

# SBML support of E-Cell version 3.1.103

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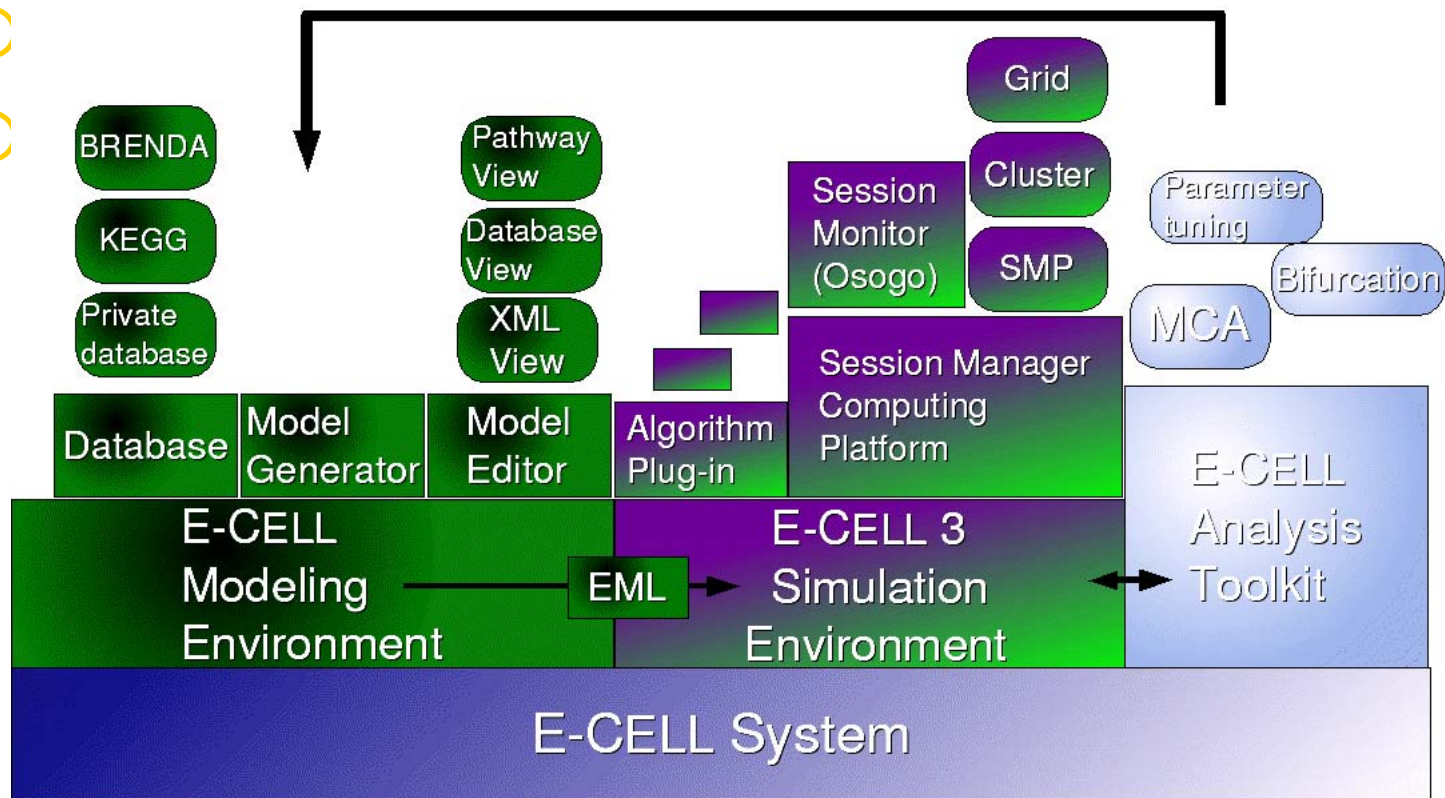
# E-Cell System



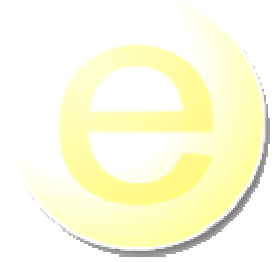
● An Integrated system software for the..

