Updates about SBML

Michael Hucka, Ph.D.

Department of Computing + Mathematical Sciences
California Institute of Technology
Pasadena, CA, USA

(on behalf of many people)

Email: mhucka@caltech.edu *Twitter: @mhucka*

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Outline

Brief summary of SBML for the unfamiliar

Recent development in Level 3 packages

Recent developments in the SBML Test Suite

Closing

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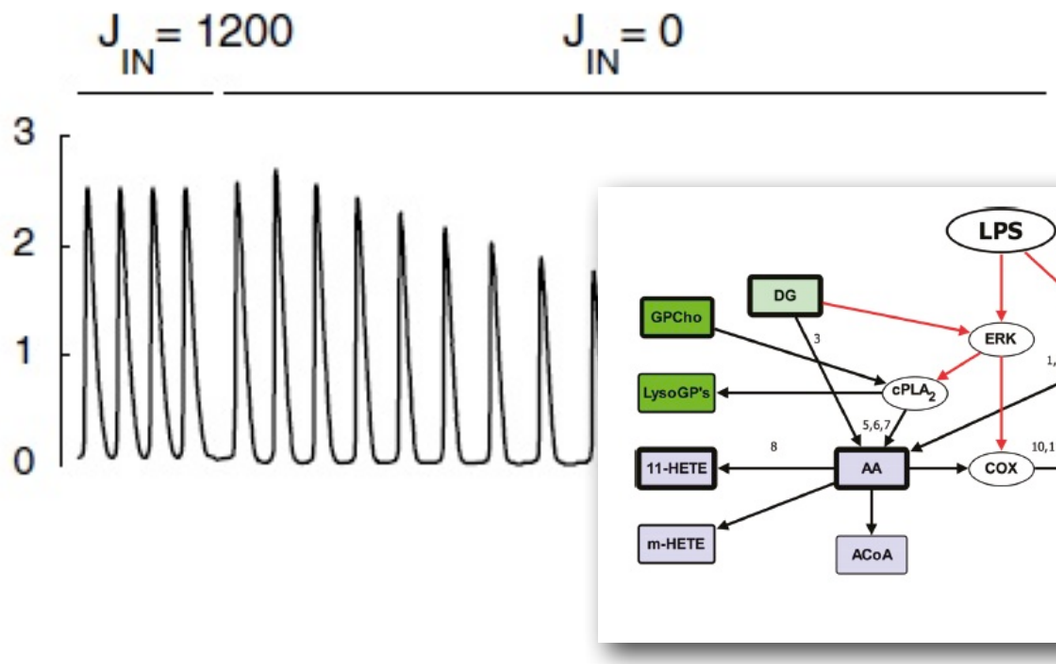
What are the outcomes of modeling and simulation?

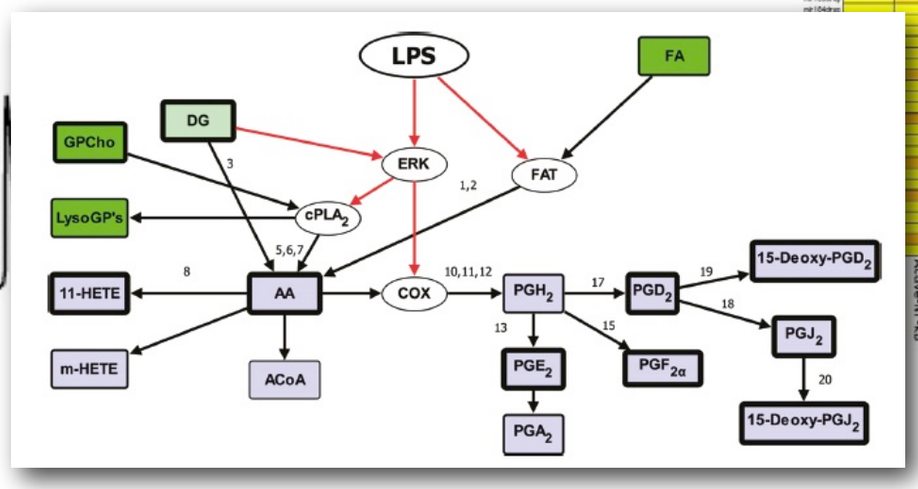
Usually, there are at least two scientific outcomes:

