:0000290 physical compartment: Specific location of space, that can be bounded or not. A physical compartment can have 1, 2 or 3 dimensions

SBO:0000297 protein complex: Macromolecular complex containing one or more polypeptide chains possibly associated with simple chemicals. CHEBI:3608

SBO:0000330 dephosphorylation: Removal of a phosphate group (-H2PO4) from a chemical entity.

SBO:0000339 bimolecular association rate constant: Rate with which two components associate into a complex

SBO:0000356 decay constant: Kinetic constant characterising a mono-exponential decay. It is the inverse of the mean lifetime of the continuant being decayed. Its unit is“per tim”.

SBO:0000472 molar concentration of an entity: Molarity, or molar concentration, denotes the number of moles of a given substance per litre of solution. The unit of measure of molarity is mol/L, molar, or the capital letter M as an abbreviated form

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