○ Modeling

○  
○



# The seven requirements for cell simulation software



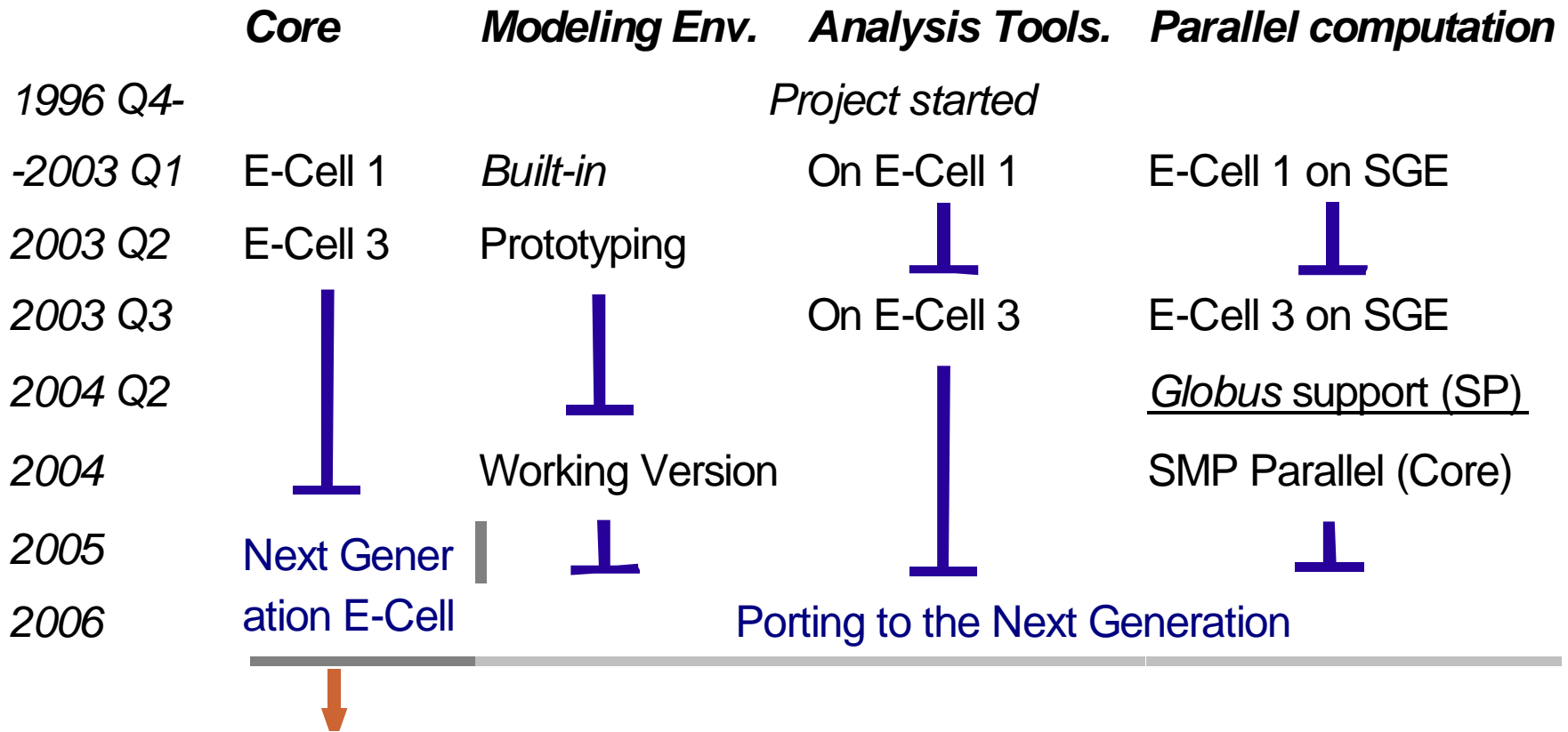
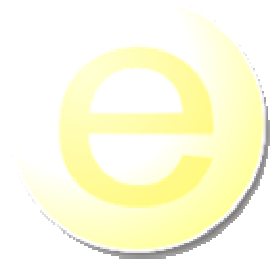
- 1) Multi-algorithm simulation
- 2) Object-oriented modeling
- 3) Object-oriented simulation
- 4) Real-time interaction
- 5) Common spatial information interface
- 6) Multi-timescale simulation
- 7) Mixed continuous/discrete simulation

