SBML Model Report

Model name: "Mueller2015 - Hepatocyte proliferation, T160 phosphorylation of CDK2"

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1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Audald Lloret i Villas[1] and Marcel Schilling[2] at March 19th 2015 at 4:40 p. m. and last time modified at March 20th 2015 at 3:41 p. m. Table 1 shows 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	2
species types	0	species	39
events	0	constraints	0
reactions	69	function definitions	69
global parameters	79	unit definitions	2
rules	30	initial assignments	0

Model Notes

Mueller2015 - Hepatocyte proliferation, T160phosphorylation of CDK2

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This model is described in the article:T160-phosphorylated CDK2 defines threshold for HGF-dependent proliferation in primary hepatocytes.Mueller S, Huard J, Waldow K, Huang X, D'Alessandro LA, Bohl S, Brner K, Grimm D, Klamt S, Klingmller U, Schilling M.Mol. Syst. Biol. 2015; 11(3): 795

Abstract:

Liver regeneration is a tightly controlled process mainly achieved by proliferation of usually quiescent hepatocytes. The specific molecular mechanisms ensuring cell division only in response to proliferative signals such as hepatocyte growth factor (HGF) are not fully understood. Here, we combined quantitative time-resolved analysis of primary mouse hepatocyte proliferation at the single cell and at the population level with mathematical modeling. We showed that numerous G1/S transition components are activated upon hepatocyte isolation whereas DNA replication only occurs upon additional HGF stimulation. In response to HGF, Cyclin:CDK complex formation was increased, p21 rather than p27 was regulated, and Rb expression was enhanced. Quantification of protein levels at the restriction point showed an excess of CDK2 over CDK4 and limiting amounts of the transcription factor E2F-1. Analysis with our mathematical model revealed that T160 phosphorylation of CDK2 correlated best with growth factor-dependent proliferation, which we validated experimentally on both the population and the single cell level. In conclusion, we identified CDK2 phosphorylation as a gate-keeping mechanism to maintain hepatocyte quiescence in the absence of HGF.

2 Unit Definitions

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

2.1 Unit `time`

Name time

Definition 3600 s

2.2 Unit `substance`

Name substance

Definition nmol

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 Compartments

This model contains two compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
cell	Cytoplasm		3	1	litre	☑	
Nucleus	Nucleus		3	1	litre	☑	

3.1 Compartment cell

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

Name Cytoplasm

3.2 Compartment Nucleus

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

Name Nucleus

4 Species

This model contains 39 species. The boundary condition of 15 of these species is set to `true` so that these species' amount cannot be changed by any reaction. Section 9 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
S4	@cyto::C2E(T160Ũ,b)	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☐
S10	@cyto::C4D1(b)	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☐
S12	@cyto::p21(b)	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☐
S19	@cyto::C4D1(b!1).p21(b!1)	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☐
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☐
hgf	HGF	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
inhp53	inhp53	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
inherk	inhERK	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
inhakt	inhAKT	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
inhc4d1	inhc4d1	cell	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsTotCycECDK2_obs	TotCycECDK2	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsTotCDK2T160_obs	TotCDK2T160	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsTotCycDCDK4_obs	TotCycDCDK4	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsTotP21_obs	TotP21	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsCDK2P21_obs	CDK2P21	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsTotE2F_obs	TotE2F	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsTotRb_obs	TotRb	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑
ObsPhosRbS788_obs	PhosRbS788	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	☐	☑

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
ObsPhosRbS800_obs	PhosRbS800	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	☑
ObsDNAContent_obs	DNAContent	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	☑
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S18	@nuc::C2E(T160P̃,b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S13	@nuc::C2E(T160Ũ,b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S24	@nuc::C4D1(b!1).p21(b!1)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S26	@nuc::C4D1(b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S5	@nuc::dnapre()	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S17	@nuc::dnapre1()	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S22	@nuc::dnapre2()	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S25	@nuc::dnapre3()	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S27	@nuc::dnapre4()	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S14	@nuc::e2f(b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S11	@nuc::p21(b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S21	@nuc::rb(S788P̃,S800P̃,b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S15	@nuc::rb(S788P̃,S800Ũ,b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S1	@nuc::rb(S788Ũ,S800Ũ,b)	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟
S28	@nuc::dnapre5()	Nucleus	$\mathrm{nmol} \cdot \mathrm{l}^{-1}$	⊟	⊟

5 Parameters

This model contains 79 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Vnuc	Vnuc		0.250		☑
Vcyto	Vcyto		12.670		☑
perk	perk		0.009		☑
nerk	nerk		1.147		☑
pakt	pakt		0.035		☑
nakt	nakt		1.096		☑
aerk	aerk		0.160		☑
aakt	aakt		0.530		☑
atf	atf		0.601		☑
ks_c4	ks_c4		14298.672		☑
kdeg_c4	kdeg_c4		1.014		☑
kdeg_c4gsk3b	kdeg_c4gsk3b		0.108		☑
ks_c2myc	ks_c2myc		0.158		☑
ks_c2e2f	ks_c2e2f		2.199		☑
kdeg_c2c2gsk3b	kdeg_c2c2gsk3b		5.588		☑
kdeg_c2gsk3b	kdeg_c2gsk3b		$1.55090179808215 \cdot 10^{-5}$		☑
kdeg_c2	kdeg_c2		0.226		☑
kdp_c2cak	kdp_c2cak		101.282		☑
kc2cak	kc2cak		0.317		☑
ks_p21p53	ks_p21p53		$3.84136205729286 \cdot 10^{-6}$		☑
ks_p21e2f	ks_p21e2f		0.812		☑
kdeg_p21erkskp2	kdeg_p21erkskp2		$2.82976267377082 \cdot 10^{-4}$		☑
kdeg_p21c2skp2	kdeg_p21c2skp2		0.040		☑
kdeg_p21skp2	kdeg_p21skp2		0.751		☑
kdeg_p21gsk3b	kdeg_p21gsk3b		0.005		☑
kdeg_p21erk	kdeg_p21erk		0.736		☑
Kd_p21c4	Kd_p21c4		99.997		☑
kb_p21c4	kb_p21c4		14.308		☑
Kd_p21c2	Kd_p21c2		0.010		☑
kb_p21c2	kb_p21c2		997.938		☑
ki	ki		0.092		☑
kinh_p21akt	kinh_p21akt		0.440		☑
ks_e2fe2f	ks_e2fe2f		0.460		☑

Id	Name	SBO	Value	Unit	Constant
ks_e2fmyc	ks_e2fmyc		$2.49174531457788 \cdot 10^{-6}$		☑
kdege2fplus	kdege2fplus		$4.18153340918872 \cdot 10^{-5}$		☑
kdeg_e2fbound	kdeg_e2fbound		0.100		☑
ks_rb	ks_rb		72.525		☑
ks_rbe2f	ks_rbe2f		20.013		☑
kdeg_rbp21	kdeg_rbp21		0.864		☑
kdeg_rbbound	kdeg_rbbound		0.089		☑
kdegrbplus	kdegrbplus		0.258		☑
kb_rbe2f	kb_rbe2f		229.976		☑
Kd_rb_e2f	Kd_rb_e2f		50.003		☑
kb_rbpe2f	kb_rbpe2f		182.218		☑
Kd_rbp_e2f	Kd_rbp_e2f		481.485		☑
kcatprbc4	kcatprbc4		2797.823		☑
kcatp_rbc2	kcatp_rbc2		7142308.072		☑
kcatdp_rbc2	kcatdp_rbc2		0.003		☑
kcatdp_rbc4	kcatdp_rbc4		2892.022		☑
kinh_pp1	kinh_pp1		16634.940		☑
Km_dprb	Km_dprb		0.119		☑
Km_prb	Km_prb		2.035		☑
nrb	nrb		3.000		☑
k_dna	k_dna		0.009		☑
k_delay	k_delay		23.666		☑
Vratio	Vratio		0.020		⊟
erk	erk		0.160		⊟
akt	akt		0.530		⊟
gsk3b	gsk3b		0.470		⊟
tf	tf		0.635		⊟
tfp21	tfp21		0.635		⊟
kp_c2cak	kp_c2cak		101.599		⊟
kd_p21c4	kd_p21c4		1430.784		⊟
kd_p21c2	kd_p21c2		9.982		⊟
kimport	kimport		0.074		⊟
kdeg_e2ffree	kdeg_e2ffree		0.100		⊟
kdeg_rbfree	kdeg_rbfree		0.347		⊟
kd_rbe2f	kd_rbe2f		11499.401		⊟
kd_rbpe2f	kd_rbpe2f		87735.366		⊟
kcatp_rbc4	kcatp_rbc4		2797.823		⊟
scale_TotcycDCDK4	scale_TotcycDCDK4		0.565		☑
scale_TotcycECDK2	scale_TotcycECDK2		0.189		☑

Id	Name	SBO	Value	Unit	Constant
scale_Totp21CDK2	scale_Totp21CDK2		0.340		☑
scale_TotCDK2T160	scale_TotCDK2T160		2.728		☑
scale_TotRb	scale_TotRb		0.261		☑
scale_PhosRbS788	scale_PhosRbS788		0.674		☑
scale_PhosRbS800	scale_PhosRbS800		0.824		☑
scale_Totp21	scale_Totp21		0.173		☑
scale_TotE2F	scale_TotE2F		28.742		☑

6 Function definitions

This is an overview of 69 function definitions.

6.1 Function definition Function_for_reaction_1_0

Name Function for reaction_1

Arguments vol (cell), ks_c4, tf

Mathematical Expression

$$\frac{\text{ks\_c4} \cdot \text{tf}}{\text{vol}\,(\text{cell})} \tag{1}$$

6.2 Function definition Function_for_reaction_2_0

Name Function for reaction_2

Arguments [S14], [S16], vol (cell), ks_c2e2f, ks_c2myc, tf

Mathematical Expression

$$\frac{\text{ks\_c2myc} \cdot \text{tf} + \text{ks\_c2e2f} \cdot ([\text{S14}] + [\text{S16}])}{\text{vol}\,(\text{cell})} \tag{2}$$

6.3 Function definition Function_for_reaction_58_0

Name Function for reaction_58

Arguments [S22], vol (cell), k_delay

Mathematical Expression

$$\frac{\text{k\_delay} \cdot [\text{S22}]}{\text{vol}\,(\text{cell})} \tag{3}$$

6.4 Function definition Function_for_reaction_59_0

Name Function for reaction_59

Arguments [S24], vol (cell), kdeg_c4

Mathematical Expression

$$\frac{\text{kdeg\_c4} \cdot [\text{S24}]}{\text{vol}\,(\text{cell})} \tag{4}$$

6.5 Function definition Function_for_reaction_3_0

Name Function for reaction_3

Arguments [S3], vol (cell), gsk3b, kdeg_c2, kdeg_c2gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}) \cdot [\text{S3}]}{\text{vol}\,(\text{cell})} \tag{5}$$

6.6 Function definition Function_for_reaction_4_0

Name Function for reaction_4

Arguments [S4], vol (cell), gsk3b, kdeg_c2, kdeg_c2gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}) \cdot [\text{S4}]}{\text{vol}\,(\text{cell})} \tag{6}$$

6.7 Function definition Function_for_reaction_5_0

Name Function for reaction_5

Arguments [S14], vol (cell), ks_p21e2f, ks_p21p53, tfp21

Mathematical Expression

$$\frac{(\text{ks\_p21p53} + \text{ks\_p21e2f} \cdot [\text{S14}]) \cdot \text{tfp21}}{\text{vol}\,(\text{cell})} \tag{7}$$

6.8 Function definition Function_for_reaction_6_0

Name Function for reaction_6

Arguments [S3], vol (cell), kd_p21c2

Mathematical Expression

$$\frac{\text{kd\_p21c2} \cdot [\text{S3}]}{\text{vol}\,(\text{cell})} \tag{8}$$

6.9 Function definition Function_for_reaction_7_0

Name Function for reaction_7

Arguments [S14], [S18], [S3], vol (cell), erk, kdeg_p21c2skp2, kdeg_p21erkskp2, kdeg_p21skp2

Mathematical Expression

$$\frac{(\text{kdeg\_p21erkskp2} \cdot \text{erk} + \text{kdeg\_p21c2skp2} \cdot [\text{S18}] + \text{kdeg\_p21skp2}) \cdot [\text{S14}] \cdot [\text{S3}]}{\text{vol}\,(\text{cell})} \tag{9}$$

6.10 Function definition Function_for_reaction_8_0

Name Function for reaction_8

Arguments [S14], vol (cell), ks_rb, ks_rbe2f

Mathematical Expression

$$\frac{\text{ks\_rb} + \text{ks\_rbe2f} \cdot [\text{S14}]}{\text{vol}\,(\text{cell})} \tag{10}$$

6.11 Function definition Function_for_reaction_9_0

Name Function for reaction_9

Arguments [S1], vol (cell), kdeg_rbfree

Mathematical Expression

$$\frac{\text{kdeg\_rbfree} \cdot [\text{S1}]}{\text{vol}\,(\text{cell})} \tag{11}$$

6.12 Function definition Function_for_reaction_10_0

Name Function for reaction_10

Arguments [S2], vol (cell), kdeg_rbbound

Mathematical Expression

$$\frac{\text{kdeg\_rbbound} \cdot [\text{S2}]}{\text{vol}\,(\text{cell})} \tag{12}$$

6.13 Function definition Function_for_reaction_11_0

Name Function for reaction_11

Arguments [S1], [S11], vol (cell), kdeg_rbp21

Mathematical Expression

$$\frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S1}]}{\text{vol}\,(\text{cell})} \tag{13}$$

6.14 Function definition Function_for_reaction_12_0

Name Function for reaction_12

Arguments [S11], [S2], vol (cell), kdeg_rbp21

Mathematical Expression

$$\frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S2}]}{\text{vol}\,(\text{cell})} \tag{14}$$

6.15 Function definition Function_for_reaction_13_0

Name Function for reaction_13

Arguments [S14], vol (cell), ks_e2fe2f, ks_e2fmyc, tf

Mathematical Expression

$$\frac{(\text{ks\_e2fe2f} \cdot [\text{S14}] + \text{ks\_e2fmyc}) \cdot \text{tf}}{\text{vol}\,(\text{cell})} \tag{15}$$

6.16 Function definition Function_for_reaction_14_0

Name Function for reaction_14

Arguments [S2], vol (cell), kdeg_e2fbound

Mathematical Expression

$$\frac{\text{kdeg\_e2fbound} \cdot [\text{S2}]}{\text{vol}\,(\text{cell})} \tag{16}$$

6.17 Function definition Function_for_reaction_15_0

Name Function for reaction_15

Arguments [S2], vol (cell), kd_rbe2f

Mathematical Expression

$$\frac{\text{kd\_rbe2f} \cdot [\text{S2}]}{\text{vol}\,(\text{cell})} \tag{17}$$

6.18 Function definition Function_for_reaction_16_0

Name Function for reaction_16

Arguments Km_prb, [S1], [S24], vol (cell), kcatp_rbc4, nrb

Mathematical Expression

$$\frac{\frac{\text{kcatp\_rbc4} \cdot [\text{S24}] \cdot [\text{S1}]^{\text{nrb}}}{\text{Km\_prb}^{\text{nrb}} + [\text{S1}]^{\text{nrb}}}}{\text{vol}\,(\text{cell})} \tag{18}$$

6.19 Function definition Function_for_reaction_17_0

Name Function for reaction_17

Arguments Km_prb, [S2], [S24], vol (cell), kcatp_rbc4, nrb

Mathematical Expression

$$\frac{\frac{\text{kcatp\_rbc4} \cdot [\text{S24}] \cdot [\text{S2}]^{\text{nrb}}}{\text{Km\_prb}^{\text{nrb}} + [\text{S2}]^{\text{nrb}}}}{\text{vol}\,(\text{cell})} \tag{19}$$

6.20 Function definition Function_for_reaction_18_0

Name Function for reaction_18

Arguments [S14], [S18], [S5], vol (cell), k_dna

Mathematical Expression

$$\frac{\text{k\_dna} \cdot [\text{S18}] \cdot [\text{S14}] \cdot [\text{S5}]}{\text{vol}\,(\text{cell})} \tag{20}$$

6.21 Function definition Function_for_reaction_19_0

Name Function for reaction_19

Arguments [S10], vol (cell), gsk3b, kdeg_c4, kdeg_c4gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c4} + \text{kdeg\_c4gsk3b} \cdot \text{gsk3b}) \cdot [\text{S10}]}{\text{vol}\,(\text{cell})} \tag{21}$$

6.22 Function definition Function_for_reaction_20_0

Name Function for reaction_20

Arguments [S13], vol (cell), gsk3b, kdeg_c2, kdeg_c2gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}) \cdot [\text{S13}]}{\text{vol}\,(\text{cell})} \tag{22}$$

6.23 Function definition Function_for_reaction_21_0

Name Function for reaction_21

Arguments [S13], vol (cell), kp_c2cak

Mathematical Expression

$$\frac{\text{kp\_c2cak} \cdot [\text{S13}]}{\text{vol}\,(\text{cell})} \tag{23}$$

6.24 Function definition Function_for_reaction_22_0

Name Function for reaction_22

Arguments [S10], [S12], vol (cell), kb_p21c4

Mathematical Expression

$$\frac{\text{kb\_p21c4} \cdot [\text{S10}] \cdot [\text{S12}]}{\text{vol}\,(\text{cell})} \tag{24}$$

6.25 Function definition Function_for_reaction_23_0

Name Function for reaction_23

Arguments [S12], [S4], vol (cell), kb_p21c2

Mathematical Expression

$$\frac{\text{kb\_p21c2} \cdot [\text{S4}] \cdot [\text{S12}]}{\text{vol}\,(\text{cell})} \tag{25}$$

