**SBML Model Report**

# Model name: "Wierschem2004 - Electrical bursting activity in Pancreatic Islets"

May 17, 2018

## 1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Ethan Choi[1] and Matthew Grant Roberts[2] at June 25$^{\text{th}}$ 2010 at 12:07 a. m. and last time modified at March 14$^{\text{th}}$ 2018 at 9:28 a. 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 | 34 | unit definitions | 11 |
| rules | 14 | initial assignments | 0 |

### Model Notes

This a model from the article:
**Complex bursting in pancreatic islets: a potential glycolytic mechanism.**
Wierschem K, Bertram R. J Theor Biol 2004 Jun 21;228(4):513-21 15178199 ,
**Abstract:**

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The electrical activity of insulin-secreting pancreatic islets of Langerhans ischaracterized by bursts of action potentials. Most often this bursting isperiodic, but in some cases it is modulated by an underlying slower rhythm. Wesuggest that the modulatory rhythm for this complex bursting pattern is due tooscillations in glycolysis, while the bursting itself is generated by some otherslow process. To demonstrate this hypothesis, we couple a minimal model ofglycolytic oscillations to a minimal model for activity-dependent bursting inislets. We show that the combined model can reproduce several complex burstingpatterns from mouse islets published in the literature, and we illustrate howthese complex oscillations are produced through the use of a fast/slow analysis.

This model was taken from the CellML repository and automatically converted to SBML.
The original model was: **Wierschem K, Bertram R. () - version=1.0**
The original CellML model was created by:
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## 2 Unit Definitions

This is an overview of 15 unit definitions of which four are predefined by SBML and not mentioned in the model.

### 2.1 Unit `millisecond`

**Name** millisecond

**Definition** ms

### 2.2 Unit `per_millisecond`

**Name** per_millisecond

**Definition** $\mathrm{ms}^{-1}$

### 2.3 Unit `millivolt`

**Name** millivolt

**Definition** mV

### 2.4 Unit `picosiemens`

**Name** picosiemens

**Definition** pS

### 2.5 Unit `per_litre`

**Name** per_litre

**Definition** $\mathrm{l}^{-1}$

### 2.6 Unit `micromolar`

**Name** micromolar

**Definition** $\mu\mathrm{mol} \cdot \mathrm{l}^{-1}$

### 2.7 Unit `femtoampere`

**Name** femtoampere

**Definition** fA

### 2.8 Unit `micromolar_per_fA_ms`

**Name** micromolar_per_fA_ms

**Definition** $\mu\mathrm{mol} \cdot \mathrm{l}^{-1} \cdot \mathrm{fA}^{-1} \cdot \mathrm{ms}^{-1}$

### 2.9 Unit `micromolar_per_ms`

**Name** micromolar_per_ms

**Definition** $\mu\mathrm{mol} \cdot \mathrm{l}^{-1} \cdot \mathrm{ms}^{-1}$

### 2.10 Unit `femtofarad`

**Name** femtofarad

**Definition** fF

### 2.11 Unit `time`

**Name** time

**Definition** ms

### 2.12 Unit `substance`

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

**Definition** mol

### 2.13 Unit `volume`

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

**Definition** l

### 2.14 Unit `area`

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

**Definition** $m^2$

### 2.15 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` | Pancreatic Islet Cell | | 3 | 1 | | ☑ | |

### 3.1 Compartment `COMpartment`

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

**Name** Pancreatic Islet Cell

# 4 Parameters

This model contains 34 global parameters.

Table 3: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant |
|---|---|---|---|---|---|
| tau_c | tau_c | | 1200.000 | | ☑ |
| eta | eta | | 185.000 | | ☑ |
| v | v | | 10.000 | | ☑ |
| k | k | | 20.000 | | ☑ |
| phi | phi | | 15.530 | | ☐ |
| ADP | ADP | | 0.086 | | ☐ |
| ATP | ATP | | 2.105 | | ☐ |
| C_m | C_m | | 5300.000 | | ☑ |
| V_membrane | V | | $-67.018$ | | ☐ |
| g_Ca_ | g_Ca_ | | 1200.000 | | ☑ |
| V_Ca | V_Ca | | 25.000 | | ☑ |
| v_m | v_m | | $-20.000$ | | ☑ |
| s_m | s_m | | 12.000 | | ☑ |
| m_infinity | m_infinity | | 0.019 | | ☐ |
| I_Ca | I_Ca | | $-2152.127$ | | ☐ |
| g_K_ | g_K_ | | 3000.000 | | ☑ |
| V_K | V_K | | $-75.000$ | | ☑ |
| I_K | I_K | | 2.634 | | ☐ |
| g_KCa_ | g_KCa_ | | 300.000 | | ☑ |
| k_D | k_D | | 0.300 | | ☑ |
| omega | omega | | 0.343 | | ☐ |
| I_KCa | I_KCa | | 821.482 | | ☐ |
| g_KATP_ | g_KATP_ | | 350.000 | | ☑ |
| I_KATP | I_KATP | | 1327.363 | | ☐ |
| tau_n | tau_n | | 16.000 | | ☑ |
| v_n | v_n | | $-16.000$ | | ☑ |
| s_n | s_n | | 5.600 | | ☑ |
| n_infinity | n_infinity | | $1.10503026085849 \cdot 10^{-4}$ | | ☐ |
| n | n | | $1.1 \cdot 10^{-4}$ | | ☐ |
| c | c | | 0.157 | | ☐ |
| f | f | | 0.001 | | ☑ |
| alpha | alpha | | $2.25 \cdot 10^{-6}$ | | ☑ |
| k_c | k_c | | 0.100 | | ☑ |
| J_mem | J_mem | | $-1.08237146404908 \cdot 10^{-5}$ | | ☐ |