(K. Takahashi et.al., IEEE Intelligent Systems, Sep/Oct 2002)



The aim of E-Cell System development

# Overview of the development



# Version 3.1.103



- Platform: Linux (FC2), WindowsXP
- New GUI front-end (more affordable, support phase plotting)
- SBML supported version (libSBML module is needed)
- Added algorithm module for tauleap
- Optimization of ODE/DAE switching

<http://www.e-cell.org/software>

**E-Cell Session Monitor**

File Tools View Preferences Help

Load Script Save EntityList Logger Stepper Interface Board Message Speed Timer

Start Step Simulator Time [s] 519.51

All systems ID contains Find Clear

System (1/1)

- CELL
  - CYTOPLASM
  - MEMBRANE

Variable (1/62)

ID	Process (0/88)
CRHR_CRF	42011
Ca	23811
Ca_AA_PKC	9:
Ca_DAG_PKC	817:
Ca_PIP2_PLA2	1:
Ca_PKC	94:
Ca_PLA2	9:
DAG	266977:
PKC_AA_PKC	100:

Process (0/88)

ID
AA_APC
AA_PKC_N
AA_PKC_PKC
ADD
ADDCa
ADDGlu
AMPAR_AMPAR_P1
AMPAR_AMPAR_P2

Variable Property

FullID: Variable:/CELL/CYTOPLASM:Ca

Summary Properties

Name: Ca  
ClassName: Variable

Quantities (Not Fixed)

Value: 23810.8230305

Concentrations

Molar	Number
3.95388285199e-008	2.38108230305e+016

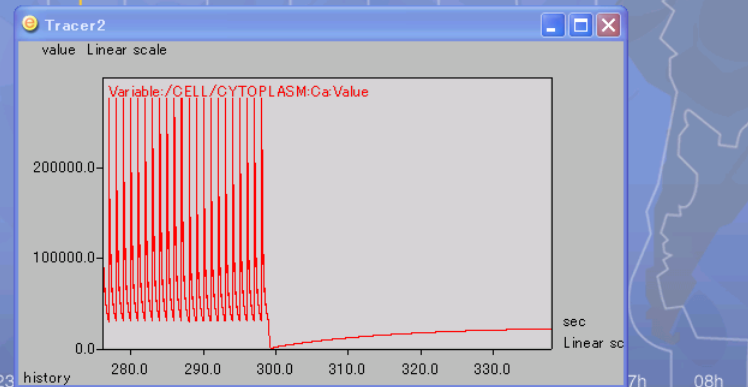
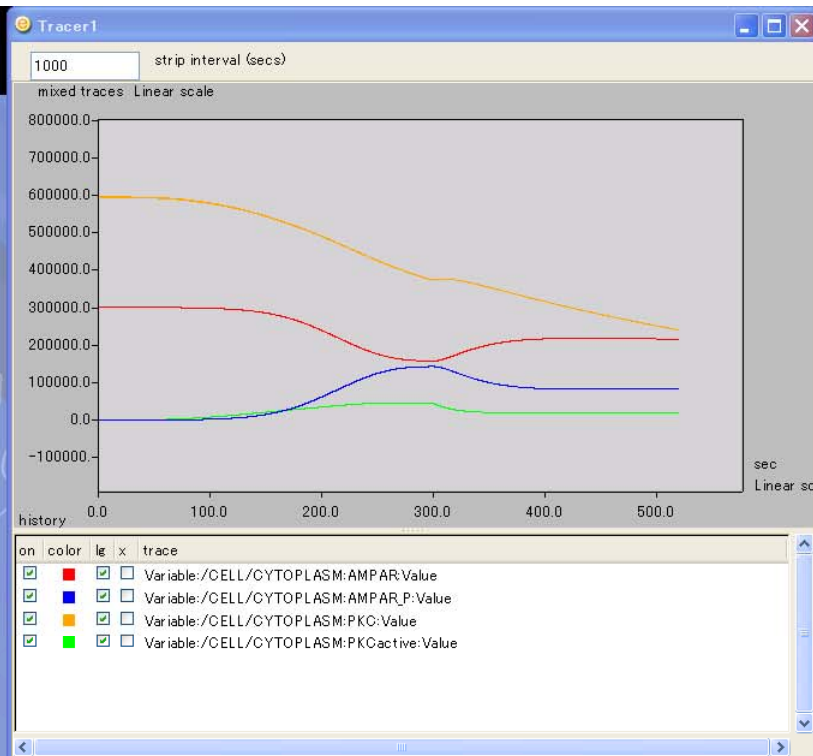
Velocities