6.26 Function definition Function_for_reaction_24_0

Name Function for reaction_24

Arguments [S11], [S13], vol (cell), kb_p21c2

Mathematical Expression

$$\frac{\text{kb\_p21c2} \cdot [\text{S11}] \cdot [\text{S13}]}{\text{vol}\,(\text{cell})} \tag{26}$$

6.27 Function definition Function_for_reaction_25_0

Name Function for reaction_25

Arguments [S12], Vratio, vol (cell), kimport

Mathematical Expression

$$\frac{\frac{\text{kimport}}{\text{Vratio}} \cdot [\text{S12}]}{\text{vol}\,(\text{cell})} \tag{27}$$

6.28 Function definition Function_for_reaction_26_0

Name Function for reaction_26

Arguments [S12], Vratio, vol (cell), kimport

Mathematical Expression

$$\frac{\text{kimport} \cdot \left(1 - \frac{1}{\text{Vratio}}\right) \cdot [\text{S12}]}{\text{vol}\,(\text{cell})} \tag{28}$$

6.29 Function definition Function_for_reaction_27_0

Name Function for reaction_27

Arguments [S11], vol (cell), erk, gsk3b, kdeg_p21erk, kdeg_p21gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_p21gsk3b} \cdot \text{gsk3b} + \text{kdeg\_p21erk} \cdot \text{erk}) \cdot [\text{S11}]}{\text{vol}\,(\text{cell})} \tag{29}$$

6.30 Function definition Function_for_reaction_28_0

Name Function for reaction_28

Arguments [S12], vol (cell), erk, gsk3b, kdeg_p21erk, kdeg_p21gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_p21gsk3b} \cdot \text{gsk3b} + \text{kdeg\_p21erk} \cdot \text{erk}) \cdot [\text{S12}]}{\text{vol}\,(\text{cell})} \tag{30}$$

6.31 Function definition Function_for_reaction_29_0

Name Function for reaction_29

Arguments [S15], vol (cell), kdeg_rbfree

Mathematical Expression

$$\frac{\text{kdeg\_rbfree} \cdot [\text{S15}]}{\text{vol}\,(\text{cell})} \tag{31}$$

6.32 Function definition Function_for_reaction_30_0

Name Function for reaction_30

Arguments [S16], vol (cell), kdeg_rbbound

Mathematical Expression

$$\frac{\text{kdeg\_rbbound} \cdot [\text{S16}]}{\text{vol}\,(\text{cell})} \tag{32}$$

6.33 Function definition Function_for_reaction_31_0

Name Function for reaction_31

Arguments [S11], [S15], vol (cell), kdeg_rbp21

Mathematical Expression

$$\frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S15}]}{\text{vol}\,(\text{cell})} \tag{33}$$

6.34 Function definition Function_for_reaction_32_0

Name Function for reaction_32

Arguments [S11], [S16], vol (cell), kdeg_rbp21

Mathematical Expression

$$\frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S16}]}{\text{vol}\,(\text{cell})} \tag{34}$$

6.35 Function definition Function_for_reaction_33_0

Name Function for reaction_33

Arguments [S14], vol (cell), kdeg_e2ffree

Mathematical Expression

$$\frac{\text{kdeg\_e2ffree} \cdot [\text{S14}]}{\text{vol}\,(\text{cell})} \tag{35}$$

6.36 Function definition Function_for_reaction_34_0

Name Function for reaction_34

Arguments [S16], vol (cell), kdeg_e2fbound

Mathematical Expression

$$\frac{\text{kdeg\_e2fbound} \cdot [\text{S16}]}{\text{vol}\,(\text{cell})} \tag{36}$$

6.37 Function definition Function_for_reaction_35_0

Name Function for reaction_35

Arguments [S1], [S14], vol (cell), kb_rbe2f

Mathematical Expression

$$\frac{\text{kb\_rbe2f} \cdot [\text{S1}] \cdot [\text{S14}]}{\text{vol}\,(\text{cell})} \tag{37}$$

6.38 Function definition Function_for_reaction_36_0

Name Function for reaction_36

Arguments [S14], [S15], vol (cell), kb_rbpe2f

Mathematical Expression

$$\frac{\text{kb\_rbpe2f} \cdot [\text{S14}] \cdot [\text{S15}]}{\text{vol}\,(\text{cell})} \tag{38}$$

6.39 Function definition Function_for_reaction_37_0

Name Function for reaction_37

Arguments [S16], vol (cell), kd_rbpe2f

Mathematical Expression

$$\frac{\text{kd\_rbpe2f} \cdot [\text{S16}]}{\text{vol}\,(\text{cell})} \tag{39}$$

6.40 Function definition Function_for_reaction_38_0

Name Function for reaction_38

Arguments Km_prb, [S15], [S18], vol (cell), kcatp_rbc2, nrb

Mathematical Expression

$$\frac{\frac{\text{kcatp\_rbc2} \cdot [\text{S18}] \cdot [\text{S15}]^{\text{nrb}}}{\text{Km\_prb}^{\text{nrb}} + [\text{S15}]^{\text{nrb}}}}{\text{vol}\,(\text{cell})} \tag{40}$$

6.41 Function definition Function_for_reaction_39_0

Name Function for reaction_39

Arguments Km_prb, [S16], [S18], vol (cell), kcatp_rbc2, nrb

Mathematical Expression

$$\frac{\frac{\text{kcatp\_rbc2}\cdot[\text{S18}]\cdot[\text{S16}]^{\text{nrb}}}{\text{Km\_prb}^{\text{nrb}}+[\text{S16}]^{\text{nrb}}}}{\text{vol}\,(\text{cell})} \tag{41}$$

6.42 Function definition Function_for_reaction_40_0

Name Function for reaction_40

Arguments Km_dprb, [S15], [S18], vol (cell), kcatdp_rbc4, kinh_pp1, nrb

Mathematical Expression

$$\frac{\frac{\frac{\text{kcatdp\_rbc4}\cdot[\text{S15}]^{\text{nrb}}}{\text{Km\_dprb}^{\text{nrb}}+[\text{S15}]^{\text{nrb}}}\cdot 1}{1+\text{kinh\_pp1}\cdot[\text{S18}]}}{\text{vol}\,(\text{cell})} \tag{42}$$

6.43 Function definition Function_for_reaction_41_0

Name Function for reaction_41

Arguments Km_dprb, [S16], [S18], vol (cell), kcatdp_rbc4, kinh_pp1, nrb

Mathematical Expression

$$\frac{\frac{\frac{\text{kcatdp\_rbc4}\cdot[\text{S16}]^{\text{nrb}}}{\text{Km\_dprb}^{\text{nrb}}+[\text{S16}]^{\text{nrb}}}\cdot 1}{1+\text{kinh\_pp1}\cdot[\text{S18}]}}{\text{vol}\,(\text{cell})} \tag{43}$$

6.44 Function definition Function_for_reaction_42_0

Name Function for reaction_42

Arguments [S17], vol (cell), k_delay

Mathematical Expression

$$\frac{\text{k\_delay}\cdot[\text{S17}]}{\text{vol}\,(\text{cell})} \tag{44}$$

6.45 Function definition Function_for_reaction_43_0

Name Function for reaction_43

Arguments [S19], vol (cell), gsk3b, kdeg_c4, kdeg_c4gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c4} + \text{kdeg\_c4gsk3b} \cdot \text{gsk3b}) \cdot [\text{S19}]}{\text{vol}\,(\text{cell})} \tag{45}$$

6.46 Function definition Function_for_reaction_44_0

Name Function for reaction_44

Arguments [S18], vol (cell), gsk3b, kdeg_c2, kdeg_c2gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}) \cdot [\text{S18}]}{\text{vol}\,(\text{cell})} \tag{46}$$

6.47 Function definition Function_for_reaction_45_0

Name Function for reaction_45

Arguments [S20], vol (cell), gsk3b, kdeg_c2, kdeg_c2gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}) \cdot [\text{S20}]}{\text{vol}\,(\text{cell})} \tag{47}$$

6.48 Function definition Function_for_reaction_46_0

Name Function for reaction_46

Arguments [S18], vol (cell), gsk3b, kdeg_c2c2gsk3b

Mathematical Expression

$$\frac{\text{kdeg\_c2c2gsk3b} \cdot \text{gsk3b} \cdot [\text{S18}]}{\text{vol}\,(\text{cell})} \tag{48}$$

6.49 Function definition Function_for_reaction_47_0

Name Function for reaction_47

Arguments [S18], vol (cell), kdp_c2cak

Mathematical Expression

$$\frac{\text{kdp\_c2cak} \cdot [\text{S18}]}{\text{vol}\,(\text{cell})} \tag{49}$$

6.50 Function definition Function_for_reaction_48_0

Name Function for reaction_48

Arguments [S19], vol (cell), kd_p21c4

Mathematical Expression

$$\frac{\text{kd\_p21c4} \cdot [\text{S19}]}{\text{vol}\,(\text{cell})} \tag{50}$$

6.51 Function definition Function_for_reaction_49_0

Name Function for reaction_49

Arguments [S11], [S18], vol (cell), kb_p21c2

Mathematical Expression

$$\frac{\text{kb\_p21c2} \cdot [\text{S11}] \cdot [\text{S18}]}{\text{vol}\,(\text{cell})} \tag{51}$$

6.52 Function definition Function_for_reaction_50_0

Name Function for reaction_50

Arguments [S20], vol (cell), kd_p21c2

Mathematical Expression

$$\frac{\text{kd\_p21c2} \cdot [\text{S20}]}{\text{vol}\,(\text{cell})} \tag{52}$$

6.53 Function definition Function_for_reaction_51_0

Name Function for reaction_51

Arguments [S19], Vratio, vol (cell), kimport

Mathematical Expression

$$\frac{\frac{\text{kimport}}{\text{Vratio}} \cdot [\text{S19}]}{\text{vol}\,(\text{cell})} \tag{53}$$

6.54 Function definition Function_for_reaction_52_0

Name Function for reaction_52

Arguments [S20], Vratio, vol (cell), kimport

Mathematical Expression

$$\frac{\frac{\text{kimport}}{\text{Vratio}} \cdot [\text{S20}]}{\text{vol}\,(\text{cell})} \tag{54}$$

6.55 Function definition Function_for_reaction_53_0

Name Function for reaction_53

Arguments [S19], Vratio, vol (cell), kimport

Mathematical Expression

$$\frac{\text{kimport} \cdot \left(1 - \frac{1}{\text{Vratio}}\right) \cdot [\text{S19}]}{\text{vol}\,(\text{cell})} \tag{55}$$

6.56 Function definition Function_for_reaction_54_0

Name Function for reaction_54

Arguments [S20], Vratio, vol (cell), kimport

Mathematical Expression

$$\frac{\text{kimport} \cdot \left(1 - \frac{1}{\text{Vratio}}\right) \cdot [\text{S20}]}{\text{vol}\,(\text{cell})} \tag{56}$$

6.57 Function definition Function_for_reaction_55_0

Name Function for reaction_55

Arguments [S21], vol (cell), kdeg_rbfree

Mathematical Expression

$$\frac{\text{kdeg\_rbfree} \cdot [\text{S21}]}{\text{vol}\,(\text{cell})} \tag{57}$$

6.58 Function definition Function_for_reaction_56_0

Name Function for reaction_56

Arguments [S11], [S21], vol (cell), kdeg_rbp21

Mathematical Expression

$$\frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S21}]}{\text{vol}\,(\text{cell})} \tag{58}$$

6.59 Function definition Function_for_reaction_57_0

Name Function for reaction_57

Arguments Km_dprb, [S18], [S21], vol (cell), kcatdp_rbc2, kinh_pp1, nrb

Mathematical Expression

$$\frac{\frac{\frac{\text{kcatdp\_rbc2} \cdot [\text{S21}]^{\text{nrb}}}{\text{Km\_dprb}^{\text{nrb}} + [\text{S21}]^{\text{nrb}}} \cdot 1}{1 + \text{kinh\_pp1} \cdot [\text{S18}]}}{\text{vol}\,(\text{cell})} \tag{59}$$

6.60 Function definition Function_for_reaction_60_0

Name Function for reaction_60

Arguments [S23], vol (cell), gsk3b, kdeg_c2, kdeg_c2gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}) \cdot [\text{S23}]}{\text{vol}\,(\text{cell})} \tag{60}$$

6.61 Function definition Function_for_reaction_61_0

Name Function for reaction_61

Arguments [S24], vol (cell), kd_p21c4

Mathematical Expression

$$\frac{\text{kd\_p21c4} \cdot [\text{S24}]}{\text{vol}\,(\text{cell})} \tag{61}$$

6.62 Function definition Function_for_reaction_62_0

Name Function for reaction_62

Arguments [S23], vol (cell), kd_p21c2

Mathematical Expression

$$\frac{\text{kd\_p21c2} \cdot [\text{S23}]}{\text{vol}\,(\text{cell})} \tag{62}$$

6.63 Function definition Function_for_reaction_63_0

Name Function for reaction_63

Arguments [S14], [S18], [S23], vol (cell), erk, kdeg_p21c2skp2, kdeg_p21erkskp2, kdeg_p21skp2

Mathematical Expression

$$\frac{(\text{kdeg\_p21erkskp2} \cdot \text{erk} + \text{kdeg\_p21c2skp2} \cdot [\text{S18}] + \text{kdeg\_p21skp2}) \cdot [\text{S14}] \cdot [\text{S23}]}{\text{vol}\,(\text{cell})} \tag{63}$$

6.64 Function definition Function_for_reaction_64_0

Name Function for reaction_64

Arguments [S14], [S18], [S24], vol (cell), erk, kdeg_p21c2skp2, kdeg_p21erkskp2, kdeg_p21skp2

Mathematical Expression

$$\frac{(\text{kdeg\_p21erkskp2} \cdot \text{erk} + \text{kdeg\_p21c2skp2} \cdot [\text{S18}] + \text{kdeg\_p21skp2}) \cdot [\text{S14}] \cdot [\text{S24}]}{\text{vol}\,(\text{cell})} \tag{64}$$

6.65 Function definition Function_for_reaction_65_0

Name Function for reaction_65

Arguments [S25], vol (cell), k_delay

Mathematical Expression

$$\frac{\text{k\_delay} \cdot [\text{S25}]}{\text{vol}\,(\text{cell})} \tag{65}$$

6.66 Function definition Function_for_reaction_66_0

Name Function for reaction_66

Arguments [S26], vol (cell), gsk3b, kdeg_c4, kdeg_c4gsk3b

Mathematical Expression

$$\frac{(\text{kdeg\_c4} + \text{kdeg\_c4gsk3b} \cdot \text{gsk3b}) \cdot [\text{S26}]}{\text{vol}\,(\text{cell})} \tag{66}$$

6.67 Function definition Function_for_reaction_67_0

Name Function for reaction_67

Arguments [S11], [S26], vol (cell), kb_p21c4

Mathematical Expression

$$\frac{\text{kb\_p21c4} \cdot [\text{S11}] \cdot [\text{S26}]}{\text{vol}\,(\text{cell})} \tag{67}$$

6.68 Function definition Function_for_reaction_68_0

Name Function for reaction_68

Arguments [S27], vol (cell), k_delay

Mathematical Expression

$$\frac{\text{k\_delay} \cdot [\text{S27}]}{\text{vol}\,(\text{cell})} \tag{68}$$

6.69 Function definition Function_for_reaction_69_0

Name Function for reaction_69

Arguments [S28], vol (cell), k_delay

Mathematical Expression

$$\frac{\text{k\_delay} \cdot [\text{S28}]}{\text{vol}\,(\text{cell})} \tag{69}$$

7 Rules

This is an overview of 30 rules.

