SBML Model Report

Model name: “Smallbone2013 - Colon Crypt cycle - Version 1”

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Kieran Smallbone[2] at December first 2011 at no o’ clock in the morning. and last time modified at February 28th 2014 at 4:53 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	1
species types	0	species	3
events	0	constraints	0
reactions	7	function definitions	0
global parameters	13	unit definitions	6
rules	5	initial assignments	0

Model Notes

Smallbone2013 - Colon Crypt cycle - Version 1

This model is described in the article:A mathematical model of the colon crypt capturing compositional dynamic interactions between cell typesKieran Smallbone, Bernard M. CorfeInt J Exp Pathol. 2014 Feb;95(1):1-7.

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Abstract:

Models of the development and early progression of colorectal cancer are based upon understanding the cycle of stem cell turnover, proliferation, differentiation and death. Existing crypt compartmental models feature a linear pathway of cell types, with little regulatory mechanism. Previous work has shown that there are perturbations in the enteroendocrine cell population of macroscopically normal crypts, a compartment not included in existing models. We show that existing models do not adequately recapitulate the dynamics of cell fate pathways in the crypt. We report the progressive development, iterative testing and fitting of a developed compartmental model with additional cell types, and which includes feedback mechanisms and cross-regulatory mechanisms between cell types. The fitting of the model to existing data sets suggests a need to invoke cross-talk between cell types as a feature of colon crypt cycle models.

This model is hosted on BioModels Database and identifiedby: MODEL1306190001 .

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

2 Unit Definitions

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

2.1 Unit substance

Name cell

Definition item

2.2 Unit time

Name day

Definition 86400 s

2.3 Unit volume

Definition dimensionless

2.4 Unit per_day

Name per day

Definition $(86400\ \mathrm{s})^{-1}$

2.5 Unit `cell`

Name cell

Definition item

2.6 Unit `cell_per_day`

Name cell per_day

Definition $\text{item} \cdot (86400\ \text{s})^{-1}$

2.7 Unit `area`

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

Definition m^2

2.8 Unit `length`

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

Definition m

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`compartment`	crypt		3	1	dimensionless	☑	

3.1 Compartment `compartment`

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

Name crypt

4 Species

This model contains three species. Section 8 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
N0	N0	compartment	item $\cdot$ dimensionless^{-1}	⊟	⊟
N1	N1	compartment	item $\cdot$ dimensionless^{-1}	⊟	⊟
N2	N2	compartment	item $\cdot$ dimensionless^{-1}	⊟	⊟

5 Parameters

This model contains 13 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
d0			0.100	$(86400\ \mathrm{s})^{-1}$	☑
d1			0.420	$(86400\ \mathrm{s})^{-1}$	☑
d2			1.101	$(86400\ \mathrm{s})^{-1}$	☑
T	cellularity		0.000	item	☐
K	capacity		120.000	item	☑
r0			1.839	$(86400\ \mathrm{s})^{-1}$	☑
f0	N0 division rate		0.000	$\mathrm{item} \cdot (86400\ \mathrm{s})^{-1}$	☐
p00			0.000	dimensionless	☐
p01			0.856	dimensionless	☑
r1			5.880	$(86400\ \mathrm{s})^{-1}$	☑
f1	N1 division rate		0.000	$\mathrm{item} \cdot (86400\ \mathrm{s})^{-1}$	☐
p11			0.000	dimensionless	☐
p12			0.827	dimensionless	☑

6 Rules

This is an overview of five rules.

6.1 Rule T

Rule T is an assignment rule for parameter T:

$$\mathrm{T} = [\mathrm{N0}] + [\mathrm{N1}] + [\mathrm{N2}] \tag{1}$$

Derived unit item

6.2 Rule f0

Rule f0 is an assignment rule for parameter f0:

$$\mathrm{f0} = \mathrm{r0} \cdot [\mathrm{N0}] \cdot \left(1 - \frac{\mathrm{T}}{\mathrm{K}}\right) \tag{2}$$

6.3 Rule p00

Rule p00 is an assignment rule for parameter p00:

$$\mathrm{p00} = 1 - \mathrm{p01} \tag{3}$$

6.4 Rule `f1`

Rule `f1` is an assignment rule for parameter `f1`:

$$\mathrm{f1} = \mathrm{r1} \cdot [\mathrm{N1}] \cdot \left(1 - \frac{\mathrm{T}}{\mathrm{K}}\right) \tag{4}$$

6.5 Rule `p11`

Rule `p11` is an assignment rule for parameter `p11`:

$$\mathrm{p11} = 1 - \mathrm{p12} \tag{5}$$

7 Reactions

This model contains seven 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	`R0X`	N0 death	$\mathrm{N0} \xrightarrow{\mathrm{N0}} \emptyset$	
2	`R01`	N0 differentiation	$\mathrm{N0} \longrightarrow \mathrm{N0} + \mathrm{N1}$	
3	`R00`	N0 renewal	$\mathrm{N0} \longrightarrow 2\,\mathrm{N0}$	
4	`R1X`	N1 death	$\mathrm{N1} \xrightarrow{\mathrm{N1}} \emptyset$	
5	`R12`	N1 differentiation	$\mathrm{N1} \longrightarrow \mathrm{N1} + \mathrm{N2}$	
6	`R11`	N1 renewal	$\mathrm{N1} \longrightarrow 2\,\mathrm{N1}$	
7	`R2X`	N2 death	$\mathrm{N2} \xrightarrow{\mathrm{N2}} \emptyset$	

7.1 Reaction `R0X`

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

Name N0 death

Reaction equation

$$\mathrm{N0} \xrightarrow{\mathrm{N0}} \emptyset \tag{6}$$

Reactant

Table 6: Properties of each reactant.