Total Velocity	Velocity
-7.9018070056	-7.90166808414

TracerWindow View Selected

Message

519.51-Stop



GMT

12h 13h 14h 15h 16h 17h 18h 19h 20h 21h 22h 23h 7h 08h

スタート E-Cell Session Monit... Tracer1 Tracer2

caps KANA 100%

251

# Implementation for SBML support



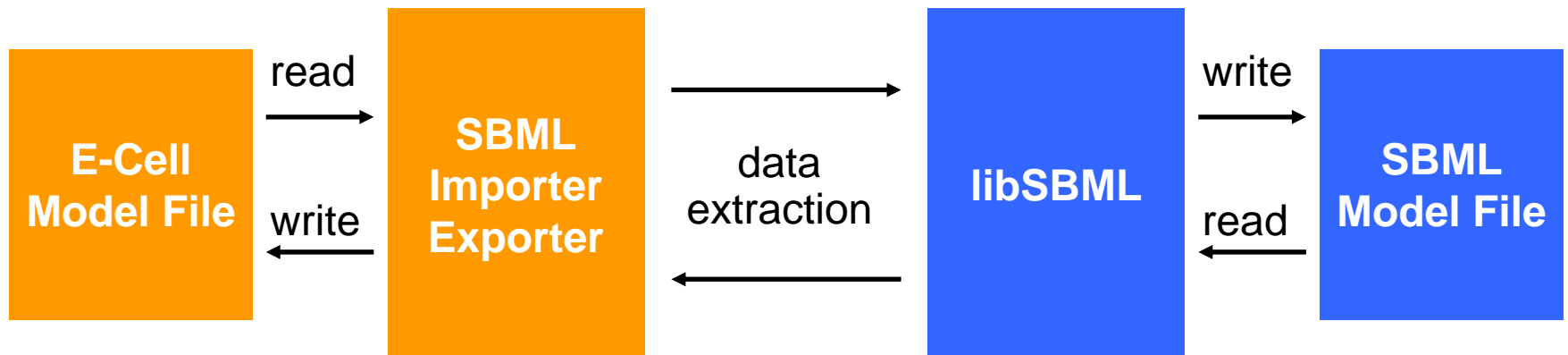
- SBML importer/exporter
  - Bidirectional conversion, SBML model to E-Cell Model Using libSBML with SWIG wrapper
- ExpressionFluxProcess/PythonProcess
  - New algorithm module for processing reaction entries in SBML Model

# SBML importer/exporter



- SBML Importer / exporter

- Convert the ontology of SBML to the E-Cell model
- developed using Python and libSBML (with SWIG wrapper)