7.1 Rule ObsCDK2P21_obs

Rule ObsCDK2P21_obs is an assignment rule for species ObsCDK2P21_obs:

$$\text{ObsCDK2P21\_obs} = \frac{\text{scale\_Totp21CDK2} \cdot (\text{Vnuc} \cdot ([\text{S3}] + [\text{S23}]) + \text{Vcyto} \cdot [\text{S20}])}{\text{Vnuc} + \text{Vcyto}} \tag{70}$$

7.2 Rule ObsTotE2F_obs

Rule ObsTotE2F_obs is an assignment rule for species ObsTotE2F_obs:

$$\text{ObsTotE2F\_obs} = \frac{(\text{scale\_TotE2F} + \text{scale\_TotRb}) \cdot \text{Vnuc} \cdot ([\text{S2}] + [\text{S14}] + [\text{S16}])}{\text{Vnuc} + \text{Vcyto}} \tag{71}$$

7.3 Rule hgf

Rule hgf is an assignment rule for species hgf:

$$\text{hgf} = \begin{cases} 0 & \text{if time} < 1 \\ \begin{cases} 0 & \text{if time} < 24 \\ 1 & \text{otherwise} \end{cases} & \text{otherwise} \end{cases} \tag{72}$$

7.4 Rule inhp53

Rule inhp53 is an assignment rule for species inhp53:

$$\text{inhp53} = \begin{cases} 0 & \text{if time} < 1 \\ \begin{cases} 0 & \text{if time} < 0 \\ 0 & \text{otherwise} \end{cases} & \text{otherwise} \end{cases} \tag{73}$$

7.5 Rule inherk

Rule inherk is an assignment rule for species inherk:

$$\text{inherk} = \begin{cases} 0 & \text{if time} < 1 \\ \begin{cases} 0 & \text{if time} < 0 \\ 0 & \text{otherwise} \end{cases} & \text{otherwise} \end{cases} \tag{74}$$

7.6 Rule inhakt

Rule inhakt is an assignment rule for species inhakt:

$$\text{inhakt} = \begin{cases} 0 & \text{if time} < 1 \\ \begin{cases} 0 & \text{if time} < 0 \\ 0 & \text{otherwise} \end{cases} & \text{otherwise} \end{cases} \tag{75}$$

7.7 Rule inhc4d1

Rule inhc4d1 is an assignment rule for species inhc4d1:

$$\text{inhc4d1} = \begin{cases} 0 & \text{if time} < 1 \\ \begin{cases} 0 & \text{if time} < 0 \\ 0 & \text{otherwise} \end{cases} & \text{otherwise} \end{cases} \tag{76}$$

7.8 Rule ObsTotCycECDK2_obs

Rule ObsTotCycECDK2_obs is an assignment rule for species ObsTotCycECDK2_obs:

$$\begin{aligned} &\text{ObsTotCycECDK2\_obs} \\ &= \frac{\text{scale\_TotcycECDK2} \cdot (\text{Vnuc} \cdot ([\text{S3}] + [\text{S13}] + [\text{S18}] + [\text{S23}]) + \text{Vcyto} \cdot ([\text{S4}] + [\text{S20}]))}{\text{Vnuc} + \text{Vcyto}} \end{aligned} \tag{77}$$

7.9 Rule ObsTotCDK2T160_obs

Rule ObsTotCDK2T160_obs is an assignment rule for species ObsTotCDK2T160_obs:

$$\text{ObsTotCDK2T160\_obs} = \frac{\text{scale\_TotCDK2T160} \cdot \text{Vnuc} \cdot ([\text{S18}] + [\text{S23}])}{\text{Vnuc} + \text{Vcyto}} \tag{78}$$

7.10 Rule ObsTotCycDCDK4_obs

Rule ObsTotCycDCDK4_obs is an assignment rule for species ObsTotCycDCDK4_obs:

$$\text{ObsTotCycDCDK4\_obs} = \frac{\text{scale\_TotcycDCDK4} \cdot (\text{Vnuc} \cdot [\text{S24}] + \text{Vcyto} \cdot [\text{S19}])}{\text{Vnuc} + \text{Vcyto}} \tag{79}$$

7.11 Rule ObsTotP21_obs

Rule ObsTotP21_obs is an assignment rule for species ObsTotP21_obs:

$$\begin{aligned} &\text{ObsTotP21\_obs} \\ &= \frac{\text{scale\_Totp21} \cdot (\text{Vnuc} \cdot ([\text{S3}] + [\text{S11}] + [\text{S23}] + [\text{S24}]) + \text{Vcyto} \cdot ([\text{S12}] + [\text{S19}] + [\text{S20}]))}{\text{Vnuc} + \text{Vcyto}} \end{aligned} \tag{80}$$

7.12 Rule ObsTotRb_obs

Rule ObsTotRb_obs is an assignment rule for species ObsTotRb_obs:

$$\text{ObsTotRb\_obs} = \frac{\text{scale\_TotRb} \cdot \text{Vnuc} \cdot ([\text{S1}] + [\text{S2}] + [\text{S15}] + [\text{S16}] + [\text{S21}])}{\text{Vnuc} + \text{Vcyto}} \tag{81}$$

7.13 Rule ObsPhosRbS788_obs

Rule ObsPhosRbS788_obs is an assignment rule for species ObsPhosRbS788_obs:

$$\text{ObsPhosRbS788\_obs} = \frac{\text{scale\_PhosRbS788} \cdot \text{Vnuc} \cdot ([\text{S15}] + [\text{S16}] + [\text{S21}])}{\text{Vnuc} + \text{Vcyto}} \tag{82}$$

7.14 Rule ObsPhosRbS800_obs

Rule ObsPhosRbS800_obs is an assignment rule for species ObsPhosRbS800_obs:

$$\text{ObsPhosRbS800\_obs} = \frac{\text{scale\_PhosRbS800} \cdot \text{Vnuc} \cdot [\text{S21}]}{\text{Vnuc} + \text{Vcyto}} \tag{83}$$

7.15 Rule ObsDNAContent_obs

Rule ObsDNAContent_obs is an assignment rule for species ObsDNAContent_obs:

$$\text{ObsDNAContent\_obs} = 2 - ([\text{S5}] + [\text{S17}] + [\text{S22}] + [\text{S25}] + [\text{S27}] + [\text{S28}]) \tag{84}$$

7.16 Rule Vratio

Rule Vratio is an assignment rule for parameter Vratio:

$$\text{Vratio} = \frac{\text{Vnuc}}{\text{Vcyto}} \tag{85}$$

7.17 Rule erk

Rule erk is an assignment rule for parameter erk:

$$\text{erk} = (1 - [\text{inherk}]) \cdot \left(\frac{(1 - \text{aerk}) \cdot \left(\text{perk}^{\text{nerk}} + 1\right) \cdot [\text{hgf}]^{\text{nerk}}}{[\text{hgf}]^{\text{nerk}} + \text{perk}^{\text{nerk}}} + \text{aerk} \right) \tag{86}$$

7.18 Rule akt

Rule akt is an assignment rule for parameter akt:

$$\text{akt} = (1 - [\text{inhakt}]) \cdot \left(\frac{(1 - \text{aakt}) \cdot \left(\text{pakt}^{\text{nakt}} + 1\right) \cdot [\text{hgf}]^{\text{nakt}}}{[\text{hgf}]^{\text{nakt}} + \text{pakt}^{\text{nakt}}} + \text{aakt} \right) \tag{87}$$

7.19 Rule gsk3b

Rule gsk3b is an assignment rule for parameter gsk3b:

$$\text{gsk3b} = 1 - \text{akt} \tag{88}$$

7.20 Rule tf

Rule tf is an assignment rule for parameter tf:

$$\mathrm{tf} = (1 - \mathrm{atf}) \cdot \mathrm{erk} \cdot (1 - \mathrm{gsk3b}) + \mathrm{atf} \tag{89}$$

7.21 Rule tfp21

Rule tfp21 is an assignment rule for parameter tfp21:

$$\mathrm{tfp21} = (1 - [\mathrm{inhp53}]) \cdot \mathrm{tf} \tag{90}$$

7.22 Rule kp_c2cak

Rule kp_c2cak is an assignment rule for parameter kp_c2cak:

$$\mathrm{kp\_c2cak} = \mathrm{kdp\_c2cak} + \mathrm{kc2cak} \tag{91}$$

7.23 Rule kd_p21c4

Rule kd_p21c4 is an assignment rule for parameter kd_p21c4:

$$\mathrm{kd\_p21c4} = \mathrm{Kd\_p21c4} \cdot \mathrm{kb\_p21c4} \tag{92}$$

7.24 Rule kd_p21c2

Rule kd_p21c2 is an assignment rule for parameter kd_p21c2:

$$\mathrm{kd\_p21c2} = \mathrm{Kd\_p21c2} \cdot \mathrm{kb\_p21c2} \tag{93}$$

7.25 Rule kimport

Rule kimport is an assignment rule for parameter kimport:

$$\mathrm{kimport} = \frac{\mathrm{ki}}{1 + \mathrm{kinh\_p21akt} \cdot \mathrm{akt}} \tag{94}$$

7.26 Rule kdeg_e2ffree

Rule kdeg_e2ffree is an assignment rule for parameter kdeg_e2ffree:

$$\mathrm{kdeg\_e2ffree} = \mathrm{kdeg\_e2fbound} + \mathrm{kdege2fplus} \tag{95}$$

7.27 Rule kdeg_rbfree

Rule kdeg_rbfree is an assignment rule for parameter kdeg_rbfree:

$$\mathrm{kdeg\_rbfree} = \mathrm{kdeg\_rbbound} + \mathrm{kdegrbplus} \tag{96}$$

7.28 Rule kd_rbe2f

Rule kd_rbe2f is an assignment rule for parameter kd_rbe2f:

$$\text{kd\_rbe2f} = \text{kb\_rbe2f} \cdot \text{Kd\_rb\_e2f} \tag{97}$$

7.29 Rule kd_rbpe2f

Rule kd_rbpe2f is an assignment rule for parameter kd_rbpe2f:

$$\text{kd\_rbpe2f} = \text{kb\_rbpe2f} \cdot \text{Kd\_rbp\_e2f} \tag{98}$$

7.30 Rule kcatp_rbc4

Rule kcatp_rbc4 is an assignment rule for parameter kcatp_rbc4:

$$\text{kcatp\_rbc4} = \text{kcatprbc4} \cdot (1 - [\text{inhc4d1}]) \tag{99}$$

8 Reactions

This model contains 69 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	reaction_1	reaction_1	$\emptyset \longrightarrow \mathrm{S10}$	
2	reaction_2	reaction_2	$\emptyset \xrightarrow{\mathrm{S14,\ S16}} \mathrm{S4}$	
3	reaction_3	reaction_3	$\mathrm{S3} \xrightarrow{\mathrm{S3}} \mathrm{S11}$	
4	reaction_4	reaction_4	$\mathrm{S4} \xrightarrow{\mathrm{S4}} \emptyset$	
5	reaction_5	reaction_5	$\emptyset \xrightarrow{\mathrm{S14}} \mathrm{S12}$	
6	reaction_6	reaction_6	$\mathrm{S3} \xrightarrow{\mathrm{S3}} \mathrm{S11} + \mathrm{S13}$	
7	reaction_7	reaction_7	$\mathrm{S3} \xrightarrow{\mathrm{S18,\ S14,\ S3}} \mathrm{S13}$	
8	reaction_8	reaction_8	$\emptyset \xrightarrow{\mathrm{S14}} \mathrm{S1}$	
9	reaction_9	reaction_9	$\mathrm{S1} \xrightarrow{\mathrm{S1}} \emptyset$	
10	reaction_10	reaction_10	$\mathrm{S2} \xrightarrow{\mathrm{S2}} \mathrm{S14}$	
11	reaction_11	reaction_11	$\mathrm{S1} \xrightarrow{\mathrm{S11,\ S1}} \emptyset$	
12	reaction_12	reaction_12	$\mathrm{S2} \xrightarrow{\mathrm{S11,\ S2}} \mathrm{S14}$	
13	reaction_13	reaction_13	$\emptyset \xrightarrow{\mathrm{S14}} \mathrm{S14}$	
14	reaction_14	reaction_14	$\mathrm{S2} \xrightarrow{\mathrm{S2}} \mathrm{S1}$	
15	reaction_15	reaction_15	$\mathrm{S2} \xrightarrow{\mathrm{S2}} \mathrm{S1} + \mathrm{S14}$	
16	reaction_16	reaction_16	$\mathrm{S1} \xrightarrow{\mathrm{S24,\ S1}} \mathrm{S15}$	
17	reaction_17	reaction_17	$\mathrm{S2} \xrightarrow{\mathrm{S24,\ S2}} \mathrm{S16}$	

№	Id	Name	Reaction Equation	SBO
18	reaction_18	reaction_18	$S5 \xrightarrow{S18,\ S14,\ S5} S17$	
19	reaction_19	reaction_19	$S10 \xrightarrow{S10} \emptyset$	
20	reaction_20	reaction_20	$S13 \xrightarrow{S13} \emptyset$	
21	reaction_21	reaction_21	$S13 \xrightarrow{S13} S18$	
22	reaction_22	reaction_22	$S10 + S12 \xrightarrow{S10,\ S12} S19$	
23	reaction_23	reaction_23	$S4 + S12 \xrightarrow{S4,\ S12} S20$	
24	reaction_24	reaction_24	$S11 + S13 \xrightarrow{S11,\ S13} S3$	
25	reaction_25	reaction_25	$S12 \xrightarrow{S12} S11$	
26	reaction_26	reaction_26	$S12 \xrightleftharpoons{S12} \emptyset$	
27	reaction_27	reaction_27	$S11 \xrightarrow{S11} \emptyset$	
28	reaction_28	reaction_28	$S12 \xrightarrow{S12} \emptyset$	
29	reaction_29	reaction_29	$S15 \xrightarrow{S15} \emptyset$	
30	reaction_30	reaction_30	$S16 \xrightarrow{S16} S14$	
31	reaction_31	reaction_31	$S15 \xrightarrow{S11,\ S15} \emptyset$	
32	reaction_32	reaction_32	$S16 \xrightarrow{S11,\ S16} S14$	
33	reaction_33	reaction_33	$S14 \xrightarrow{S14} \emptyset$	
34	reaction_34	reaction_34	$S16 \xrightarrow{S16} S15$	
35	reaction_35	reaction_35	$S1 + S14 \xrightarrow{S1,\ S14} S2$	
36	reaction_36	reaction_36	$S14 + S15 \xrightarrow{S14,\ S15} S16$	
37	reaction_37	reaction_37	$S16 \xrightarrow{S16} S14 + S15$	
38	reaction_38	reaction_38	$S15 \xrightarrow{S18,\ S15} S21$	

№	Id	Name	Reaction Equation	SBO
39	reaction_39	reaction_39	$\mathrm{S16} \xrightarrow{\mathrm{S18,\ S16}} \mathrm{S14} + \mathrm{S21}$	
40	reaction_40	reaction_40	$\mathrm{S15} \xrightarrow{\mathrm{S18,\ S15}} \mathrm{S1}$	
41	reaction_41	reaction_41	$\mathrm{S16} \xrightarrow{\mathrm{S18,\ S16}} \mathrm{S2}$	
42	reaction_42	reaction_42	$\mathrm{S17} \xrightarrow{\mathrm{S17}} \mathrm{S22}$	
43	reaction_43	reaction_43	$\mathrm{S19} \xrightarrow{\mathrm{S19}} \mathrm{S12}$	
44	reaction_44	reaction_44	$\mathrm{S18} \xrightarrow{\mathrm{S18}} \emptyset$	
45	reaction_45	reaction_45	$\mathrm{S20} \xrightarrow{\mathrm{S20}} \mathrm{S12}$	
46	reaction_46	reaction_46	$\mathrm{S18} \xrightarrow{\mathrm{S18}} \emptyset$	
47	reaction_47	reaction_47	$\mathrm{S18} \xrightarrow{\mathrm{S18}} \mathrm{S13}$	
48	reaction_48	reaction_48	$\mathrm{S19} \xrightarrow{\mathrm{S19}} \mathrm{S10} + \mathrm{S12}$	
49	reaction_49	reaction_49	$\mathrm{S11} + \mathrm{S18} \xrightarrow{\mathrm{S11,\ S18}} \mathrm{S23}$	
50	reaction_50	reaction_50	$\mathrm{S20} \xrightarrow{\mathrm{S20}} \mathrm{S4} + \mathrm{S12}$	
51	reaction_51	reaction_51	$\mathrm{S19} \xrightarrow{\mathrm{S19}} \mathrm{S24}$	
52	reaction_52	reaction_52	$\mathrm{S20} \xrightarrow{\mathrm{S20}} \mathrm{S3}$	
53	reaction_53	reaction_53	$\mathrm{S19} \xrightleftharpoons{\mathrm{S19}} \emptyset$	
54	reaction_54	reaction_54	$\mathrm{S20} \xrightleftharpoons{\mathrm{S20}} \emptyset$	
55	reaction_55	reaction_55	$\mathrm{S21} \xrightarrow{\mathrm{S21}} \emptyset$	
56	reaction_56	reaction_56	$\mathrm{S21} \xrightarrow{\mathrm{S11,\ S21}} \emptyset$	
57	reaction_57	reaction_57	$\mathrm{S21} \xrightarrow{\mathrm{S18,\ S21}} \mathrm{S15}$	
58	reaction_58	reaction_58	$\mathrm{S22} \xrightarrow{\mathrm{S22}} \mathrm{S25}$	
59	reaction_59	reaction_59	$\mathrm{S24} \xrightarrow{\mathrm{S24}} \emptyset$	

№	Id	Name	Reaction Equation	SBO
60	reaction_60	reaction_60	$S23 \xrightarrow{S23} S11$	
61	reaction_61	reaction_61	$S24 \xrightarrow{S24} S11 + S26$	
62	reaction_62	reaction_62	$S23 \xrightarrow{S23} S11 + S18$	
63	reaction_63	reaction_63	$S23 \xrightarrow{S18,\ S14,\ S23} S18$	
64	reaction_64	reaction_64	$S24 \xrightarrow{S18,\ S14,\ S24} S26$	
65	reaction_65	reaction_65	$S25 \xrightarrow{S25} S27$	
66	reaction_66	reaction_66	$S26 \xrightarrow{S26} \emptyset$	
67	reaction_67	reaction_67	$S11 + S26 \xrightarrow{S11,\ S26} S24$	
68	reaction_68	reaction_68	$S27 \xrightarrow{S27} S28$	
69	reaction_69	reaction_69	$S28 \xrightarrow{S28} \emptyset$	

8.1 Reaction reaction_1

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

Name reaction_1

Reaction equation

$$\emptyset \longrightarrow \mathrm{S10} \tag{100}$$

Product

Table 6: Properties of each product.

Id	Name	SBO
S10	@cyto::C4D1(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_1\_0}\left(\mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_c4}, \mathrm{tf}\right) \tag{101}$$

$$\mathrm{Function\_for\_reaction\_1\_0}\left(\mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_c4}, \mathrm{tf}\right) = \frac{\mathrm{ks\_c4} \cdot \mathrm{tf}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{102}$$

$$\mathrm{Function\_for\_reaction\_1\_0}\left(\mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_c4}, \mathrm{tf}\right) = \frac{\mathrm{ks\_c4} \cdot \mathrm{tf}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{103}$$

8.2 Reaction reaction_2

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

Name reaction_2

Reaction equation

$$\emptyset \xrightarrow{\mathrm{S14,\ S16}} \mathrm{S4} \tag{104}$$

Modifiers

Table 7: Properties of each modifier.

