SBML Model Report

Model name: “Perelson1993_HIVinfection-_CD4Tcells_ModelA”

April 21, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following three authors: Ethan Choi[1], Ethan Choi[2] and Ethan Choi[3] at June 25th 2010 at 1:37 p. m. and last time modified at June 25th 2010 at 1:37 p. m. Table 1 provides an overview of the quantities of all components of this model.

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

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	0
events	0	constraints	0
reactions	0	function definitions	0
global parameters	14	unit definitions	7
rules	5	initial assignments	0

Model Notes

This a model from the article:
Dynamics of HIV infection of CD4+ T cells.
Perelson AS, Kirschner DE, De Boer R. Math Biosci 1993 Mar;114(1):81-125 8096155 ,

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Abstract:
We examine a model for the interaction of HIV with CD4+ T cells that considersfour populations: uninfected T cells, latently infected T cells, activelyinfected T cells, and free virus. Using this model we show that many of thepuzzling quantitative features of HIV infection can be explained simply. We alsoconsider effects of AZT on viral growth and T-cell population dynamics. Themodel exhibits two steady states, an uninfected state in which no virus ispresent and an endemically infected state, in which virus and infected T cellsare present. We show that if N, the number of infectious virions produced peractively infected T cell, is less a critical value, Ncrit, then the uninfectedstate is the only steady state in the nonnegative orthant, and this state isstable. For N > Ncrit, the uninfected state is unstable, and the endemicallyinfected state can be either stable, or unstable and surrounded by a stablelimit cycle. Using numerical bifurcation techniques we map out the parameterregimes of these various behaviors. oscillatory behavior seems to lie outsidethe region of biologically realistic parameter values. When the endemicallyinfected state is stable, it is characterized by a reduced number of T cellscompared with the uninfected state. Thus T-cell depletion occurs through theestablishment of a new steady state. The dynamics of the establishment of thisnew steady state are examined both numerically and via the quasi-steady-stateapproximation. We develop approximations for the dynamics at early times inwhich the free virus rapidly binds to T cells, during an intermediate time scalein which the virus grows exponentially, and a third time scale on which viralgrowth slows and the endemically infected steady state is approached. Using thequasi-steady-state approximation the model can be simplified to two ordinarydifferential equations the summarize much of the dynamical behavior. We computethe level of T cells in the endemically infected state and show how that levelvaries with the parameters in the model. The model predicts that different viralstrains, characterized by generating differing numbers of infective virionswithin infected T cells, can cause different amounts of T-cell depletion andgenerate depletion at different rates. Two versions of the model are studied. Inone the source of T cells from precursors is constant, whereas in the other thesource of T cells decreases with viral load, mimicking the infection and killingof T-cell precursors.(ABSTRACT TRUNCATED AT 400 WORDS)

This model was taken from the CellML repository and automatically converted to SBML.
The original model was: **Perelson AS, Kirschner DE, De Boer R. (1993) - version=1.0**
The original CellML model was created by:
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To cite BioModels Database, please use: Li C, Donizelli M, Rodriguez N, Dharuri H, Endler L, Chelliah V, Li L, He E, Henry A, Stefan MI, Snoep JL, Hucka M, Le Novre N, Laibe C (2010) BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models. BMC Syst Biol., 4:92.

2 Unit Definitions

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

2.1 Unit day

Name day

Definition 86400 s

2.2 Unit per_day

Name per_day

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

2.3 Unit mm3

Name mm3

Definition mm^3

2.4 Unit per_mm3

Name per_mm3

Definition mm^{-3}

2.5 Unit per_day_mm3

Name per_day_mm3

Definition $(86400\ \mathrm{s})^{-1} \cdot \mathrm{mm}^{-3}$

2.6 Unit mm3_per_day

Name mm3_per_day

Definition $\mathrm{mm}^3 \cdot (86400\ \mathrm{s})^{-1}$

2.7 Unit `time`

Name time

Definition 86400 s

2.8 Unit `substance`

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

Definition mol

2.9 Unit `volume`

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

Definition l

2.10 Unit `area`

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

Definition m^2

2.11 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`			3	1		☑	

3.1 Compartment `COMpartment`

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

4 Parameters

This model contains 14 global parameters.

Table 3: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
s	s		10.000		☑
r	r		0.030		☑
T_max	T_max		1500.000		☑
mu_T	mu_T		0.020		☑
T	T		1000.000		☐
k_1	k_1		$2.4 \cdot 10^{-5}$		☑
T_1	T_1		0.000		☐
k_2	k_2		0.003		☑
mu_b	mu_b		0.240		☑
T_2	T_2		0.000		☐
mu_V	mu_V		2.400		☑
N	N		1400.000		☑
V	V		0.001		☐
T_tot	T_tot		0.000		☐

5 Rules

This is an overview of five rules.

5.1 Rule T

Rule T is a rate rule for parameter T:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T} = \mathrm{s} - \mathrm{mu\_T} \cdot \mathrm{T} + \mathrm{r} \cdot \mathrm{T} \cdot \left(1 - \frac{\mathrm{T} + \mathrm{T\_1} + \mathrm{T\_2}}{\mathrm{T\_max}}\right) - \mathrm{k\_1} \cdot \mathrm{V} \cdot \mathrm{T} \tag{1}$$

5.2 Rule T_1

Rule T_1 is a rate rule for parameter T_1:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T\_1} = \mathrm{k\_1} \cdot \mathrm{V} \cdot \mathrm{T} - \mathrm{mu\_T} \cdot \mathrm{T\_1} - \mathrm{k\_2} \cdot \mathrm{T\_1} \tag{2}$$

5.3 Rule T_2

Rule T_2 is a rate rule for parameter T_2:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{T\_2} = \mathrm{k\_2} \cdot \mathrm{T\_1} - \mathrm{mu\_b} \cdot \mathrm{T\_2} \tag{3}$$

5.4 Rule V

Rule V is a rate rule for parameter V:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{V} = \mathrm{N} \cdot \mathrm{mu\_b} \cdot \mathrm{T\_2} - \mathrm{k\_1} \cdot \mathrm{V} \cdot \mathrm{T} - \mathrm{mu\_V} \cdot \mathrm{V} \tag{4}$$

5.5 Rule T_tot

Rule T_tot is an assignment rule for parameter T_tot:

$$\mathrm{T\_tot} = \mathrm{T} + \mathrm{T\_1} + \mathrm{T\_2} \tag{5}$$