# New plug-in modules for SBML support



## SBML

### Kinetic Formula, Rule

```
( Vmax * kP * CaPump_PM *  
  ( Ca_C * Ca_Rest ) )
```

Import



## E-Cell

Export



### Expression

```
( Vmax * kP *  
  CaPump_PM.MolarConc *  
  ( Ca_C.MolarConc * Ca_Rest ) )
```

## Algorithm modules

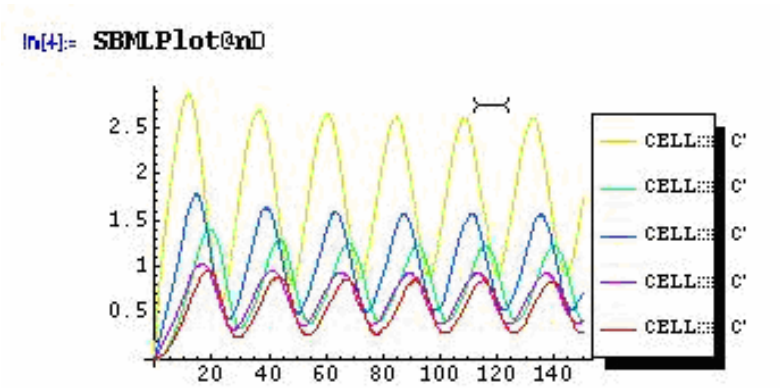
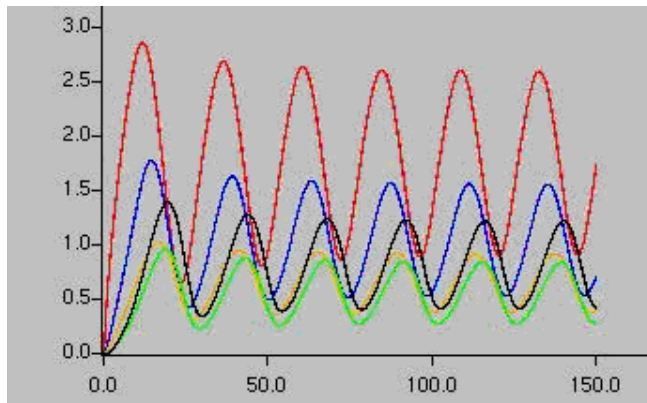
### PythonProcess

- Process the Python script
- More flexible
- Low-speed

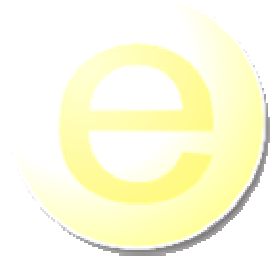
### ExpressionFluxProcess

- Self compiler to process simple expression written in C++ style
- High-speed but terms are restricted

# Interoperability using SBML



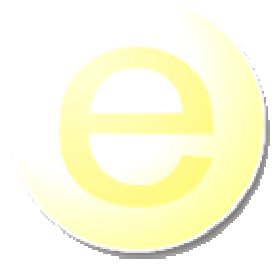
# Current status



<b><i>Level</i></b>	<b><i>Ver.</i></b>	<b><i>Status</i></b>
<b>1</b>	<b>1</b>	<b><i>Supported</i></b>
<b>1</b>	<b>2</b>	<b><i>Supported</i></b>
<b>2</b>	<b>1</b>	<b><i>Supported*</i></b>
<b>2</b>	<b>2</b>	<b><i>Will be support</i></b> 😊
<b>3</b>	<b>1</b>	<b><i>Will be support</i></b>