Id	Name	SBO
S14	@nuc::e2f(b)	
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Product

Table 8: Properties of each product.

Id	Name	SBO
S4	@cyto::C2E(T160Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_2\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_c2e2f}, \mathrm{ks\_c2myc}, \mathrm{tf}\right) \tag{105}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_2\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_c2e2f}, \mathrm{ks\_c2myc}, \mathrm{tf}\right) \\ &= \frac{\mathrm{ks\_c2myc} \cdot \mathrm{tf} + \mathrm{ks\_c2e2f} \cdot \left(\left[\mathrm{S14}\right] + \left[\mathrm{S16}\right]\right)}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{106}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_2\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_c2e2f}, \mathrm{ks\_c2myc}, \mathrm{tf}\right) \\ &= \frac{\mathrm{ks\_c2myc} \cdot \mathrm{tf} + \mathrm{ks\_c2e2f} \cdot \left(\left[\mathrm{S14}\right] + \left[\mathrm{S16}\right]\right)}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{107}$$

8.3 Reaction reaction_3

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

Name reaction_3

Reaction equation

$$\mathrm{S3} \xrightarrow{\mathrm{S3}} \mathrm{S11} \tag{108}$$

Reactant

Table 9: Properties of each reactant.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Modifier

Table 10: Properties of each modifier.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Product

Table 11: Properties of each product.

Id	Name	SBO
S11	@nuc::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_3\_0}\left(\left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \tag{109}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_3\_0}\left(\left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S3}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{110}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_3\_0}\left(\left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S3}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{111}$$

8.4 Reaction `reaction_4`

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

Name reaction_4

Reaction equation

$$\mathrm{S4} \xrightarrow{\mathrm{S4}} \emptyset \tag{112}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
S4	@cyto::C2E(T160Ũ,b)	

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
S4	@cyto::C2E(T160Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_4\_0}\left(\left[\mathrm{S4}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \tag{113}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_4\_0}\left(\left[\mathrm{S4}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S4}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{114}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_4\_0}\left(\left[\mathrm{S4}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S4}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{115}$$

8.5 Reaction `reaction_5`

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

Name reaction_5

Reaction equation

$$\emptyset \xrightarrow{\mathrm{S14}} \mathrm{S12} \tag{116}$$

Modifier

Table 14: Properties of each modifier.

Id	Name	SBO
S14	@nuc::e2f(b)	

Product

Table 15: Properties of each product.

Id	Name	SBO
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_5\_0}\left(\left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_p21e2f}, \mathrm{ks\_p21p53}, \mathrm{tfp21}\right) \quad (117)$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_5\_0}\left(\left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_p21e2f}, \mathrm{ks\_p21p53}, \mathrm{tfp21}\right) \\ &= \frac{\left(\mathrm{ks\_p21p53} + \mathrm{ks\_p21e2f} \cdot \left[\mathrm{S14}\right]\right) \cdot \mathrm{tfp21}}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \quad (118)$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_5\_0}\left(\left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_p21e2f}, \mathrm{ks\_p21p53}, \mathrm{tfp21}\right) \\ &= \frac{\left(\mathrm{ks\_p21p53} + \mathrm{ks\_p21e2f} \cdot \left[\mathrm{S14}\right]\right) \cdot \mathrm{tfp21}}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \quad (119)$$

8.6 Reaction reaction_6

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

Name reaction_6

Reaction equation

$$\mathrm{S3} \xrightarrow{\mathrm{S3}} \mathrm{S11} + \mathrm{S13} \quad (120)$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Modifier

Table 17: Properties of each modifier.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Products

Table 18: Properties of each product.

Id	Name	SBO
S11	@nuc::p21(b)	
S13	@nuc::C2E(T160Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_6\_0}\left(\left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c2}\right) \tag{121}$$

$$\mathrm{Function\_for\_reaction\_6\_0}\left(\left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c2}\right) = \frac{\mathrm{kd\_p21c2} \cdot \left[\mathrm{S3}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{122}$$

$$\mathrm{Function\_for\_reaction\_6\_0}\left(\left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c2}\right) = \frac{\mathrm{kd\_p21c2} \cdot \left[\mathrm{S3}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{123}$$

8.7 Reaction reaction_7

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

Name reaction_7

Reaction equation

$$\mathrm{S3} \xrightarrow{\mathrm{S18,\ S14,\ S3}} \mathrm{S13} \tag{124}$$

Reactant

Table 19: Properties of each reactant.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Modifiers

Table 20: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S14	@nuc::e2f(b)	
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Product

Table 21: Properties of each product.

Id	Name	SBO
S13	@nuc::C2E(T160Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_7\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right) \tag{125}$$

$$\mathrm{Function\_for\_reaction\_7\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right) = \frac{\left(\mathrm{kdeg\_p21erkskp2} \cdot \mathrm{erk} + \mathrm{kdeg\_p21c2skp2} \cdot \left[\mathrm{S18}\right] + \mathrm{kdeg\_p21skp2}\right) \cdot \left[\mathrm{S14}\right] \cdot \left[\mathrm{S3}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{126}$$

$$\mathrm{Function\_for\_reaction\_7\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S3}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right) = \frac{\left(\mathrm{kdeg\_p21erkskp2} \cdot \mathrm{erk} + \mathrm{kdeg\_p21c2skp2} \cdot \left[\mathrm{S18}\right] + \mathrm{kdeg\_p21skp2}\right) \cdot \left[\mathrm{S14}\right] \cdot \left[\mathrm{S3}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{127}$$

8.8 Reaction reaction_8

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

Name reaction_8

Reaction equation

$$\emptyset \xrightarrow{\text{S14}} \text{S1} \tag{128}$$

Modifier

Table 22: Properties of each modifier.

Id	Name	SBO
S14	@nuc::e2f(b)	

Product

Table 23: Properties of each product.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \text{vol}\left(\text{Nucleus}\right) \cdot \text{Function\_for\_reaction\_8\_0}\left(\left[\text{S14}\right], \text{vol}\left(\text{cell}\right), \text{ks\_rb}, \text{ks\_rbe2f}\right) \tag{129}$$

$$\text{Function\_for\_reaction\_8\_0}\left(\left[\text{S14}\right], \text{vol}\left(\text{cell}\right), \text{ks\_rb}, \text{ks\_rbe2f}\right) = \frac{\text{ks\_rb} + \text{ks\_rbe2f} \cdot \left[\text{S14}\right]}{\text{vol}\left(\text{cell}\right)} \tag{130}$$

$$\text{Function\_for\_reaction\_8\_0}\left(\left[\text{S14}\right], \text{vol}\left(\text{cell}\right), \text{ks\_rb}, \text{ks\_rbe2f}\right) = \frac{\text{ks\_rb} + \text{ks\_rbe2f} \cdot \left[\text{S14}\right]}{\text{vol}\left(\text{cell}\right)} \tag{131}$$

8.9 Reaction reaction_9

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

Name reaction_9

Reaction equation

$$\mathrm{S1} \xrightarrow{\mathrm{S1}} \emptyset \tag{132}$$

Reactant

Table 24: Properties of each reactant.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Modifier

Table 25: Properties of each modifier.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_9\_0}\left(\left[\mathrm{S1}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbfree}\right) \tag{133}$$

$$\mathrm{Function\_for\_reaction\_9\_0}\left(\left[\mathrm{S1}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbfree}\right) = \frac{\mathrm{kdeg\_rbfree} \cdot \left[\mathrm{S1}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{134}$$

$$\mathrm{Function\_for\_reaction\_9\_0}\left(\left[\mathrm{S1}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbfree}\right) = \frac{\mathrm{kdeg\_rbfree} \cdot \left[\mathrm{S1}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{135}$$

8.10 Reaction reaction_10

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

Name reaction_10

Reaction equation

$$\mathrm{S2} \xrightarrow{\mathrm{S2}} \mathrm{S14} \tag{136}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Modifier

Table 27: Properties of each modifier.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Product

Table 28: Properties of each product.

Id	Name	SBO
S14	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_10\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbbound}\right) \quad (137)$$

$$\mathrm{Function\_for\_reaction\_10\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbbound}\right) = \frac{\mathrm{kdeg\_rbbound} \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (138)$$

$$\mathrm{Function\_for\_reaction\_10\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbbound}\right) = \frac{\mathrm{kdeg\_rbbound} \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (139)$$

8.11 Reaction reaction_11

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

Name reaction_11

Reaction equation

$$\mathrm{S1} \xrightarrow{\mathrm{S11,\ S1}} \emptyset \quad (140)$$

Reactant

Table 29: Properties of each reactant.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Modifiers

Table 30: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_11\_0}\left(\left[\mathrm{S1}\right], \left[\mathrm{S11}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) \quad (141)$$

$$\mathrm{Function\_for\_reaction\_11\_0}\left(\left[\mathrm{S1}\right], \left[\mathrm{S11}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) = \frac{\mathrm{kdeg\_rbp21} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S1}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (142)$$

$$\mathrm{Function\_for\_reaction\_11\_0}\left(\left[\mathrm{S1}\right], \left[\mathrm{S11}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) = \frac{\mathrm{kdeg\_rbp21} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S1}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (143)$$

8.12 Reaction reaction_12

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

Name reaction_12

Reaction equation

$$\mathrm{S2} \xrightarrow{\mathrm{S11,\ S2}} \mathrm{S14} \quad (144)$$

Reactant

Table 31: Properties of each reactant.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Modifiers

Table 32: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Product

Table 33: Properties of each product.

Id	Name	SBO
S14	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_12\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) \quad (145)$$

$$\mathrm{Function\_for\_reaction\_12\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) = \frac{\mathrm{kdeg\_rbp21} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (146)$$

$$\mathrm{Function\_for\_reaction\_12\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) = \frac{\mathrm{kdeg\_rbp21} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (147)$$

8.13 Reaction reaction_13

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

Name reaction_13

Reaction equation

$$\emptyset \xrightarrow{\mathrm{S14}} \mathrm{S14} \quad (148)$$

Modifier

Table 34: Properties of each modifier.

Id	Name	SBO
S14	@nuc::e2f(b)	

Product

Table 35: Properties of each product.

Id	Name	SBO
S14	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_13\_0}\left(\left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_e2fe2f}, \mathrm{ks\_e2fmyc}, \mathrm{tf}\right) \tag{149}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_13\_0}\left(\left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_e2fe2f}, \mathrm{ks\_e2fmyc}, \mathrm{tf}\right) \\ &= \frac{\left(\mathrm{ks\_e2fe2f} \cdot \left[\mathrm{S14}\right] + \mathrm{ks\_e2fmyc}\right) \cdot \mathrm{tf}}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{150}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_13\_0}\left(\left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{ks\_e2fe2f}, \mathrm{ks\_e2fmyc}, \mathrm{tf}\right) \\ &= \frac{\left(\mathrm{ks\_e2fe2f} \cdot \left[\mathrm{S14}\right] + \mathrm{ks\_e2fmyc}\right) \cdot \mathrm{tf}}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{151}$$

8.14 Reaction reaction_14

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

Name reaction_14

Reaction equation

$$\mathrm{S2} \xrightarrow{\mathrm{S2}} \mathrm{S1} \tag{152}$$

Reactant

Table 36: Properties of each reactant.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Modifier

Table 37: Properties of each modifier.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Product

Table 38: Properties of each product.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_14\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_e2fbound}\right) \quad (153)$$

$$\mathrm{Function\_for\_reaction\_14\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_e2fbound}\right) = \frac{\mathrm{kdeg\_e2fbound} \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (154)$$

$$\mathrm{Function\_for\_reaction\_14\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_e2fbound}\right) = \frac{\mathrm{kdeg\_e2fbound} \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (155)$$

8.15 Reaction reaction_15

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

Name reaction_15

Reaction equation

$$\mathrm{S2} \xrightarrow{\mathrm{S2}} \mathrm{S1} + \mathrm{S14} \quad (156)$$

Reactant

Table 39: Properties of each reactant.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Modifier

Table 40: Properties of each modifier.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Products

Table 41: Properties of each product.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	
S14	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_15\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_rbe2f}\right) \tag{157}$$

$$\mathrm{Function\_for\_reaction\_15\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_rbe2f}\right) = \frac{\mathrm{kd\_rbe2f} \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{158}$$

$$\mathrm{Function\_for\_reaction\_15\_0}\left(\left[\mathrm{S2}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_rbe2f}\right) = \frac{\mathrm{kd\_rbe2f} \cdot \left[\mathrm{S2}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{159}$$

8.16 Reaction reaction_16

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

Name reaction_16

Reaction equation

$$\mathrm{S1} \xrightarrow{\mathrm{S24,\ S1}} \mathrm{S15} \tag{160}$$

Reactant

Table 42: Properties of each reactant.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Modifiers

Table 43: Properties of each modifier.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Product

Table 44: Properties of each product.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_16\_0}\left(\mathrm{Km\_prb}, [\mathrm{S1}], [\mathrm{S24}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc4}, \mathrm{nrb}\right) \tag{161}$$

$$\mathrm{Function\_for\_reaction\_16\_0}\left(\mathrm{Km\_prb}, [\mathrm{S1}], [\mathrm{S24}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc4}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc4} \cdot [\mathrm{S24}] \cdot [\mathrm{S1}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S1}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{162}$$

$$\mathrm{Function\_for\_reaction\_16\_0}\left(\mathrm{Km\_prb}, [\mathrm{S1}], [\mathrm{S24}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc4}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc4} \cdot [\mathrm{S24}] \cdot [\mathrm{S1}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S1}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{163}$$

8.17 Reaction reaction_17

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

Name reaction_17

Reaction equation

$$\mathrm{S2} \xrightarrow{\mathrm{S24,\ S2}} \mathrm{S16} \tag{164}$$

Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Modifiers

Table 46: Properties of each modifier.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Product

Table 47: Properties of each product.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_17\_0}\left(\mathrm{Km\_prb}, [\mathrm{S2}], [\mathrm{S24}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc4}, \mathrm{nrb}\right) \tag{165}$$

$$\mathrm{Function\_for\_reaction\_17\_0}\left(\mathrm{Km\_prb}, [\mathrm{S2}], [\mathrm{S24}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc4}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc4} \cdot [\mathrm{S24}] \cdot [\mathrm{S2}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S2}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{166}$$

$$\mathrm{Function\_for\_reaction\_17\_0}\left(\mathrm{Km\_prb}, [\mathrm{S2}], [\mathrm{S24}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc4}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc4} \cdot [\mathrm{S24}] \cdot [\mathrm{S2}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S2}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{167}$$

8.18 Reaction reaction_18

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

Name reaction_18

Reaction equation

$$\mathrm{S5} \xrightarrow{\mathrm{S18,\ S14,\ S5}} \mathrm{S17} \tag{168}$$

Reactant

Table 48: Properties of each reactant.

Id	Name	SBO
S5	@nuc::dnapre()	

Modifiers

Table 49: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S14	@nuc::e2f(b)	
S5	@nuc::dnapre()	

Product

Table 50: Properties of each product.

Id	Name	SBO
S17	@nuc::dnapre1()	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_18\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S5}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_dna}\right) \tag{169}$$

$$\mathrm{Function\_for\_reaction\_18\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S5}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_dna}\right) = \frac{\mathrm{k\_dna} \cdot \left[\mathrm{S18}\right] \cdot \left[\mathrm{S14}\right] \cdot \left[\mathrm{S5}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{170}$$

$$\text{Function\_for\_reaction\_18\_0}\left([\text{S14}], [\text{S18}], [\text{S5}], \text{vol}\left(\text{cell}\right), \text{k\_dna}\right) = \frac{\text{k\_dna} \cdot [\text{S18}] \cdot [\text{S14}] \cdot [\text{S5}]}{\text{vol}\left(\text{cell}\right)} \tag{171}$$

8.19 Reaction `reaction_19`

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

Name reaction_19

Reaction equation

$$\text{S10} \xrightarrow{\text{S10}} \emptyset \tag{172}$$

Reactant

Table 51: Properties of each reactant.

Id	Name	SBO
S10	@cyto::C4D1(b)	

Modifier

Table 52: Properties of each modifier.

Id	Name	SBO
S10	@cyto::C4D1(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = \text{vol}\left(\text{cell}\right) \cdot \text{Function\_for\_reaction\_19\_0}\left([\text{S10}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c4}, \text{kdeg\_c4gsk3b}\right) \tag{173}$$

$$\begin{aligned} &\text{Function\_for\_reaction\_19\_0}\left([\text{S10}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c4}, \text{kdeg\_c4gsk3b}\right) \\ &= \frac{\left(\text{kdeg\_c4} + \text{kdeg\_c4gsk3b} \cdot \text{gsk3b}\right) \cdot [\text{S10}]}{\text{vol}\left(\text{cell}\right)} \end{aligned} \tag{174}$$

$$\begin{aligned} &\text{Function\_for\_reaction\_19\_0}\left([\text{S10}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c4}, \text{kdeg\_c4gsk3b}\right) \\ &= \frac{\left(\text{kdeg\_c4} + \text{kdeg\_c4gsk3b} \cdot \text{gsk3b}\right) \cdot [\text{S10}]}{\text{vol}\left(\text{cell}\right)} \end{aligned} \tag{175}$$

8.20 Reaction reaction_20

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

Name reaction_20

Reaction equation

$$\mathrm{S13} \xrightarrow{\mathrm{S13}} \emptyset \tag{176}$$

Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
S13	@nuc::C2E(T160Ũ,b)	

Modifier

Table 54: Properties of each modifier.

