SBML Model Report

Model name: “Morris1981_MuscleFibre_Voltage_reduced”

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: Nicolas Le Novre[1] and Lukas Endler[2] at November 24th 2010 at 2:13 a. m. and last time modified at April eighth 2016 at 4:51 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	0
events	0	constraints	0
reactions	0	function definitions	0
global parameters	18	unit definitions	6
rules	5	initial assignments	1

Model Notes

This is the **reduced** model of the voltage oscillations in barnacle muscle fibers, generally known as the Morris-Lecar model (eg. wikipedia), described in the article:
Voltage oscillations in the barnacle giant muscle fiber.

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Morris C, Lecar H. Biophys J. 1981 Jul;35(1):193-213. PubmedID:7260316; DOI:10.1016/S0006-3495(81)84782-0

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 (9) and (2) given on pages 205 and 196 of the article. There seems to be a typo in the figure caption of figure 9. Using V2 = 15 instead of -15 allows to reproduce the results.

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
musclefiber			3	1	litre	☑	

3.1 Compartment musclefiber

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

4 Parameters

This model contains 18 global parameters.

Table 3: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Minf			0.000	dimensionless	☐
V		0000259	−50.000	mV	☐
V1		0000259	10.000	mV	☑
V2		0000259	15.000	mV	☑
Ninf			0.000	dimensionless	☐
V3		0000259	−1.000	mV	☑
V4		0000259	14.500	mV	☑
lambdaN			0.000	ms^{-1}	☐
lambdaN_bar			0.067	ms^{-1}	☑
Iapp			300.000	$\mu\mathrm{A}\cdot\mathrm{cm}^{-2}$	☑
gL		0000257	2.000	$\mathrm{mS}\cdot\mathrm{cm}^{-2}$	☑
VL		0000259	−50.000	mV	☑
gCa		0000257	4.000	$\mathrm{mS}\cdot\mathrm{cm}^{-2}$	☑
VCa		0000259	100.000	mV	☑
gK		0000257	8.000	$\mathrm{mS}\cdot\mathrm{cm}^{-2}$	☑
N			0.000	dimensionless	☐
VK		0000259	−70.000	mV	☑
C		0000258	20.000	$\mu\mathrm{F}\cdot\mathrm{cm}^{-2}$	☑

5 Initialassignment

This is an overview of one initialassignment.

5.1 Initialassignment `N`

Derived unit contains undeclared units

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

6 Rules

This is an overview of five rules.

6.1 Rule `Minf`

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

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

6.2 Rule `V`

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

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

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

6.3 Rule `Ninf`

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

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

6.4 Rule `lambdaN`

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

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

Derived unit ms^{-1}

6.5 Rule `N`

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

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{N} = \mathrm{lambdaN}\cdot(\mathrm{Ninf}-\mathrm{N}) \tag{5}$$

Derived unit ms^{-1}

A Glossary of Systems Biology Ontology Terms

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

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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