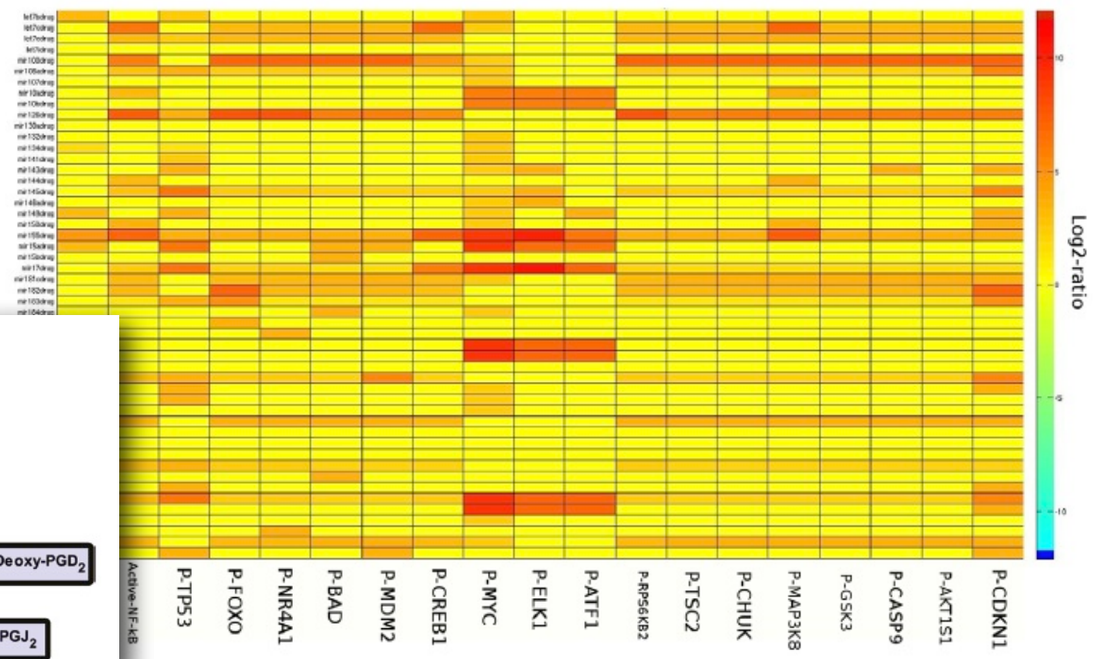
- One or more models (+ associated claims about their behaviors)
- Publication of the results (in some form)

Models come in many forms

$$dx_1/dt = -k_{12}[\mathrm{G}]_{\mathrm{out}}\,x_1 + k_{21}x_2 + k_{41}x_4 - k_{14}x_1,$$
$$dx_2/dt = k_{12}[\mathrm{G}]_{\mathrm{out}}\,x_1 - k_{21}x_2 - k_{23}x_2 + k_{32}x_3,$$
$$dx_3/dt = k_{23}x_2 - k_{32}x_3 - k_{34}x_3 + k_{43}[\mathrm{G}]_{\mathrm{in}}\,x_4,$$
$$dx_4/dt = k_{34}x_3 - k_{43}[\mathrm{G}]_{\mathrm{in}}\,x_4 - k_{41}x_4 + k_{14}x_1.$$







Models a fundamentally important scientific work product

Models serve as **statements of our current understanding** of the phenomena being studied*

- A computational model documents your theory in a concrete form

Model can—

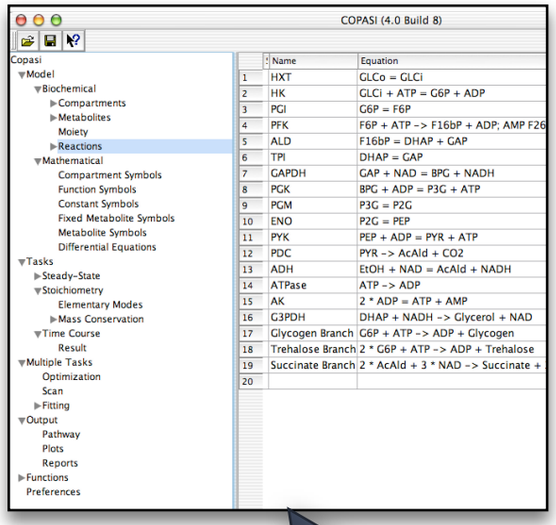
- **Reduce ambiguity** in communication
- Offer a **concrete framework** for adding new data and theories
- **Support direct evaluation** of relationships between theories

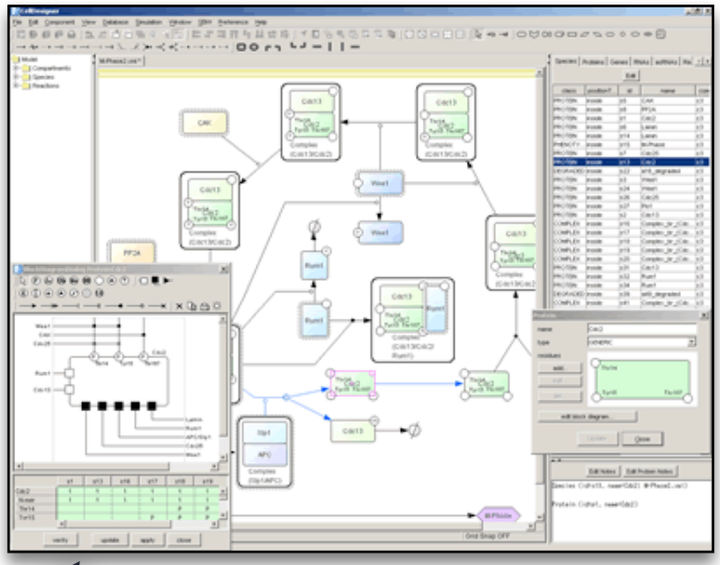
Bower & Bolouri, Computational modeling of genetic and biochemical networks, MIT Press, 2001