Id	Name	SBO
S13	@nuc::C2E(T160Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_20\_0}\left(\left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \tag{177}$$

$$\mathrm{Function\_for\_reaction\_20\_0}\left(\left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S13}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{178}$$

$$\mathrm{Function\_for\_reaction\_20\_0}\left(\left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S13}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{179}$$

8.21 Reaction reaction_21

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

Name reaction_21

Reaction equation

$$\mathrm{S13} \xrightarrow{\mathrm{S13}} \mathrm{S18} \tag{180}$$

Reactant

Table 55: Properties of each reactant.

Id	Name	SBO
S13	@nuc::C2E(T160Ũ,b)	

Modifier

Table 56: Properties of each modifier.

Id	Name	SBO
S13	@nuc::C2E(T160Ũ,b)	

Product

Table 57: Properties of each product.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_21\_0}\left(\left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kp\_c2cak}\right) \tag{181}$$

$$\mathrm{Function\_for\_reaction\_21\_0}\left(\left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kp\_c2cak}\right) = \frac{\mathrm{kp\_c2cak} \cdot \left[\mathrm{S13}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{182}$$

$$\mathrm{Function\_for\_reaction\_21\_0}\left(\left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kp\_c2cak}\right) = \frac{\mathrm{kp\_c2cak} \cdot \left[\mathrm{S13}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{183}$$

8.22 Reaction `reaction_22`

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

Name reaction_22

Reaction equation

$$\mathrm{S10} + \mathrm{S12} \xrightarrow{\mathrm{S10,\ S12}} \mathrm{S19} \tag{184}$$

Reactants

Table 58: Properties of each reactant.

Id	Name	SBO
`S10`	@cyto::C4D1(b)	
`S12`	@cyto::p21(b)	

Modifiers

Table 59: Properties of each modifier.

Id	Name	SBO
`S10`	@cyto::C4D1(b)	
`S12`	@cyto::p21(b)	

Product

Table 60: Properties of each product.

Id	Name	SBO
`S19`	@cyto::C4D1(b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_22\_0}\left(\left[\mathrm{S10}\right], \left[\mathrm{S12}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c4}\right) \tag{185}$$

$$\mathrm{Function\_for\_reaction\_22\_0}\left(\left[\mathrm{S10}\right], \left[\mathrm{S12}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c4}\right) = \frac{\mathrm{kb\_p21c4} \cdot \left[\mathrm{S10}\right] \cdot \left[\mathrm{S12}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{186}$$

$$\text{Function\_for\_reaction\_22\_0}\left([\text{S10}], [\text{S12}], \text{vol}\left(\text{cell}\right), \text{kb\_p21c4}\right) = \frac{\text{kb\_p21c4} \cdot [\text{S10}] \cdot [\text{S12}]}{\text{vol}\left(\text{cell}\right)} \tag{187}$$

8.23 Reaction `reaction_23`

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

Name reaction_23

Reaction equation

$$\text{S4} + \text{S12} \xrightarrow{\text{S4, S12}} \text{S20} \tag{188}$$

Reactants

Table 61: Properties of each reactant.

Id	Name	SBO
S4	@cyto::C2E(T160Ũ,b)	
S12	@cyto::p21(b)	

Modifiers

Table 62: Properties of each modifier.

Id	Name	SBO
S4	@cyto::C2E(T160Ũ,b)	
S12	@cyto::p21(b)	

Product

Table 63: Properties of each product.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = \text{vol}\left(\text{cell}\right) \cdot \text{Function\_for\_reaction\_23\_0}\left([\text{S12}], [\text{S4}], \text{vol}\left(\text{cell}\right), \text{kb\_p21c2}\right) \tag{189}$$

$$\text{Function\_for\_reaction\_23\_0}\left([\text{S12}], [\text{S4}], \text{vol}\left(\text{cell}\right), \text{kb\_p21c2}\right) = \frac{\text{kb\_p21c2} \cdot [\text{S4}] \cdot [\text{S12}]}{\text{vol}\left(\text{cell}\right)} \quad (190)$$

$$\text{Function\_for\_reaction\_23\_0}\left([\text{S12}], [\text{S4}], \text{vol}\left(\text{cell}\right), \text{kb\_p21c2}\right) = \frac{\text{kb\_p21c2} \cdot [\text{S4}] \cdot [\text{S12}]}{\text{vol}\left(\text{cell}\right)} \quad (191)$$

8.24 Reaction `reaction_24`

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

Name reaction_24

Reaction equation

$$\text{S11} + \text{S13} \xrightarrow{\text{S11, S13}} \text{S3} \quad (192)$$

Reactants

Table 64: Properties of each reactant.

Id	Name	SBO
S11	@nuc::p21(b)	
S13	@nuc::C2E(T160Ũ,b)	

Modifiers

Table 65: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S13	@nuc::C2E(T160Ũ,b)	

Product

Table 66: Properties of each product.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_24\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c2}\right) \quad (193)$$

$$\mathrm{Function\_for\_reaction\_24\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c2}\right) = \frac{\mathrm{kb\_p21c2} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S13}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (194)$$

$$\mathrm{Function\_for\_reaction\_24\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S13}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c2}\right) = \frac{\mathrm{kb\_p21c2} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S13}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (195)$$

8.25 Reaction `reaction_25`

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

Name reaction_25

Reaction equation

$$\mathrm{S12} \xrightarrow{\mathrm{S12}} \mathrm{S11} \quad (196)$$

Reactant

Table 67: Properties of each reactant.

Id	Name	SBO
S12	@cyto::p21(b)	

Modifier

Table 68: Properties of each modifier.

Id	Name	SBO
S12	@cyto::p21(b)	

Product

Table 69: Properties of each product.

Id	Name	SBO
S11	@nuc::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = \text{Function\_for\_reaction\_25\_0}\left(\left[\text{S12}\right], \text{Vratio}, \text{vol}\left(\text{cell}\right), \text{kimport}\right) \tag{197}$$

$$\text{Function\_for\_reaction\_25\_0}\left(\left[\text{S12}\right], \text{Vratio}, \text{vol}\left(\text{cell}\right), \text{kimport}\right) = \frac{\frac{\text{kimport}}{\text{Vratio}} \cdot \left[\text{S12}\right]}{\text{vol}\left(\text{cell}\right)} \tag{198}$$

8.26 Reaction reaction_26

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

Name reaction_26

Reaction equation

$$\text{S12} \rightleftharpoons^{\text{S12}} \emptyset \tag{199}$$

Reactant

Table 70: Properties of each reactant.

Id	Name	SBO
S12	@cyto::p21(b)	

Modifier

Table 71: Properties of each modifier.

Id	Name	SBO
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_26\_0}\left(\left[\mathrm{S12}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) \quad (200)$$

$$\mathrm{Function\_for\_reaction\_26\_0}\left(\left[\mathrm{S12}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) = \frac{\mathrm{kimport} \cdot \left(1 - \frac{1}{\mathrm{Vratio}}\right) \cdot \left[\mathrm{S12}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (201)$$

$$\mathrm{Function\_for\_reaction\_26\_0}\left(\left[\mathrm{S12}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) = \frac{\mathrm{kimport} \cdot \left(1 - \frac{1}{\mathrm{Vratio}}\right) \cdot \left[\mathrm{S12}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (202)$$

8.27 Reaction `reaction_27`

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

Name reaction_27

Reaction equation

$$\mathrm{S11} \xrightarrow{\mathrm{S11}} \emptyset \quad (203)$$

Reactant

Table 72: Properties of each reactant.

Id	Name	SBO
`S11`	@nuc::p21(b)	

Modifier

Table 73: Properties of each modifier.

Id	Name	SBO
`S11`	@nuc::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_27\_0}\left(\left[\mathrm{S11}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{erk}, \mathrm{gsk3b}, \mathrm{kdeg\_p21erk}, \mathrm{kdeg\_p21gsk3b}\right) \quad (204)$$

$$\begin{aligned}&\text{Function\_for\_reaction\_27\_0}\left([\text{S11}], \text{vol}\left(\text{cell}\right), \text{erk}, \text{gsk3b}, \text{kdeg\_p21erk}, \text{kdeg\_p21gsk3b}\right)\\ &= \frac{\left(\text{kdeg\_p21gsk3b} \cdot \text{gsk3b} + \text{kdeg\_p21erk} \cdot \text{erk}\right) \cdot [\text{S11}]}{\text{vol}\left(\text{cell}\right)}\end{aligned} \tag{205}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_27\_0}\left([\text{S11}], \text{vol}\left(\text{cell}\right), \text{erk}, \text{gsk3b}, \text{kdeg\_p21erk}, \text{kdeg\_p21gsk3b}\right)\\ &= \frac{\left(\text{kdeg\_p21gsk3b} \cdot \text{gsk3b} + \text{kdeg\_p21erk} \cdot \text{erk}\right) \cdot [\text{S11}]}{\text{vol}\left(\text{cell}\right)}\end{aligned} \tag{206}$$

8.28 Reaction `reaction_28`

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

Name reaction_28

Reaction equation

$$\text{S12} \xrightarrow{\text{S12}} \emptyset \tag{207}$$

Reactant

Table 74: Properties of each reactant.

Id	Name	SBO
S12	@cyto::p21(b)	

Modifier

Table 75: Properties of each modifier.

Id	Name	SBO
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$\begin{aligned}v_{28} = \text{vol}\left(\text{cell}\right) \cdot \text{Function\_for\_reaction\_28\_0}\left([\text{S12}], \text{vol}\left(\text{cell}\right), \text{erk}, \text{gsk3b}, \text{kdeg\_p21erk},\right.\\ \left.\text{kdeg\_p21gsk3b}\right)\end{aligned} \tag{208}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_28\_0}\left(\left[\text{S12}\right],\text{vol}\left(\text{cell}\right),\text{erk},\text{gsk3b},\text{kdeg\_p21erk},\text{kdeg\_p21gsk3b}\right)\\&=\frac{\left(\text{kdeg\_p21gsk3b}\cdot\text{gsk3b}+\text{kdeg\_p21erk}\cdot\text{erk}\right)\cdot\left[\text{S12}\right]}{\text{vol}\left(\text{cell}\right)}\end{aligned}\tag{209}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_28\_0}\left(\left[\text{S12}\right],\text{vol}\left(\text{cell}\right),\text{erk},\text{gsk3b},\text{kdeg\_p21erk},\text{kdeg\_p21gsk3b}\right)\\&=\frac{\left(\text{kdeg\_p21gsk3b}\cdot\text{gsk3b}+\text{kdeg\_p21erk}\cdot\text{erk}\right)\cdot\left[\text{S12}\right]}{\text{vol}\left(\text{cell}\right)}\end{aligned}\tag{210}$$

8.29 Reaction `reaction_29`

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

Name reaction_29

Reaction equation

$$\text{S15}\xrightarrow{\text{S15}}\emptyset\tag{211}$$

Reactant

Table 76: Properties of each reactant.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Modifier

Table 77: Properties of each modifier.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{29}=\text{vol}\left(\text{Nucleus}\right)\cdot\text{Function\_for\_reaction\_29\_0}\left(\left[\text{S15}\right],\text{vol}\left(\text{cell}\right),\text{kdeg\_rbfree}\right)\tag{212}$$

$$\text{Function\_for\_reaction\_29\_0}\left(\left[\text{S15}\right],\text{vol}\left(\text{cell}\right),\text{kdeg\_rbfree}\right)=\frac{\text{kdeg\_rbfree}\cdot\left[\text{S15}\right]}{\text{vol}\left(\text{cell}\right)}\tag{213}$$

$$\text{Function\_for\_reaction\_29\_0}\left([\text{S15}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbfree}\right) = \frac{\text{kdeg\_rbfree} \cdot [\text{S15}]}{\text{vol}\left(\text{cell}\right)} \quad (214)$$

8.30 Reaction `reaction_30`

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

Name reaction_30

Reaction equation

$$\text{S16} \xrightarrow{\text{S16}} \text{S14} \quad (215)$$

Reactant

Table 78: Properties of each reactant.

Id	Name	SBO
`S16`	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Modifier

Table 79: Properties of each modifier.

Id	Name	SBO
`S16`	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Product

Table 80: Properties of each product.

Id	Name	SBO
`S14`	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{30} = \text{vol}\left(\text{Nucleus}\right) \cdot \text{Function\_for\_reaction\_30\_0}\left([\text{S16}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbbound}\right) \quad (216)$$

$$\text{Function\_for\_reaction\_30\_0}\left([\text{S16}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbbound}\right) = \frac{\text{kdeg\_rbbound} \cdot [\text{S16}]}{\text{vol}\left(\text{cell}\right)} \quad (217)$$

$$\text{Function\_for\_reaction\_30\_0}\left([\text{S16}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbbound}\right) = \frac{\text{kdeg\_rbbound} \cdot [\text{S16}]}{\text{vol}\left(\text{cell}\right)} \quad (218)$$

8.31 Reaction `reaction_31`

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

Name reaction_31

Reaction equation

$$\text{S15} \xrightarrow{\text{S11, S15}} \emptyset \quad (219)$$

Reactant

Table 81: Properties of each reactant.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Modifiers

Table 82: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{31} = \text{vol}\left(\text{Nucleus}\right) \cdot \text{Function\_for\_reaction\_31\_0}\left([\text{S11}], [\text{S15}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) \quad (220)$$

$$\text{Function\_for\_reaction\_31\_0}\left([\text{S11}], [\text{S15}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) = \frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S15}]}{\text{vol}\left(\text{cell}\right)} \quad (221)$$

$$\text{Function\_for\_reaction\_31\_0}\left([\text{S11}], [\text{S15}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) = \frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S15}]}{\text{vol}\left(\text{cell}\right)} \quad (222)$$

8.32 Reaction reaction_32

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

Name reaction_32

Reaction equation

$$\mathrm{S16} \xrightarrow{\mathrm{S11,\ S16}} \mathrm{S14} \tag{223}$$

Reactant

Table 83: Properties of each reactant.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Modifiers

Table 84: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Product

Table 85: Properties of each product.

Id	Name	SBO
S14	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{32} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_32\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) \tag{224}$$

$$\mathrm{Function\_for\_reaction\_32\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbp21}\right) = \frac{\mathrm{kdeg\_rbp21} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S16}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{225}$$

$$\text{Function\_for\_reaction\_32\_0}\left([\text{S11}], [\text{S16}], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) = \frac{\text{kdeg\_rbp21} \cdot [\text{S11}] \cdot [\text{S16}]}{\text{vol}\left(\text{cell}\right)} \tag{226}$$

8.33 Reaction `reaction_33`

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

Name reaction_33

Reaction equation

$$\text{S14} \xrightarrow{\text{S14}} \emptyset \tag{227}$$

Reactant

Table 86: Properties of each reactant.

Id	Name	SBO
S14	@nuc::e2f(b)	

Modifier

Table 87: Properties of each modifier.

Id	Name	SBO
S14	@nuc::e2f(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{33} = \text{vol}\left(\text{Nucleus}\right) \cdot \text{Function\_for\_reaction\_33\_0}\left([\text{S14}], \text{vol}\left(\text{cell}\right), \text{kdeg\_e2ffree}\right) \tag{228}$$

$$\text{Function\_for\_reaction\_33\_0}\left([\text{S14}], \text{vol}\left(\text{cell}\right), \text{kdeg\_e2ffree}\right) = \frac{\text{kdeg\_e2ffree} \cdot [\text{S14}]}{\text{vol}\left(\text{cell}\right)} \tag{229}$$

$$\text{Function\_for\_reaction\_33\_0}\left([\text{S14}], \text{vol}\left(\text{cell}\right), \text{kdeg\_e2ffree}\right) = \frac{\text{kdeg\_e2ffree} \cdot [\text{S14}]}{\text{vol}\left(\text{cell}\right)} \tag{230}$$

8.34 Reaction `reaction_34`

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

Name reaction_34

Reaction equation

$$\mathrm{S16} \xrightarrow{\mathrm{S16}} \mathrm{S15} \tag{231}$$

Reactant

Table 88: Properties of each reactant.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Modifier

Table 89: Properties of each modifier.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Product

Table 90: Properties of each product.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{34} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_34\_0}\left(\left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_e2fbound}\right) \tag{232}$$

$$\mathrm{Function\_for\_reaction\_34\_0}\left(\left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_e2fbound}\right) = \frac{\mathrm{kdeg\_e2fbound} \cdot \left[\mathrm{S16}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{233}$$

$$\mathrm{Function\_for\_reaction\_34\_0}\left(\left[\mathrm{S16}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_e2fbound}\right) = \frac{\mathrm{kdeg\_e2fbound} \cdot \left[\mathrm{S16}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{234}$$

8.35 Reaction reaction_35

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

Name reaction_35

Reaction equation

$$\mathrm{S1} + \mathrm{S14} \xrightarrow{\mathrm{S1,\ S14}} \mathrm{S2} \tag{235}$$

Reactants

Table 91: Properties of each reactant.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	
S14	@nuc::e2f(b)	

Modifiers

Table 92: Properties of each modifier.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	
S14	@nuc::e2f(b)	

Product

Table 93: Properties of each product.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{35} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_35\_0}\left(\left[\mathrm{S1}\right], \left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_rbe2f}\right) \tag{236}$$

$$\mathrm{Function\_for\_reaction\_35\_0}\left(\left[\mathrm{S1}\right], \left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_rbe2f}\right) = \frac{\mathrm{kb\_rbe2f} \cdot \left[\mathrm{S1}\right] \cdot \left[\mathrm{S14}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{237}$$

$$\mathrm{Function\_for\_reaction\_35\_0}\left(\left[\mathrm{S1}\right], \left[\mathrm{S14}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_rbe2f}\right) = \frac{\mathrm{kb\_rbe2f} \cdot \left[\mathrm{S1}\right] \cdot \left[\mathrm{S14}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{238}$$

8.36 Reaction reaction_36

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

Name reaction_36

Reaction equation

$$\mathrm{S14} + \mathrm{S15} \xrightarrow{\mathrm{S14,\ S15}} \mathrm{S16} \tag{239}$$

Reactants

Table 94: Properties of each reactant.

