SBML Model Report

Model name: "Morris1981_MuscleFibre_Voltage_full"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by Lukas Endler[1] at March 31st 2011 at 0:20 a. m. and last time modified at April fourth 2014 at 2:05 p. m. Table 1 gives 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	21	unit definitions	6
rules	7	initial assignments	2

Model Notes

This is the full model (eq. 1 and 2) of the voltage oscillations in barnacle muscle fibers described in the article:
Voltage oscillations in the barnacle giant muscle fiber.
Morris C, Lecar H. Biophys J. 1981 Jul;35(1):193-213. PubmedID:7260316; DOI:10.1016/S0006-3495(81)84782-0

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Abstract:
Barnacle muscle fibers subjected to constant current stimulation produce a variety of types of oscillatory behavior when the internal medium contains the Ca++ chelator EGTA. Oscillations are abolished if Ca++ is removed from the external medium, or if the K+ conductance is blocked. Available voltage-clamp data indicate that the cell's active conductance systems are exceptionally simple. Given the complexity of barnacle fiber voltage behavior, this seems paradoxical. This paper presents an analysis of the possible modes of behavior available to a system of two noninactivating conductance mechanisms, and indicates a good correspondence to the types of behavior exhibited by barnacle fiber. The differential equations of a simple equivalent circuit for the fiber are dealt with by means of some of the mathematical techniques of nonlinear mechanics. General features of the system are (a) a propensity to produce damped or sustained oscillations over a rather broad parameter range, and (b) considerable latitude in the shape of the oscillatory potentials. It is concluded that for cells subject to changeable parameters (either from cell to cell or with time during cellular activity), a system dominated by two noninactivating conductances can exhibit varied oscillatory and bistable behavior.

The model consists of the differential equations (1) and (2) given on pages 195 and 196 of the article. There is one typo in the equation for I in (1), $g_L(V_L)$ should be $g_L(V - V_L)$. This was changed in the SBML file. As there are no current values given, for reproducing the time courses in figure 6 an applied current of 50 uA was assumed. The legend for the broken and the full line in this figure seems to be confounded in the article.

Originally created by libAntimony v1.4 (using libSBML 3.4.1)

2 Unit Definitions

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

2.1 Unit `time`

Name ms

Definition ms

2.2 Unit `per_ms`

Name per ms

Definition ms^{-1}

2.3 Unit `mV`

Name mV

Definition mV

2.4 Unit mS_per_cm2

Name mS_per_cm2

Definition $\mathrm{mS} \cdot \mathrm{cm}^{-2}$

2.5 Unit uA_per_cm2

Name microA_per_cm2

Definition $\mu\mathrm{A} \cdot \mathrm{cm}^{-2}$

2.6 Unit uF_per_cm2

Name microF per cm2

Definition $\mu\mathrm{F} \cdot \mathrm{cm}^{-2}$

2.7 Unit substance

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

Definition mol

2.8 Unit volume

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

Definition l

2.9 Unit area

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

Definition m^2

2.10 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
musclefibre		0000290	3	1	litre	☑	

3.1 Compartment musclefibre

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

SBO:0000290 physical compartment

4 Parameters

This model contains 21 global parameters.

Table 3: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Minf		0000498	0.0	dimensionless	⊟
V		0000259	−50.0	mV	⊟
V1		0000259	0.0	mV	☑
V2		0000002	15.0	mV	☑
Ninf		0000498	0.0	dimensionless	⊟
V3		0000259	10.0	mV	☑
V4		0000002	10.0	mV	☑
lambdaN		0000009	0.0	ms^{-1}	⊟
lambdaN_bar		0000009	0.1	ms^{-1}	☑
lambdaM		0000009	0.0	ms^{-1}	⊟
lambdaM_bar		0000009	1.0	ms^{-1}	☑
Iapp	I	0000002	50.0	$\mu A \cdot cm^{-2}$	☑
gL		0000257	2.0	$mS \cdot cm^{-2}$	☑
VL		0000259	−50.0	mV	☑
gCa		0000257	4.0	$mS \cdot cm^{-2}$	☑
VCa		0000259	100.0	mV	☑
gK		0000257	8.0	$mS \cdot cm^{-2}$	☑
N		0000498	0.0	dimensionless	⊟
VK		0000259	−70.0	mV	☑
C		0000258	20.0	$\mu F \cdot cm^{-2}$	☑
M		0000498	0.0	dimensionless	⊟

5 Initialassignments

This is an overview of two initialassignments.

5.1 Initialassignment N

Derived unit contains undeclared units

Math $\frac{1+\tanh\left(\frac{V-V3}{V4}\right)}{2}$

5.2 Initialassignment M

Derived unit contains undeclared units

Math $\frac{1+\tanh\left(\frac{V-V1}{V2}\right)}{2}$

6 Rules

This is an overview of seven rules.

6.1 Rule Minf

Rule Minf is an assignment rule for parameter Minf:

$$\mathrm{Minf} = \frac{1+\tanh\left(\frac{V-V1}{V2}\right)}{2} \tag{1}$$

6.2 Rule V

Rule V is a rate rule for parameter V:

$$\frac{d}{dt}V = \frac{\mathrm{Iapp} - gL\cdot(V-VL) - gCa\cdot M\cdot(V-VCa) - gK\cdot N\cdot(V-VK)}{C} \tag{2}$$

Derived unit $\mu A\cdot\mu F^{-1}$

6.3 Rule Ninf

Rule Ninf is an assignment rule for parameter Ninf:

$$\mathrm{Ninf} = \frac{1+\tanh\left(\frac{V-V3}{V4}\right)}{2} \tag{3}$$

6.4 Rule `lambdaN`

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

$$\text{lambdaN} = \text{lambdaN\_bar} \cdot \cosh\left(\frac{\text{V} - \text{V3}}{2 \cdot \text{V4}}\right) \tag{4}$$

Derived unit ms^{-1}

6.5 Rule `lambdaM`

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

$$\text{lambdaM} = \text{lambdaM\_bar} \cdot \cosh\left(\frac{\text{V} - \text{V1}}{2 \cdot \text{V2}}\right) \tag{5}$$

Derived unit ms^{-1}

6.6 Rule `N`

Rule `N` is a rate rule for parameter `N`:

$$\frac{\text{d}}{\text{d}t}\text{N} = \text{lambdaN} \cdot (\text{Ninf} - \text{N}) \tag{6}$$

Derived unit ms^{-1}

6.7 Rule `M`

Rule `M` is a rate rule for parameter `M`:

$$\frac{\text{d}}{\text{d}t}\text{M} = \text{lambdaM} \cdot (\text{Minf} - \text{M}) \tag{7}$$

Derived unit ms^{-1}

A Glossary of Systems Biology Ontology Terms

SBO:0000002 quantitative systems description parameter: A numerical value that defines certain characteristics of systems or system functions. It may be part of a calculation, but its value is not determined by the form of the equation itself, and may be arbitrarily assigned

SBO:0000009 kinetic constant: Numerical parameter that quantifies the velocity of a chemical reaction

SBO:0000257 conductance: Measure of how easily electricity flows along a certain path through an electrical element. The SI derived unit of conductance is the Siemens

SBO:0000258 capacitance: Measure of the amount of electric charge stored (or separated) for a given electric potential. The unit of capacitance id the Farad

SBO:0000259 voltage: Difference of electrical potential between two points of an electrical network, expressed in volts

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

SBO:0000498 relative activity: Value which ranges from 0 to 1, to describe the relative activity of a process or reaction.

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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