\*Event and Function definition partially supported

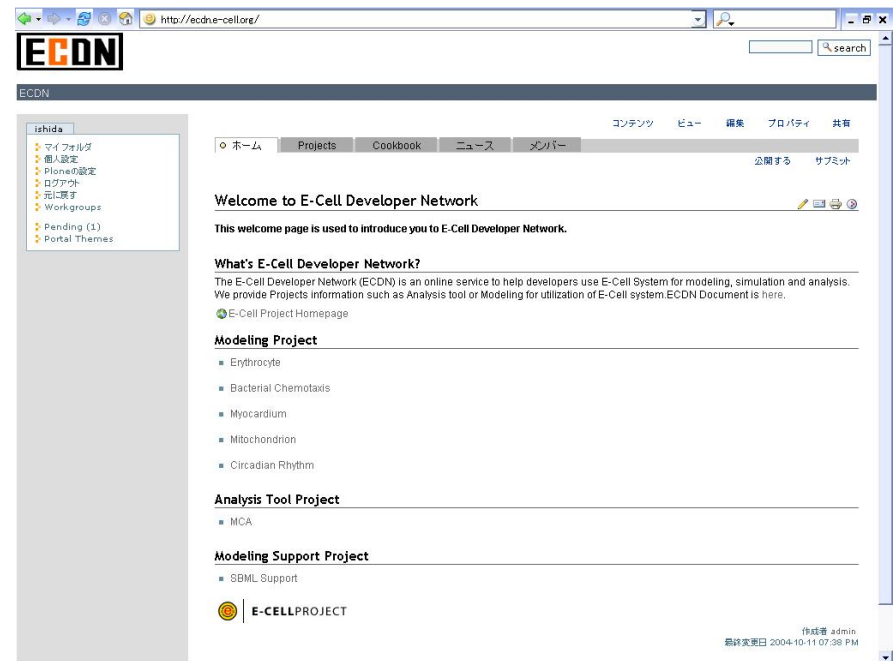
# ECDN.e-cell.org



- Model repository
- Issue tracker
- Mailing list
- CVS
- Modelers's cookbook

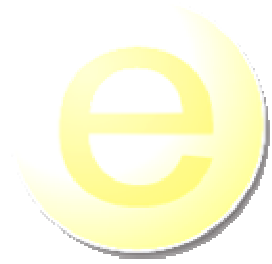
## Projects

- Circadian Rhythm
- Mitochondrion
- Myocardium
- Bacterial Chemotaxis
- Erythrocyte
- MCA tools
- SBML Support



The E-Cell Developer Network top page

# Model repository



## Contents

- Model Name
- Author
- Reference
- Model Description
- Links (SBML model repository)
- Model file (E-Cell, SBML)

Model Name	Reference	Model File	
CellCycle-1991Gol (Goldbeter, 1991)	Goldbeter, A. A minimal cascade model for the mitotic oscillator involving cyclin and cdc2 kinase. <a href="#">Proc. Natl. Acad. Sci. USA 88: 9107-1101 (1991)</a>	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
CellCycle-1991Tys (Tyson, 1991)	Tyson JJ. Modeling the cell division cycle: cdc2 and cyclin interactions. <a href="#">PNAS, 88: 7328-7332 (1991)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
CellCycle-1991Tys-2 (Tyson, 1991)	Tyson JJ. Modeling the cell division cycle: cdc2 and cyclin interactions. <a href="#">PNAS, 88: 7328-7332 (1991)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
CellCycle-1997Nov (Novak & Tyson, 1997)	Novak B, Tyson JJ. Modeling the control of DNA replication in fission yeast, <a href="#">PNAS, USA, 94:9147-9152 (1997)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ]
CellCycle-1998Gar (Gardner et al., 1998)	Gardner TS, Dolnik M, Collins JJ. A theory for controlling cell cycle dynamics using a reversibly binding inhibitor. <a href="#">PNAS 95: 14190-14195 (1998)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ]
CircClock-1999Lei (Leloup & Goldbeter, 1999)	Leloup J-C, Goldbeter A. Chaos and birhythmicity in a model of circadian oscillations of the PER and TIM proteins in Drosophila. <a href="#">J Theor Biol 198: 445 - 459 (1999)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ]
CircClock-2001Ued (Ueda et al, 2001)	Ueda HR, Hagiwara M, Kitano H. Robust oscillations within the interlocked feedback model of Drosophila circadian rhythm. <a href="#">J Theor Biol 210: 401-406 (2001)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ]
CircClock-2002Vil (Vilar et al, 2002)	Vilar JMG, Kueh HY, Barkai N, Leibler S. Mechanisms of noise resistance in genetic oscillators, <a href="#">PNAS, 99(9):5988-5992 (2002)</a> .	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
ElectroPhys-1952Hod (Hodgkin & Huxley, 1952)	Hodgkin A L & Huxley A F. A quantitative description of membrane current and its application to conduction and excitation in nerve. <a href="#">A quantitative description of membrane current and its application to conduction and excitation in nerve.</a>	E-Cell	[ <a href="#">DOWNLOAD</a> ] [ <a href="#">DESCRIPTION</a> ]
		SBML	[ <a href="#">DOWNLOAD</a> ]

Models from SBML support project



# Future prospects

- More speed up: ExpressionFluxProcess by JIT (Just in compiler)
- SBML Lv2 ver.2 full support
- Provide useful tools/information on ECDN for..
  - Analyze the simulation result
  - Management system for modeling project

# Acknowledgements



- Member of Keio University, IAB
  - Tatsuya Ishida
  - Satya Arjunan
  - Dr. Kouichi Takahashi
  - Prof. Masaru Tomita
- libSBML development team
- JST
- NEDO