Id	Name	SBO
S14	@nuc::e2f(b)	
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Modifiers

Table 95: Properties of each modifier.

Id	Name	SBO
S14	@nuc::e2f(b)	
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Product

Table 96: Properties of each product.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{36} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_36\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S15}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_rbpe2f}\right) \tag{240}$$

$$\mathrm{Function\_for\_reaction\_36\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S15}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_rbpe2f}\right) = \frac{\mathrm{kb\_rbpe2f} \cdot \left[\mathrm{S14}\right] \cdot \left[\mathrm{S15}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{241}$$

$$\text{Function\_for\_reaction\_36\_0}\left([\text{S14}],[\text{S15}],\text{vol}\left(\text{cell}\right),\text{kb\_rbpe2f}\right) = \frac{\text{kb\_rbpe2f}\cdot[\text{S14}]\cdot[\text{S15}]}{\text{vol}\left(\text{cell}\right)} \tag{242}$$

8.37 Reaction `reaction_37`

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

Name reaction_37

Reaction equation

$$\text{S16} \xrightarrow{\text{S16}} \text{S14} + \text{S15} \tag{243}$$

Reactant

Table 97: Properties of each reactant.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Modifier

Table 98: Properties of each modifier.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Products

Table 99: Properties of each product.

Id	Name	SBO
S14	@nuc::e2f(b)	
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{37} = \text{vol}\left(\text{Nucleus}\right)\cdot\text{Function\_for\_reaction\_37\_0}\left([\text{S16}],\text{vol}\left(\text{cell}\right),\text{kd\_rbpe2f}\right) \tag{244}$$

$$\text{Function\_for\_reaction\_37\_0}\left([\text{S16}], \text{vol}\left(\text{cell}\right), \text{kd\_rbpe2f}\right) = \frac{\text{kd\_rbpe2f} \cdot [\text{S16}]}{\text{vol}\left(\text{cell}\right)} \tag{245}$$

$$\text{Function\_for\_reaction\_37\_0}\left([\text{S16}], \text{vol}\left(\text{cell}\right), \text{kd\_rbpe2f}\right) = \frac{\text{kd\_rbpe2f} \cdot [\text{S16}]}{\text{vol}\left(\text{cell}\right)} \tag{246}$$

8.38 Reaction `reaction_38`

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

Name reaction_38

Reaction equation

$$\text{S15} \xrightarrow{\text{S18, S15}} \text{S21} \tag{247}$$

Reactant

Table 100: Properties of each reactant.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Modifiers

Table 101: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Product

Table 102: Properties of each product.

Id	Name	SBO
S21	@nuc::rb(S788P̃,S800P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{38} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_38\_0}\left(\mathrm{Km\_prb}, [\mathrm{S15}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc2}, \mathrm{nrb}\right) \tag{248}$$

$$\mathrm{Function\_for\_reaction\_38\_0}\left(\mathrm{Km\_prb}, [\mathrm{S15}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc2}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc2} \cdot [\mathrm{S18}] \cdot [\mathrm{S15}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S15}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{249}$$

$$\mathrm{Function\_for\_reaction\_38\_0}\left(\mathrm{Km\_prb}, [\mathrm{S15}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc2}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc2} \cdot [\mathrm{S18}] \cdot [\mathrm{S15}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S15}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{250}$$

8.39 Reaction `reaction_39`

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

Name reaction_39

Reaction equation

$$\mathrm{S16} \xrightarrow{\mathrm{S18,\ S16}} \mathrm{S14} + \mathrm{S21} \tag{251}$$

Reactant

Table 103: Properties of each reactant.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Modifiers

Table 104: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Products

Table 105: Properties of each product.

Id	Name	SBO
S14	@nuc::e2f(b)	
S21	@nuc::rb(S788P̃,S800P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{39} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_39\_0}\left(\mathrm{Km\_prb}, [\mathrm{S16}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc2}, \mathrm{nrb}\right) \tag{252}$$

$$\mathrm{Function\_for\_reaction\_39\_0}\left(\mathrm{Km\_prb}, [\mathrm{S16}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc2}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc2} \cdot [\mathrm{S18}] \cdot [\mathrm{S16}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S16}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{253}$$

$$\mathrm{Function\_for\_reaction\_39\_0}\left(\mathrm{Km\_prb}, [\mathrm{S16}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatp\_rbc2}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatp\_rbc2} \cdot [\mathrm{S18}] \cdot [\mathrm{S16}]^{\mathrm{nrb}}}{\mathrm{Km\_prb}^{\mathrm{nrb}} + [\mathrm{S16}]^{\mathrm{nrb}}}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{254}$$

8.40 Reaction reaction_40

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

Name reaction_40

Reaction equation

$$\mathrm{S15} \xrightarrow{\mathrm{S18,\ S15}} \mathrm{S1} \tag{255}$$

Reactant

Table 106: Properties of each reactant.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Modifiers

Table 107: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Product

Table 108: Properties of each product.

Id	Name	SBO
S1	@nuc::rb(S788Ũ,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{40} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_40\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S15}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc4}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) \tag{256}$$

$$\mathrm{Function\_for\_reaction\_40\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S15}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc4}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatdp\_rbc4} \cdot [\mathrm{S15}]^{\mathrm{nrb}}}{\mathrm{Km\_dprb}^{\mathrm{nrb}} + [\mathrm{S15}]^{\mathrm{nrb}}} \cdot 1}{1 + \mathrm{kinh\_pp1} \cdot [\mathrm{S18}]}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{257}$$

$$\mathrm{Function\_for\_reaction\_40\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S15}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc4}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatdp\_rbc4} \cdot [\mathrm{S15}]^{\mathrm{nrb}}}{\mathrm{Km\_dprb}^{\mathrm{nrb}} + [\mathrm{S15}]^{\mathrm{nrb}}} \cdot 1}{1 + \mathrm{kinh\_pp1} \cdot [\mathrm{S18}]}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{258}$$

8.41 Reaction reaction_41

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

Name reaction_41

Reaction equation

$$\mathrm{S16} \xrightarrow{\mathrm{S18,\ S16}} \mathrm{S2} \tag{259}$$

Reactant

Table 109: Properties of each reactant.

Id	Name	SBO
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Modifiers

Table 110: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S16	@nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)	

Product

Table 111: Properties of each product.

Id	Name	SBO
S2	@nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{41} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_41\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S16}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc4}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) \tag{260}$$

$$\mathrm{Function\_for\_reaction\_41\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S16}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc4}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatdp\_rbc4} \cdot [\mathrm{S16}]^{\mathrm{nrb}}}{\mathrm{Km\_dprb}^{\mathrm{nrb}} + [\mathrm{S16}]^{\mathrm{nrb}}} \cdot 1}{1 + \mathrm{kinh\_pp1} \cdot [\mathrm{S18}]}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{261}$$

$$\mathrm{Function\_for\_reaction\_41\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S16}], [\mathrm{S18}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc4}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatdp\_rbc4} \cdot [\mathrm{S16}]^{\mathrm{nrb}}}{\mathrm{Km\_dprb}^{\mathrm{nrb}} + [\mathrm{S16}]^{\mathrm{nrb}}} \cdot 1}{1 + \mathrm{kinh\_pp1} \cdot [\mathrm{S18}]}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{262}$$

8.42 Reaction reaction_42

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

Name reaction_42

Reaction equation

$$\mathrm{S17} \xrightarrow{\mathrm{S17}} \mathrm{S22} \tag{263}$$

Reactant

Table 112: Properties of each reactant.

Id	Name	SBO
S17	@nuc::dnapre1()	

Modifier

Table 113: Properties of each modifier.

Id	Name	SBO
S17	@nuc::dnapre1()	

Product

Table 114: Properties of each product.

Id	Name	SBO
S22	@nuc::dnapre2()	

Kinetic Law

Derived unit contains undeclared units

$$v_{42} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_42\_0}\left(\left[\mathrm{S17}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) \tag{264}$$

$$\mathrm{Function\_for\_reaction\_42\_0}\left(\left[\mathrm{S17}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S17}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{265}$$

$$\mathrm{Function\_for\_reaction\_42\_0}\left(\left[\mathrm{S17}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S17}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{266}$$

8.43 Reaction `reaction_43`

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

Name reaction_43

Reaction equation

$$\mathrm{S19} \xrightarrow{\mathrm{S19}} \mathrm{S12} \tag{267}$$

Reactant

Table 115: Properties of each reactant.

Id	Name	SBO
S19	@cyto::C4D1(b!1).p21(b!1)	

Modifier

Table 116: Properties of each modifier.

Id	Name	SBO
S19	@cyto::C4D1(b!1).p21(b!1)	

Product

Table 117: Properties of each product.

Id	Name	SBO
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{43} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_43\_0}\left(\left[\mathrm{S19}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c4}, \mathrm{kdeg\_c4gsk3b}\right) \tag{268}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_43\_0}\left(\left[\mathrm{S19}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c4}, \mathrm{kdeg\_c4gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c4} + \mathrm{kdeg\_c4gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S19}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{269}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_43\_0}\left(\left[\mathrm{S19}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c4}, \mathrm{kdeg\_c4gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c4} + \mathrm{kdeg\_c4gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S19}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{270}$$

8.44 Reaction reaction_44

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

Name reaction_44

Reaction equation

$$\mathrm{S18} \xrightarrow{\mathrm{S18}} \emptyset \tag{271}$$

Reactant

Table 118: Properties of each reactant.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Modifier

Table 119: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{44} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_44\_0}\left(\left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \tag{272}$$

$$\mathrm{Function\_for\_reaction\_44\_0}\left(\left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S18}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{273}$$

$$\mathrm{Function\_for\_reaction\_44\_0}\left(\left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S18}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{274}$$

8.45 Reaction reaction_45

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

Name reaction_45

Reaction equation

$$\mathrm{S20} \xrightarrow{\mathrm{S20}} \mathrm{S12} \tag{275}$$

Reactant

Table 120: Properties of each reactant.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Modifier

Table 121: Properties of each modifier.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Product

Table 122: Properties of each product.

Id	Name	SBO
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{45} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_45\_0}\left(\left[\mathrm{S20}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \tag{276}$$

$$\begin{aligned} &\mathrm{Function\_for\_reaction\_45\_0}\left(\left[\mathrm{S20}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \\ &= \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S20}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \end{aligned} \tag{277}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_45\_0}\left([\text{S20}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c2}, \text{kdeg\_c2gsk3b}\right)\\ &= \frac{\left(\text{kdeg\_c2} + \text{kdeg\_c2gsk3b} \cdot \text{gsk3b}\right) \cdot [\text{S20}]}{\text{vol}\left(\text{cell}\right)}\end{aligned} \tag{278}$$

8.46 Reaction `reaction_46`

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

Name reaction_46

Reaction equation

$$\text{S18} \xrightarrow{\text{S18}} \emptyset \tag{279}$$

Reactant

Table 123: Properties of each reactant.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Modifier

Table 124: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{46} = \text{vol}\left(\text{Nucleus}\right) \cdot \text{Function\_for\_reaction\_46\_0}\left([\text{S18}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c2c2gsk3b}\right) \tag{280}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_46\_0}\left([\text{S18}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c2c2gsk3b}\right)\\ &= \frac{\text{kdeg\_c2c2gsk3b} \cdot \text{gsk3b} \cdot [\text{S18}]}{\text{vol}\left(\text{cell}\right)}\end{aligned} \tag{281}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_46\_0}\left([\text{S18}], \text{vol}\left(\text{cell}\right), \text{gsk3b}, \text{kdeg\_c2c2gsk3b}\right)\\ &= \frac{\text{kdeg\_c2c2gsk3b} \cdot \text{gsk3b} \cdot [\text{S18}]}{\text{vol}\left(\text{cell}\right)}\end{aligned} \tag{282}$$

8.47 Reaction reaction_47

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

Name reaction_47

Reaction equation

$$\mathrm{S18} \xrightarrow{\mathrm{S18}} \mathrm{S13} \tag{283}$$

Reactant

Table 125: Properties of each reactant.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Modifier

Table 126: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Product

Table 127: Properties of each product.

Id	Name	SBO
S13	@nuc::C2E(T160Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{47} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_47\_0}\left(\left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdp\_c2cak}\right) \tag{284}$$

$$\mathrm{Function\_for\_reaction\_47\_0}\left(\left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdp\_c2cak}\right) = \frac{\mathrm{kdp\_c2cak} \cdot \left[\mathrm{S18}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{285}$$

$$\mathrm{Function\_for\_reaction\_47\_0}\left(\left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdp\_c2cak}\right) = \frac{\mathrm{kdp\_c2cak} \cdot \left[\mathrm{S18}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{286}$$

8.48 Reaction reaction_48

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

Name reaction_48

Reaction equation

$$\mathrm{S19} \xrightarrow{\mathrm{S19}} \mathrm{S10} + \mathrm{S12} \tag{287}$$

Reactant

Table 128: Properties of each reactant.

Id	Name	SBO
S19	@cyto::C4D1(b!1).p21(b!1)	

Modifier

Table 129: Properties of each modifier.

Id	Name	SBO
S19	@cyto::C4D1(b!1).p21(b!1)	

Products

Table 130: Properties of each product.

Id	Name	SBO
S10	@cyto::C4D1(b)	
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{48} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_48\_0}\left(\left[\mathrm{S19}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c4}\right) \tag{288}$$

$$\mathrm{Function\_for\_reaction\_48\_0}\left(\left[\mathrm{S19}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c4}\right) = \frac{\mathrm{kd\_p21c4} \cdot \left[\mathrm{S19}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{289}$$

$$\mathrm{Function\_for\_reaction\_48\_0}\left(\left[\mathrm{S19}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c4}\right) = \frac{\mathrm{kd\_p21c4} \cdot \left[\mathrm{S19}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{290}$$

8.49 Reaction reaction_49

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

Name reaction_49

Reaction equation

$$\mathrm{S11} + \mathrm{S18} \xrightarrow{\mathrm{S11,\ S18}} \mathrm{S23} \tag{291}$$

Reactants

Table 131: Properties of each reactant.

Id	Name	SBO
S11	@nuc::p21(b)	
S18	@nuc::C2E(T160P̃,b)	

Modifiers

Table 132: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S18	@nuc::C2E(T160P̃,b)	

Product

Table 133: Properties of each product.

Id	Name	SBO
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{49} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_49\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c2}\right) \tag{292}$$

$$\mathrm{Function\_for\_reaction\_49\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S18}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c2}\right) = \frac{\mathrm{kb\_p21c2} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S18}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{293}$$

$$\text{Function\_for\_reaction\_49\_0}\left([\text{S11}], [\text{S18}], \text{vol}\left(\text{cell}\right), \text{kb\_p21c2}\right) = \frac{\text{kb\_p21c2} \cdot [\text{S11}] \cdot [\text{S18}]}{\text{vol}\left(\text{cell}\right)} \tag{294}$$

8.50 Reaction `reaction_50`

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

Name reaction_50

Reaction equation

$$\text{S20} \xrightarrow{\text{S20}} \text{S4} + \text{S12} \tag{295}$$

Reactant

Table 134: Properties of each reactant.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Modifier

Table 135: Properties of each modifier.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Products

Table 136: Properties of each product.

Id	Name	SBO
S4	@cyto::C2E(T160Ũ,b)	
S12	@cyto::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{50} = \text{vol}\left(\text{cell}\right) \cdot \text{Function\_for\_reaction\_50\_0}\left([\text{S20}], \text{vol}\left(\text{cell}\right), \text{kd\_p21c2}\right) \tag{296}$$

$$\text{Function\_for\_reaction\_50\_0}\left(\left[\text{S20}\right], \text{vol}\left(\text{cell}\right), \text{kd\_p21c2}\right) = \frac{\text{kd\_p21c2} \cdot \left[\text{S20}\right]}{\text{vol}\left(\text{cell}\right)} \tag{297}$$

$$\text{Function\_for\_reaction\_50\_0}\left(\left[\text{S20}\right], \text{vol}\left(\text{cell}\right), \text{kd\_p21c2}\right) = \frac{\text{kd\_p21c2} \cdot \left[\text{S20}\right]}{\text{vol}\left(\text{cell}\right)} \tag{298}$$

8.51 Reaction `reaction_51`

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

Name reaction_51

Reaction equation

$$\text{S19} \xrightarrow{\text{S19}} \text{S24} \tag{299}$$

Reactant

Table 137: Properties of each reactant.

Id	Name	SBO
`S19`	@cyto::C4D1(b!1).p21(b!1)	

Modifier

Table 138: Properties of each modifier.

Id	Name	SBO
`S19`	@cyto::C4D1(b!1).p21(b!1)	

Product

Table 139: Properties of each product.

Id	Name	SBO
`S24`	@nuc::C4D1(b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{51} = \text{Function\_for\_reaction\_51\_0}\left(\left[\text{S19}\right], \text{Vratio}, \text{vol}\left(\text{cell}\right), \text{kimport}\right) \tag{300}$$

$$\text{Function\_for\_reaction\_51\_0}\left(\left[\text{S19}\right], \text{Vratio}, \text{vol}\left(\text{cell}\right), \text{kimport}\right) = \frac{\frac{\text{kimport}}{\text{Vratio}} \cdot \left[\text{S19}\right]}{\text{vol}\left(\text{cell}\right)} \tag{301}$$

8.52 Reaction `reaction_52`

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

Name reaction_52

Reaction equation

$$\text{S20} \xrightarrow{\text{S20}} \text{S3} \tag{302}$$

Reactant

Table 140: Properties of each reactant.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Modifier

Table 141: Properties of each modifier.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Product

Table 142: Properties of each product.