Id	Name	SBO
`N0`	N0	

Modifier

Table 7: Properties of each modifier.

Id	Name	SBO
`N0`	N0	

Kinetic Law

Derived unit $(86400\ \mathrm{s})^{-1} \cdot \mathrm{item}$

$$v_1 = \mathrm{d0} \cdot [\mathrm{N0}] \tag{7}$$

7.2 Reaction `R01`

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

Name N0 differentiation

Reaction equation

$$\mathrm{N0} \longrightarrow \mathrm{N0} + \mathrm{N1} \tag{8}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
N0	N0	

Products

Table 9: Properties of each product.

Id	Name	SBO
N0	N0	
N1	N1	

Kinetic Law

Derived unit item $\cdot$ (86400 s)$^{-1}$

$$v_2 = \mathrm{p01} \cdot \mathrm{f0} \tag{9}$$

7.3 Reaction R00

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

Name N0 renewal

Reaction equation

$$\mathrm{N0} \longrightarrow 2\,\mathrm{N0} \tag{10}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
N0	N0	

Product

Table 11: Properties of each product.

Id	Name	SBO
N0	N0	

Id	Name	SBO

Kinetic Law

Derived unit $\mathrm{item} \cdot (86400\ \mathrm{s})^{-1}$

$$v_3 = \mathrm{p00} \cdot \mathrm{f0} \tag{11}$$

7.4 Reaction R1X

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

Name N1 death

Reaction equation

$$\mathrm{N1} \xrightarrow{\mathrm{N1}} \emptyset \tag{12}$$

Reactant

Table 12: Properties of each reactant.

Id	Name	SBO
N1	N1	

Modifier

Table 13: Properties of each modifier.

Id	Name	SBO
N1	N1	

Kinetic Law

Derived unit $(86400\ \mathrm{s})^{-1} \cdot \mathrm{item}$

$$v_4 = \mathrm{d1} \cdot [\mathrm{N1}] \tag{13}$$

7.5 Reaction R12

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

Name N1 differentiation

Reaction equation

$$\mathrm{N1} \longrightarrow \mathrm{N1} + \mathrm{N2} \tag{14}$$

Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
N1	N1	

Products

Table 15: Properties of each product.

Id	Name	SBO
N1	N1	
N2	N2	

Kinetic Law

Derived unit item $\cdot$ (86400 s)$^{-1}$

$$v_5 = \mathrm{p12} \cdot \mathrm{f1} \tag{15}$$

7.6 Reaction R11

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

Name N1 renewal

Reaction equation

$$\mathrm{N1} \longrightarrow 2\,\mathrm{N1} \tag{16}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
N1	N1	

Product

Table 17: Properties of each product.

Id	Name	SBO
N1	N1	

Kinetic Law

Derived unit item $\cdot$ (86400 s)$^{-1}$

$$v_6 = \mathrm{p11} \cdot \mathrm{f1} \tag{17}$$

7.7 Reaction R2X

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

Name N2 death

Reaction equation

$$\mathrm{N2} \xrightarrow{\mathrm{N2}} \emptyset \tag{18}$$

Reactant

Table 18: Properties of each reactant.

Id	Name	SBO
N2	N2	

Modifier

Table 19: Properties of each modifier.

Id	Name	SBO
N2	N2	

Kinetic Law

Derived unit (86400 s)$^{-1}$ $\cdot$ item

$$v_7 = \mathrm{d2} \cdot [\mathrm{N2}] \tag{19}$$

8 Derived Rate Equations

When interpreted as an ordinary differential equation framework, this model implies the following set of equations for the rates of change of each species.

8.1 Species N0

Name N0

Initial amount 1.75444831412765 item

This species takes part in six reactions (as a reactant in R0X, R01, R00 and as a product in R01, R00 and as a modifier in R0X).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{N0} = v_2 + 2v_3 - v_1 - v_2 - v_3 \tag{20}$$

8.2 Species N1

Name N1

Initial amount 27.40585059 item

This species takes part in seven reactions (as a reactant in R1X, R12, R11 and as a product in R01, R12, R11 and as a modifier in R1X).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{N1} = v_2 + v_5 + 2v_6 - v_4 - v_5 - v_6 \tag{21}$$

8.3 Species N2

Name N2

Initial amount 45.6191494109 item

This species takes part in three reactions (as a reactant in R2X and as a product in R12 and as a modifier in R2X).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{N2} = v_5 - v_7 \tag{22}$$

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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