# 5 Rules

This is an overview of 14 rules.

## 5.1 Rule I_KATP

Rule I_KATP is an assignment rule for parameter I_KATP:

$$\mathrm{I\_KATP} = \frac{(\mathrm{V\_membrane} - \mathrm{V\_K}) \cdot \mathrm{g\_KATP\_}}{\mathrm{ATP}} \tag{1}$$

## 5.2 Rule n_infinity

Rule n_infinity is an assignment rule for parameter n_infinity:

$$\mathrm{n\_infinity} = \frac{1}{1 + \exp\left(\frac{\mathrm{v\_n} - \mathrm{V\_membrane}}{\mathrm{s\_n}}\right)} \tag{2}$$

## 5.3 Rule omega

Rule omega is an assignment rule for parameter omega:

$$\mathrm{omega} = \frac{1}{1 + \frac{\mathrm{k\_D}}{\mathrm{c}}} \tag{3}$$

## 5.4 Rule phi

Rule phi is an assignment rule for parameter phi:

$$\mathrm{phi} = \mathrm{ATP} \cdot (1 + \mathrm{k} \cdot \mathrm{ADP})^2 \tag{4}$$

## 5.5 Rule I_K

Rule I_K is an assignment rule for parameter I_K:

$$\mathrm{I\_K} = \mathrm{g\_K\_} \cdot \mathrm{n} \cdot (\mathrm{V\_membrane} - \mathrm{V\_K}) \tag{5}$$

## 5.6 Rule I_KCa

Rule I_KCa is an assignment rule for parameter I_KCa:

$$\mathrm{I\_KCa} = \mathrm{g\_KCa\_} \cdot \mathrm{omega} \cdot (\mathrm{V\_membrane} - \mathrm{V\_K}) \tag{6}$$

## 5.7 Rule m_infinity

Rule m_infinity is an assignment rule for parameter m_infinity:

$$\mathrm{m\_infinity} = \frac{1}{1 + \exp\left(\frac{\mathrm{v\_m} - \mathrm{V\_membrane}}{\mathrm{s\_m}}\right)} \tag{7}$$

## 5.8 Rule I_Ca

Rule I_Ca is an assignment rule for parameter I_Ca:

$$\mathrm{I\_Ca} = \mathrm{g\_Ca\_} \cdot \mathrm{m\_infinity} \cdot (\mathrm{V\_membrane} - \mathrm{V\_Ca}) \tag{8}$$

## 5.9 Rule J_mem

Rule J_mem is an assignment rule for parameter J_mem:

$$\mathrm{J\_mem} = \mathrm{f} \cdot (\mathrm{alpha} \cdot \mathrm{I\_Ca} + \mathrm{k\_c} \cdot \mathrm{c}) \tag{9}$$

## 5.10 Rule ADP

Rule ADP is a rate rule for parameter ADP:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ADP} = \frac{\mathrm{phi} - \mathrm{eta} \cdot \mathrm{ADP}}{1000 \cdot \mathrm{tau\_c}} \tag{10}$$

## 5.11 Rule ATP

Rule ATP is a rate rule for parameter ATP:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{ATP} = \frac{\mathrm{v} - \mathrm{phi}}{1000 \cdot \mathrm{tau\_c}} \tag{11}$$

## 5.12 Rule V_membrane

Rule V_membrane is a rate rule for parameter V_membrane:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{V\_membrane} = \frac{(\mathrm{I\_Ca} + \mathrm{I\_K} + \mathrm{I\_KCa} + \mathrm{I\_KATP})}{\mathrm{C\_m}} \tag{12}$$

## 5.13 Rule n

Rule n is a rate rule for parameter n:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{n} = \frac{\mathrm{n\_infinity} - \mathrm{n}}{\mathrm{tau\_n}} \tag{13}$$

## 5.14 Rule c

Rule c is a rate rule for parameter c:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{c} = \mathrm{J\_mem} \tag{14}$$

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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