Id	Name	SBO
S3	@nuc::C2E(T160Ũ,b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{52} = \text{Function\_for\_reaction\_52\_0}\left(\left[\text{S20}\right], \text{Vratio}, \text{vol}\left(\text{cell}\right), \text{kimport}\right) \tag{303}$$

$$\text{Function\_for\_reaction\_52\_0}\left(\left[\text{S20}\right], \text{Vratio}, \text{vol}\left(\text{cell}\right), \text{kimport}\right) = \frac{\frac{\text{kimport}}{\text{Vratio}} \cdot \left[\text{S20}\right]}{\text{vol}\left(\text{cell}\right)} \tag{304}$$

8.53 Reaction reaction_53

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

Name reaction_53

Reaction equation

$$\mathrm{S19} \overset{\mathrm{S19}}{\rightleftharpoons} \emptyset \tag{305}$$

Reactant

Table 143: Properties of each reactant.

Id	Name	SBO
S19	@cyto::C4D1(b!1).p21(b!1)	

Modifier

Table 144: Properties of each modifier.

Id	Name	SBO
S19	@cyto::C4D1(b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{53} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_53\_0}\left(\left[\mathrm{S19}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) \tag{306}$$

$$\mathrm{Function\_for\_reaction\_53\_0}\left(\left[\mathrm{S19}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) = \frac{\mathrm{kimport} \cdot \left(1 - \frac{1}{\mathrm{Vratio}}\right) \cdot \left[\mathrm{S19}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{307}$$

$$\mathrm{Function\_for\_reaction\_53\_0}\left(\left[\mathrm{S19}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) = \frac{\mathrm{kimport} \cdot \left(1 - \frac{1}{\mathrm{Vratio}}\right) \cdot \left[\mathrm{S19}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{308}$$

8.54 Reaction reaction_54

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

Name reaction_54

Reaction equation

$$\mathrm{S20} \overset{\mathrm{S20}}{\rightleftharpoons} \emptyset \tag{309}$$

Reactant

Table 145: Properties of each reactant.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Modifier

Table 146: Properties of each modifier.

Id	Name	SBO
S20	@cyto::C2E(T160Ũ,b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{54} = \mathrm{vol}\left(\mathrm{cell}\right) \cdot \mathrm{Function\_for\_reaction\_54\_0}\left(\left[\mathrm{S20}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) \tag{310}$$

$$\mathrm{Function\_for\_reaction\_54\_0}\left(\left[\mathrm{S20}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) = \frac{\mathrm{kimport} \cdot \left(1 - \frac{1}{\mathrm{Vratio}}\right) \cdot \left[\mathrm{S20}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{311}$$

$$\mathrm{Function\_for\_reaction\_54\_0}\left(\left[\mathrm{S20}\right], \mathrm{Vratio}, \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kimport}\right) = \frac{\mathrm{kimport} \cdot \left(1 - \frac{1}{\mathrm{Vratio}}\right) \cdot \left[\mathrm{S20}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{312}$$

8.55 Reaction reaction_55

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

Name reaction_55

Reaction equation

$$\mathrm{S21} \overset{\mathrm{S21}}{\longrightarrow} \emptyset \tag{313}$$

Reactant

Table 147: Properties of each reactant.

Id	Name	SBO
S21	@nuc::rb(S788P̃,S800P̃,b)	

Modifier

Table 148: Properties of each modifier.

Id	Name	SBO
S21	@nuc::rb(S788P̃,S800P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{55} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_55\_0}\left(\left[\mathrm{S21}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbfree}\right) \tag{314}$$

$$\mathrm{Function\_for\_reaction\_55\_0}\left(\left[\mathrm{S21}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbfree}\right) = \frac{\mathrm{kdeg\_rbfree} \cdot \left[\mathrm{S21}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{315}$$

$$\mathrm{Function\_for\_reaction\_55\_0}\left(\left[\mathrm{S21}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_rbfree}\right) = \frac{\mathrm{kdeg\_rbfree} \cdot \left[\mathrm{S21}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{316}$$

8.56 Reaction reaction_56

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

Name reaction_56

Reaction equation

$$\mathrm{S21} \xrightarrow{\mathrm{S11,\ S21}} \emptyset \tag{317}$$

Reactant

Table 149: Properties of each reactant.

Id	Name	SBO
S21	@nuc::rb(S788P̃,S800P̃,b)	

Modifiers

Table 150: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S21	@nuc::rb(S788P̃,S800P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{56} = \text{vol}\left(\text{Nucleus}\right) \cdot \text{Function\_for\_reaction\_56\_0}\left(\left[\text{S11}\right], \left[\text{S21}\right], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) \quad (318)$$

$$\text{Function\_for\_reaction\_56\_0}\left(\left[\text{S11}\right], \left[\text{S21}\right], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) = \frac{\text{kdeg\_rbp21} \cdot \left[\text{S11}\right] \cdot \left[\text{S21}\right]}{\text{vol}\left(\text{cell}\right)} \quad (319)$$

$$\text{Function\_for\_reaction\_56\_0}\left(\left[\text{S11}\right], \left[\text{S21}\right], \text{vol}\left(\text{cell}\right), \text{kdeg\_rbp21}\right) = \frac{\text{kdeg\_rbp21} \cdot \left[\text{S11}\right] \cdot \left[\text{S21}\right]}{\text{vol}\left(\text{cell}\right)} \quad (320)$$

8.57 Reaction reaction_57

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

Name reaction_57

Reaction equation

$$\text{S21} \xrightarrow{\text{S18, S21}} \text{S15} \quad (321)$$

Reactant

Table 151: Properties of each reactant.

Id	Name	SBO
S21	@nuc::rb(S788P̃,S800P̃,b)	

Modifiers

Table 152: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S21	@nuc::rb(S788P̃,S800P̃,b)	

Product

Table 153: Properties of each product.

Id	Name	SBO
S15	@nuc::rb(S788P̃,S800Ũ,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{57} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_57\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S18}], [\mathrm{S21}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc2}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) \tag{322}$$

$$\mathrm{Function\_for\_reaction\_57\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S18}], [\mathrm{S21}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc2}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatdp\_rbc2} \cdot [\mathrm{S21}]^{\mathrm{nrb}}}{\mathrm{Km\_dprb}^{\mathrm{nrb}} + [\mathrm{S21}]^{\mathrm{nrb}}} \cdot 1}{1 + \mathrm{kinh\_pp1} \cdot [\mathrm{S18}]}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{323}$$

$$\mathrm{Function\_for\_reaction\_57\_0}\left(\mathrm{Km\_dprb}, [\mathrm{S18}], [\mathrm{S21}], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kcatdp\_rbc2}, \mathrm{kinh\_pp1}, \mathrm{nrb}\right) = \frac{\frac{\mathrm{kcatdp\_rbc2} \cdot [\mathrm{S21}]^{\mathrm{nrb}}}{\mathrm{Km\_dprb}^{\mathrm{nrb}} + [\mathrm{S21}]^{\mathrm{nrb}}} \cdot 1}{1 + \mathrm{kinh\_pp1} \cdot [\mathrm{S18}]}}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{324}$$

8.58 Reaction reaction_58

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

Name reaction_58

Reaction equation

$$\mathrm{S22} \xrightarrow{\mathrm{S22}} \mathrm{S25} \tag{325}$$

Reactant

Table 154: Properties of each reactant.

Id	Name	SBO
S22	@nuc::dnapre2()	

Modifier

Table 155: Properties of each modifier.

Id	Name	SBO
S22	@nuc::dnapre2()	

Product

Table 156: Properties of each product.

Id	Name	SBO
S25	@nuc::dnapre3()	

Kinetic Law

Derived unit contains undeclared units

$$v_{58} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_58\_0}\left(\left[\mathrm{S22}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) \tag{326}$$

$$\mathrm{Function\_for\_reaction\_58\_0}\left(\left[\mathrm{S22}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S22}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{327}$$

$$\mathrm{Function\_for\_reaction\_58\_0}\left(\left[\mathrm{S22}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S22}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{328}$$

8.59 Reaction reaction_59

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

Name reaction_59

Reaction equation

$$\mathrm{S24} \xrightarrow{\mathrm{S24}} \emptyset \tag{329}$$

Reactant

Table 157: Properties of each reactant.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	

Modifier

Table 158: Properties of each modifier.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{59} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_59\_0}\left(\left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_c4}\right) \tag{330}$$

$$\mathrm{Function\_for\_reaction\_59\_0}\left(\left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_c4}\right) = \frac{\mathrm{kdeg\_c4} \cdot \left[\mathrm{S24}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{331}$$

$$\mathrm{Function\_for\_reaction\_59\_0}\left(\left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kdeg\_c4}\right) = \frac{\mathrm{kdeg\_c4} \cdot \left[\mathrm{S24}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{332}$$

8.60 Reaction reaction_60

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

Name reaction_60

Reaction equation

$$\mathrm{S23} \xrightarrow{\mathrm{S23}} \mathrm{S11} \tag{333}$$

Reactant

Table 159: Properties of each reactant.

Id	Name	SBO
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Modifier

Table 160: Properties of each modifier.

Id	Name	SBO
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Product

Table 161: Properties of each product.

Id	Name	SBO
S11	@nuc::p21(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{60} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_60\_0}\left(\left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) \tag{334}$$

$$\mathrm{Function\_for\_reaction\_60\_0}\left(\left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S23}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{335}$$

$$\mathrm{Function\_for\_reaction\_60\_0}\left(\left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c2}, \mathrm{kdeg\_c2gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c2} + \mathrm{kdeg\_c2gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S23}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{336}$$

8.61 Reaction reaction_61

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

Name reaction_61

Reaction equation

$$\mathrm{S24} \xrightarrow{\mathrm{S24}} \mathrm{S11} + \mathrm{S26} \tag{337}$$

Reactant

Table 162: Properties of each reactant.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	

Modifier

Table 163: Properties of each modifier.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	

Products

Table 164: Properties of each product.

Id	Name	SBO
S11	@nuc::p21(b)	
S26	@nuc::C4D1(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{61} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_61\_0}\left(\left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c4}\right) \tag{338}$$

$$\mathrm{Function\_for\_reaction\_61\_0}\left(\left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c4}\right) = \frac{\mathrm{kd\_p21c4} \cdot \left[\mathrm{S24}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{339}$$

$$\mathrm{Function\_for\_reaction\_61\_0}\left(\left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c4}\right) = \frac{\mathrm{kd\_p21c4} \cdot \left[\mathrm{S24}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{340}$$

8.62 Reaction reaction_62

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

Name reaction_62

Reaction equation

$$\mathrm{S23} \xrightarrow{\mathrm{S23}} \mathrm{S11} + \mathrm{S18} \tag{341}$$

Reactant

Table 165: Properties of each reactant.

Id	Name	SBO
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Modifier

Table 166: Properties of each modifier.

Id	Name	SBO
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Products

Table 167: Properties of each product.

Id	Name	SBO
S11	@nuc::p21(b)	
S18	@nuc::C2E(T160P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{62} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_62\_0}\left(\left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c2}\right) \tag{342}$$

$$\mathrm{Function\_for\_reaction\_62\_0}\left(\left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c2}\right) = \frac{\mathrm{kd\_p21c2} \cdot \left[\mathrm{S23}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{343}$$

$$\mathrm{Function\_for\_reaction\_62\_0}\left(\left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kd\_p21c2}\right) = \frac{\mathrm{kd\_p21c2} \cdot \left[\mathrm{S23}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{344}$$

8.63 Reaction reaction_63

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

Name reaction_63

Reaction equation

$$\mathrm{S23} \xrightarrow{\mathrm{S18,\ S14,\ S23}} \mathrm{S18} \tag{345}$$

Reactant

Table 168: Properties of each reactant.

Id	Name	SBO
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Modifiers

Table 169: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S14	@nuc::e2f(b)	
S23	@nuc::C2E(T160P̃,b!1).p21(b!1)	

Product

Table 170: Properties of each product.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{63} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_63\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right) \tag{346}$$

$$\begin{aligned}&\mathrm{Function\_for\_reaction\_63\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \right.\\ &\left.\mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right)\\ &= \frac{\left(\mathrm{kdeg\_p21erkskp2} \cdot \mathrm{erk} + \mathrm{kdeg\_p21c2skp2} \cdot \left[\mathrm{S18}\right] + \mathrm{kdeg\_p21skp2}\right) \cdot \left[\mathrm{S14}\right] \cdot \left[\mathrm{S23}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)}\end{aligned} \tag{347}$$

$$\begin{aligned}&\mathrm{Function\_for\_reaction\_63\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S23}\right], \mathrm{vol}\left(\mathrm{cell}\right), \right.\\ &\left.\mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right)\\ &= \frac{\left(\mathrm{kdeg\_p21erkskp2} \cdot \mathrm{erk} + \mathrm{kdeg\_p21c2skp2} \cdot \left[\mathrm{S18}\right] + \mathrm{kdeg\_p21skp2}\right) \cdot \left[\mathrm{S14}\right] \cdot \left[\mathrm{S23}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)}\end{aligned} \tag{348}$$

8.64 Reaction reaction_64

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

Name reaction_64

Reaction equation

$$\mathrm{S24} \xrightarrow{\mathrm{S18,\ S14,\ S24}} \mathrm{S26} \tag{349}$$

Reactant

Table 171: Properties of each reactant.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	

Modifiers

Table 172: Properties of each modifier.

Id	Name	SBO
S18	@nuc::C2E(T160P̃,b)	
S14	@nuc::e2f(b)	
S24	@nuc::C4D1(b!1).p21(b!1)	

Product

Table 173: Properties of each product.

Id	Name	SBO
S26	@nuc::C4D1(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{64} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_64\_0}\left(\left[\mathrm{S14}\right], \left[\mathrm{S18}\right], \left[\mathrm{S24}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{erk}, \mathrm{kdeg\_p21c2skp2}, \mathrm{kdeg\_p21erkskp2}, \mathrm{kdeg\_p21skp2}\right) \tag{350}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_64\_0}\left([\text{S14}],[\text{S18}],[\text{S24}],\text{vol}\left(\text{cell}\right),\right.\\&\left.\text{erk},\text{kdeg\_p21c2skp2},\text{kdeg\_p21erkskp2},\text{kdeg\_p21skp2}\right)\\&\quad=\frac{\left(\text{kdeg\_p21erkskp2}\cdot\text{erk}+\text{kdeg\_p21c2skp2}\cdot[\text{S18}]+\text{kdeg\_p21skp2}\right)\cdot[\text{S14}]\cdot[\text{S24}]}{\text{vol}\left(\text{cell}\right)}\end{aligned}\tag{351}$$

$$\begin{aligned}&\text{Function\_for\_reaction\_64\_0}\left([\text{S14}],[\text{S18}],[\text{S24}],\text{vol}\left(\text{cell}\right),\right.\\&\left.\text{erk},\text{kdeg\_p21c2skp2},\text{kdeg\_p21erkskp2},\text{kdeg\_p21skp2}\right)\\&\quad=\frac{\left(\text{kdeg\_p21erkskp2}\cdot\text{erk}+\text{kdeg\_p21c2skp2}\cdot[\text{S18}]+\text{kdeg\_p21skp2}\right)\cdot[\text{S14}]\cdot[\text{S24}]}{\text{vol}\left(\text{cell}\right)}\end{aligned}\tag{352}$$

8.65 Reaction `reaction_65`

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

Name reaction_65

Reaction equation

$$\text{S25}\xrightarrow{\text{S25}}\text{S27}\tag{353}$$

Reactant

Table 174: Properties of each reactant.

Id	Name	SBO
S25	@nuc::dnapre3()	

Modifier

Table 175: Properties of each modifier.

Id	Name	SBO
S25	@nuc::dnapre3()	

Product

Table 176: Properties of each product.

Id	Name	SBO
S27	@nuc::dnapre4()	

Kinetic Law

Derived unit contains undeclared units

$$v_{65} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_65\_0}\left(\left[\mathrm{S25}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) \tag{354}$$

$$\mathrm{Function\_for\_reaction\_65\_0}\left(\left[\mathrm{S25}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S25}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{355}$$

$$\mathrm{Function\_for\_reaction\_65\_0}\left(\left[\mathrm{S25}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S25}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{356}$$

8.66 Reaction reaction_66

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

Name reaction_66

Reaction equation

$$\mathrm{S26} \xrightarrow{\mathrm{S26}} \emptyset \tag{357}$$

Reactant

Table 177: Properties of each reactant.

Id	Name	SBO
S26	@nuc::C4D1(b)	

Modifier

Table 178: Properties of each modifier.

Id	Name	SBO
S26	@nuc::C4D1(b)	

Kinetic Law

Derived unit contains undeclared units

$$v_{66} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_66\_0}\left(\left[\mathrm{S26}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c4}, \mathrm{kdeg\_c4gsk3b}\right) \tag{358}$$

$$\mathrm{Function\_for\_reaction\_66\_0}\left(\left[\mathrm{S26}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c4}, \mathrm{kdeg\_c4gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c4} + \mathrm{kdeg\_c4gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S26}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{359}$$

$$\mathrm{Function\_for\_reaction\_66\_0}\left(\left[\mathrm{S26}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{gsk3b}, \mathrm{kdeg\_c4}, \mathrm{kdeg\_c4gsk3b}\right) = \frac{\left(\mathrm{kdeg\_c4} + \mathrm{kdeg\_c4gsk3b} \cdot \mathrm{gsk3b}\right) \cdot \left[\mathrm{S26}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{360}$$

8.67 Reaction `reaction_67`

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

Name reaction_67

Reaction equation

$$\mathrm{S11} + \mathrm{S26} \xrightarrow{\mathrm{S11,\ S26}} \mathrm{S24} \tag{361}$$

Reactants

Table 179: Properties of each reactant.

Id	Name	SBO
S11	@nuc::p21(b)	
S26	@nuc::C4D1(b)	

Modifiers

Table 180: Properties of each modifier.

Id	Name	SBO
S11	@nuc::p21(b)	
S26	@nuc::C4D1(b)	

Product

Table 181: Properties of each product.

Id	Name	SBO
S24	@nuc::C4D1(b!1).p21(b!1)	

Kinetic Law

Derived unit contains undeclared units

$$v_{67} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_67\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S26}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c4}\right) \quad (362)$$

$$\mathrm{Function\_for\_reaction\_67\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S26}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c4}\right) = \frac{\mathrm{kb\_p21c4} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S26}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (363)$$

$$\mathrm{Function\_for\_reaction\_67\_0}\left(\left[\mathrm{S11}\right], \left[\mathrm{S26}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{kb\_p21c4}\right) = \frac{\mathrm{kb\_p21c4} \cdot \left[\mathrm{S11}\right] \cdot \left[\mathrm{S26}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \quad (364)$$

8.68 Reaction reaction_68

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

Name reaction_68

Reaction equation

$$\mathrm{S27} \xrightarrow{\mathrm{S27}} \mathrm{S28} \quad (365)$$

Reactant

Table 182: Properties of each reactant.

Id	Name	SBO
S27	@nuc::dnapre4()	

Modifier

Table 183: Properties of each modifier.

Id	Name	SBO
S27	@nuc::dnapre4()	

Product

Table 184: Properties of each product.

Id	Name	SBO
S28	@nuc::dnapre5()	

Kinetic Law

Derived unit contains undeclared units

$$v_{68} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_68\_0}\left(\left[\mathrm{S27}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) \tag{366}$$

$$\mathrm{Function\_for\_reaction\_68\_0}\left(\left[\mathrm{S27}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S27}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{367}$$

$$\mathrm{Function\_for\_reaction\_68\_0}\left(\left[\mathrm{S27}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S27}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{368}$$

8.69 Reaction reaction_69

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

Name reaction_69

Reaction equation

$$\mathrm{S28} \xrightarrow{\mathrm{S28}} \emptyset \tag{369}$$

Reactant

Table 185: Properties of each reactant.

Id	Name	SBO
S28	@nuc::dnapre5()	

Modifier

Table 186: Properties of each modifier.

Id	Name	SBO
S28	@nuc::dnapre5()	

Kinetic Law

Derived unit contains undeclared units

$$v_{69} = \mathrm{vol}\left(\mathrm{Nucleus}\right) \cdot \mathrm{Function\_for\_reaction\_69\_0}\left(\left[\mathrm{S28}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) \tag{370}$$

$$\mathrm{Function\_for\_reaction\_69\_0}\left(\left[\mathrm{S28}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S28}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{371}$$

$$\mathrm{Function\_for\_reaction\_69\_0}\left(\left[\mathrm{S28}\right], \mathrm{vol}\left(\mathrm{cell}\right), \mathrm{k\_delay}\right) = \frac{\mathrm{k\_delay} \cdot \left[\mathrm{S28}\right]}{\mathrm{vol}\left(\mathrm{cell}\right)} \tag{372}$$

9 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.

9.1 Species S4

Name @cyto::C2E(T160Ũ,b)

Notes `Cyclin E:CDK2 complex - T160 phosphorylation`

Initial concentration $0.415\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

This species takes part in six reactions (as a reactant in reaction_4, reaction_23 and as a product in reaction_2, reaction_50 and as a modifier in reaction_4, reaction_23).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S4} = v_2 + v_{50} - v_4 - v_{23} \tag{373}$$

9.2 Species S10

Name @cyto::C4D1(b)

Notes Cyclin D1:CDK4 complex

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

This species takes part in six reactions (as a reactant in reaction_19, reaction_22 and as a product in reaction_1, reaction_48 and as a modifier in reaction_19, reaction_22).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S10} = v_1 + v_{48} - v_{19} - v_{22} \tag{374}$$

9.3 Species S12

Name @cyto::p21(b)

Notes p21 - Cyclin-dependent kinase inhibitor 1

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

This species takes part in 15 reactions (as a reactant in reaction_22, reaction_23, reaction_25, reaction_26, reaction_28 and as a product in reaction_5, reaction_43, reaction_45, reaction_48, reaction_50 and as a modifier in reaction_22, reaction_23, reaction_25, reaction_26, reaction_28).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S12} = v_5 + v_{43} + v_{45} + v_{48} + v_{50} - v_{22} - v_{23} - v_{25} - v_{26} - v_{28} \tag{375}$$

9.4 Species S19

Name @cyto::C4D1(b!1).p21(b!1)

Notes Cyclin D1:CDK4:p21 complex

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

This species takes part in nine reactions (as a reactant in reaction_43, reaction_48, reaction_51, reaction_53 and as a product in reaction_22 and as a modifier in reaction_43, reaction_48, reaction_51, reaction_53).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S19} = v_{22} - v_{43} - v_{48} - v_{51} - v_{53} \tag{376}$$

9.5 Species S20

Name @cyto::C2E(T160Ũ,b!1).p21(b!1)

Notes Cyclin E:CDK2:p21 complex - T160 phosphorylation

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

This species takes part in nine reactions (as a reactant in reaction_45, reaction_50, reaction_52, reaction_54 and as a product in reaction_23 and as a modifier in reaction_45, reaction_50, reaction_52, reaction_54).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S20} = v_{23} - v_{45} - v_{50} - v_{52} - v_{54} \tag{377}$$

9.6 Species hgf

Name HGF

Notes Hepatocyte Growth Factor

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

Involved in rule hgf

One rule determines the species' quantity.

9.7 Species inhp53

Name inhp53

Notes p53 tumor suppressor

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

Involved in rule inhp53

One rule determines the species' quantity.

9.8 Species inherk

Name inhERK

Notes Extracellular-signal-regulated Kinases

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

Involved in rule inherk

One rule determines the species' quantity.

9.9 Species inhakt

Name inhAKT

Notes `Protein kinase B`

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

Involved in rule inhakt

One rule determines the species' quantity.

9.10 Species inhc4d1

Name inhc4d1

Notes `Cyclin D1:CDK4 complex`

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

Involved in rule inhc4d1

One rule determines the species' quantity.

9.11 Species ObsTotCycECDK2_obs

Name TotCycECDK2

Notes `Cyclin E:CDK2 complex`

Initial concentration $0.099620260255418\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

Involved in rule ObsTotCycECDK2_obs

One rule determines the species' quantity.

9.12 Species ObsTotCDK2T160_obs

Name TotCDK2T160

Notes `CDK2 T160-phosphorylated (Thr160 site)`

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

Involved in rule ObsTotCDK2T160_obs

One rule determines the species' quantity.

9.13 Species ObsTotCycDCDK4_obs

Name TotCycDCDK4

Notes Cyclin D1:CDK4 complex

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

Involved in rule ObsTotCycDCDK4_obs

One rule determines the species' quantity.

9.14 Species ObsTotP21_obs

Name TotP21

Notes p21 - Cyclin-dependent kinase inhibitor 1

Initial concentration $0.020805213622291\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

Involved in rule ObsTotP21_obs

One rule determines the species' quantity.

9.15 Species ObsCDK2P21_obs

Name CDK2P21

Notes p21:CDK2 complex

Initial concentration $0.0409109861876772\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

Involved in rule ObsCDK2P21_obs

One rule determines the species' quantity.

9.16 Species ObsTotE2F_obs

Name TotE2F

Notes E2F-1 - E2F transcription factor

Initial concentration $0.0337275199303406\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

Involved in rule ObsTotE2F_obs

One rule determines the species' quantity.

9.17 Species ObsTotRb_obs

Name TotRb

Notes Retinoblastoma Protein

Initial concentration $0.129299840363777\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

Involved in rule ObsTotRb_obs

One rule determines the species' quantity.

9.18 Species ObsPhosRbS788_obs

Name PhosRbS788

Notes Rb S788-phosphorylated (serine 788 site)

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

Involved in rule ObsPhosRbS788_obs

One rule determines the species' quantity.

9.19 Species ObsPhosRbS800_obs

Name PhosRbS800

Notes Rb S800/S804-phosphorylated (serine 800 and 804 sites)

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

Involved in rule ObsPhosRbS800_obs

One rule determines the species' quantity.

9.20 Species ObsDNAContent_obs

Name DNAContent

Notes DNA content

Initial concentration $1\ \mathrm{nmol} \cdot \mathrm{l}^{-1}$

Involved in rule ObsDNAContent_obs

One rule determines the species' quantity.

9.21 Species S23

Name @nuc::C2E(T160P̃,b!1).p21(b!1)

Notes Cyclin E:CDK2:p21 complex - T160 phosphorylation

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

This species takes part in seven reactions (as a reactant in reaction_60, reaction_62, reaction_63 and as a product in reaction_49 and as a modifier in reaction_60, reaction_62, reaction_63).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S23} = v_{49} - v_{60} - v_{62} - v_{63} \tag{378}$$

9.22 Species S18

Name @nuc::C2E(T160P̃,b)

Notes Cyclin E:CDK2 complex - T160 phosphorylation

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

This species takes part in 20 reactions (as a reactant in reaction_44, reaction_46, reaction_47, reaction_49 and as a product in reaction_21, reaction_62, reaction_63 and as a modifier in reaction_7, reaction_18, reaction_38, reaction_39, reaction_40, reaction_41, reaction_44, reaction_46, reaction_47, reaction_49, reaction_57, reaction_63, reaction_64).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S18} = v_{21} + v_{62} + v_{63} - v_{44} - v_{46} - v_{47} - v_{49} \tag{379}$$

9.23 Species S3

Name @nuc::C2E(T160Ũ,b!1).p21(b!1)

Notes Cyclin E:CDK2:p21 complex - T160 phosphorylation

Initial concentration $6.2223\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in eight reactions (as a reactant in reaction_3, reaction_6, reaction_7 and as a product in reaction_24, reaction_52 and as a modifier in reaction_3, reaction_6, reaction_7).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S3} = v_{24} + v_{52} - v_{3} - v_{6} - v_{7} \tag{380}$$

9.24 Species S13

Name @nuc::C2E(T160Ũ,b)

Notes Cyclin E:CDK2 complex - T160 phosphorylation

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

This species takes part in nine reactions (as a reactant in reaction_20, reaction_21, reaction_24 and as a product in reaction_6, reaction_7, reaction_47 and as a modifier in reaction_20, reaction_21, reaction_24).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S13} = v_6 + v_7 + v_{47} - v_{20} - v_{21} - v_{24} \tag{381}$$

9.25 Species S24

Name @nuc::C4D1(b!1).p21(b!1)

Notes Cyclin D1:CDK4:p21 complex

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

This species takes part in ten reactions (as a reactant in reaction_59, reaction_61, reaction_64 and as a product in reaction_51, reaction_67 and as a modifier in reaction_16, reaction_17, reaction_59, reaction_61, reaction_64).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S24} = v_{51} + v_{67} - v_{59} - v_{61} - v_{64} \tag{382}$$

9.26 Species S26

Name @nuc::C4D1(b)

Notes Cyclin D1:CDK4 complex

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

This species takes part in six reactions (as a reactant in reaction_66, reaction_67 and as a product in reaction_61, reaction_64 and as a modifier in reaction_66, reaction_67).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S26} = v_{61} + v_{64} - v_{66} - v_{67} \tag{383}$$

9.27 Species S5

Name @nuc::dnapre()

Notes `Genes contributing to the formation of prereplication complexes.`

Initial concentration $1\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in two reactions (as a reactant in reaction_18 and as a modifier in reaction_18).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S5} = -v_{18} \tag{384}$$

9.28 Species S17

Name @nuc::dnapre1()

Notes `Genes contributing to the formation of prereplication complexes.`

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

This species takes part in three reactions (as a reactant in reaction_42 and as a product in reaction_18 and as a modifier in reaction_42).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S17} = v_{18} - v_{42} \tag{385}$$

9.29 Species S22

Name @nuc::dnapre2()

Notes `Genes contributing to the formation of prereplication complexes.`

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

This species takes part in three reactions (as a reactant in reaction_58 and as a product in reaction_42 and as a modifier in reaction_58).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S22} = v_{42} - v_{58} \tag{386}$$

9.30 Species S25

Name @nuc::dnapre3()

Notes `Genes contributing to the formation of prereplication complexes.`

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

This species takes part in three reactions (as a reactant in reaction_65 and as a product in reaction_58 and as a modifier in reaction_65).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S25} = v_{58} - v_{65} \tag{387}$$

9.31 Species S27

Name @nuc::dnapre4()

Notes `Genes contributing to the formation of prereplication complexes.`

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

This species takes part in three reactions (as a reactant in reaction_68 and as a product in reaction_65 and as a modifier in reaction_68).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S27} = v_{65} - v_{68} \tag{388}$$

9.32 Species S16

Name @nuc::e2f(b!1).rb(S788P̃,S800Ũ,b!1)

Notes `E2F-1: Retinoblastoma Protein complex - S788 and S800 phosphorylation`

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

This species takes part in 15 reactions (as a reactant in reaction_30, reaction_32, reaction_34, reaction_37, reaction_39, reaction_41 and as a product in reaction_17, reaction_36 and as a modifier in reaction_2, reaction_30, reaction_32, reaction_34, reaction_37, reaction_39, reaction_41).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S16} = v_{17} + v_{36} - v_{30} - v_{32} - v_{34} - v_{37} - v_{39} - v_{41} \tag{389}$$

9.33 Species S2

Name @nuc::e2f(b!1).rb(S788Ũ,S800Ũ,b!1)

Notes `E2F-1: Retinoblastoma Protein complex - S788 and S800 phosphorylation`

Initial concentration $0.0601\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in twelve reactions (as a reactant in reaction_10, reaction_12, reaction_14, reaction_15, reaction_17 and as a product in reaction_35, reaction_41 and as a modifier in reaction_10, reaction_12, reaction_14, reaction_15, reaction_17).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S2} = v_{35} + v_{41} - v_{10} - v_{12} - v_{14} - v_{15} - v_{17} \tag{390}$$

9.34 Species S14

Name @nuc::e2f(b)

Notes E2F-1 - E2F transcription factor

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

This species takes part in 22 reactions (as a reactant in reaction_33, reaction_35, reaction_36 and as a product in reaction_10, reaction_12, reaction_13, reaction_15, reaction_30, reaction_32, reaction_37, reaction_39 and as a modifier in reaction_2, reaction_5, reaction_7, reaction_8, reaction_13, reaction_18, reaction_33, reaction_35, reaction_36, reaction_63, reaction_64).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S14} = v_{10} + v_{12} + v_{13} + v_{15} + v_{30} + v_{32} + v_{37} + v_{39} - v_{33} - v_{35} - v_{36} \quad (391)$$

9.35 Species S11

Name @nuc::p21(b)

Notes p21 - Cyclin-dependent kinase inhibitor 1

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

This species takes part in 19 reactions (as a reactant in reaction_24, reaction_27, reaction_49, reaction_67 and as a product in reaction_3, reaction_6, reaction_25, reaction_60, reaction_61, reaction_62 and as a modifier in reaction_11, reaction_12, reaction_24, reaction_27, reaction_31, reaction_32, reaction_49, reaction_56, reaction_67).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S11} = v_{3} + v_{6} + v_{25} + v_{60} + v_{61} + v_{62} - v_{24} - v_{27} - v_{49} - v_{67} \quad (392)$$

9.36 Species S21

Name @nuc::rb(S788P̃,S800P̃,b)

Notes Retinoblastoma Protein - S788 and S800 phosphorylation

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

This species takes part in eight reactions (as a reactant in reaction_55, reaction_56, reaction_57 and as a product in reaction_38, reaction_39 and as a modifier in reaction_55, reaction_56, reaction_57).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S21} = v_{38} + v_{39} - v_{55} - v_{56} - v_{57} \quad (393)$$

9.37 Species S15

Name @nuc::rb(S788P̃,S800Ũ,b)

Notes Retinoblastoma Protein - S788 and S800 phosphorylation

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

This species takes part in 14 reactions (as a reactant in reaction_29, reaction_31, reaction_36, reaction_38, reaction_40 and as a product in reaction_16, reaction_34, reaction_37, reaction_57 and as a modifier in reaction_29, reaction_31, reaction_36, reaction_38, reaction_40).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S15} = v_{16} + v_{34} + v_{37} + v_{57} - v_{29} - v_{31} - v_{36} - v_{38} - v_{40} \tag{394}$$

9.38 Species S1

Name @nuc::rb(S788Ũ,S800Ũ,b)

Notes Retinoblastoma Protein - S788 and S800 phosphorylation

Initial concentration $25.5914\ \mathrm{nmol}\cdot\mathrm{l}^{-1}$

This species takes part in twelve reactions (as a reactant in reaction_9, reaction_11, reaction_16, reaction_35 and as a product in reaction_8, reaction_14, reaction_15, reaction_40 and as a modifier in reaction_9, reaction_11, reaction_16, reaction_35).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S1} = v_{8} + v_{14} + v_{15} + v_{40} - v_{9} - v_{11} - v_{16} - v_{35} \tag{395}$$

9.39 Species S28

Name @nuc::dnapre5()

Notes Genes contributing to the formation of prereplication complexes.

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

This species takes part in three reactions (as a reactant in reaction_69 and as a product in reaction_68 and as a modifier in reaction_69).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{S28} = v_{68} - v_{69} \tag{396}$$

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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