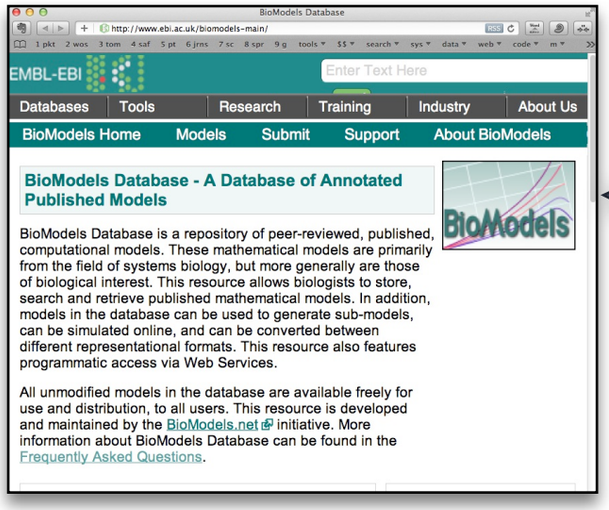
Different tools ⇒ different representation languages

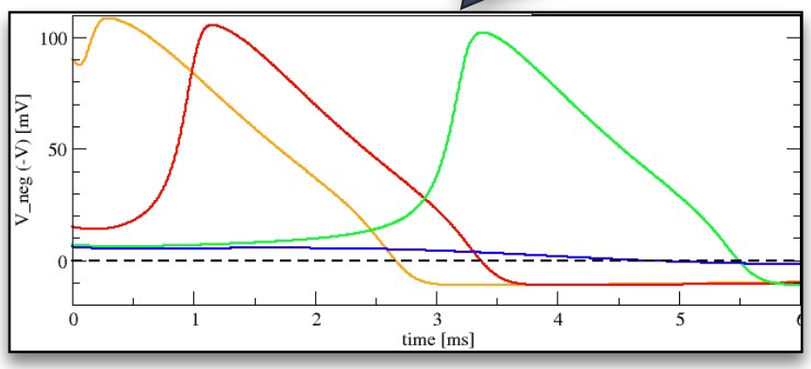
Communication is better with interoperable data formats

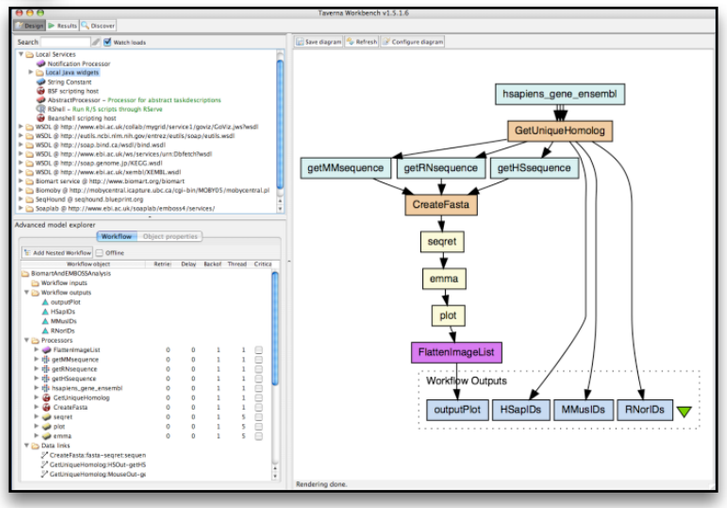
SBML: a lingua franca for software











SBML = Systems Biology Markup Language

Format for **representing** computational models of biological processes

- Data structures + usage principles + serialization to XML

Neutral with respect to modeling framework

- E.g., ODE, stochastic systems, etc.

Development started in 2000, with first specification distributed in 2001

The **process** is central

- Called a “reaction” in SBML
- Participants are pools of entities (**species**)

Models can further include:

- Other constants & variables
- Compartments
- Explicit math
- Discontinuous events
- Unit definitions
- Annotations

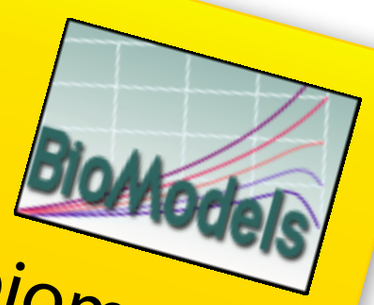
Basic SBML concepts are fairly simple

Today: spatially homogeneous models

- Metabolic network models
- Signaling pathway models
- Conductance-based models
- Neural models
- Pharmacokinetic/dynamics models
- Infectious diseases

Find examples in BioModels Database

http://biomodels.net/biomodels



Coming: SBML Level 3 *packages* to support other types

- E.g.: Spatially inhomogeneous models, also qualitative/logical

Scope of SBML encompasses many types of models

Find software in the SBML Software Guide

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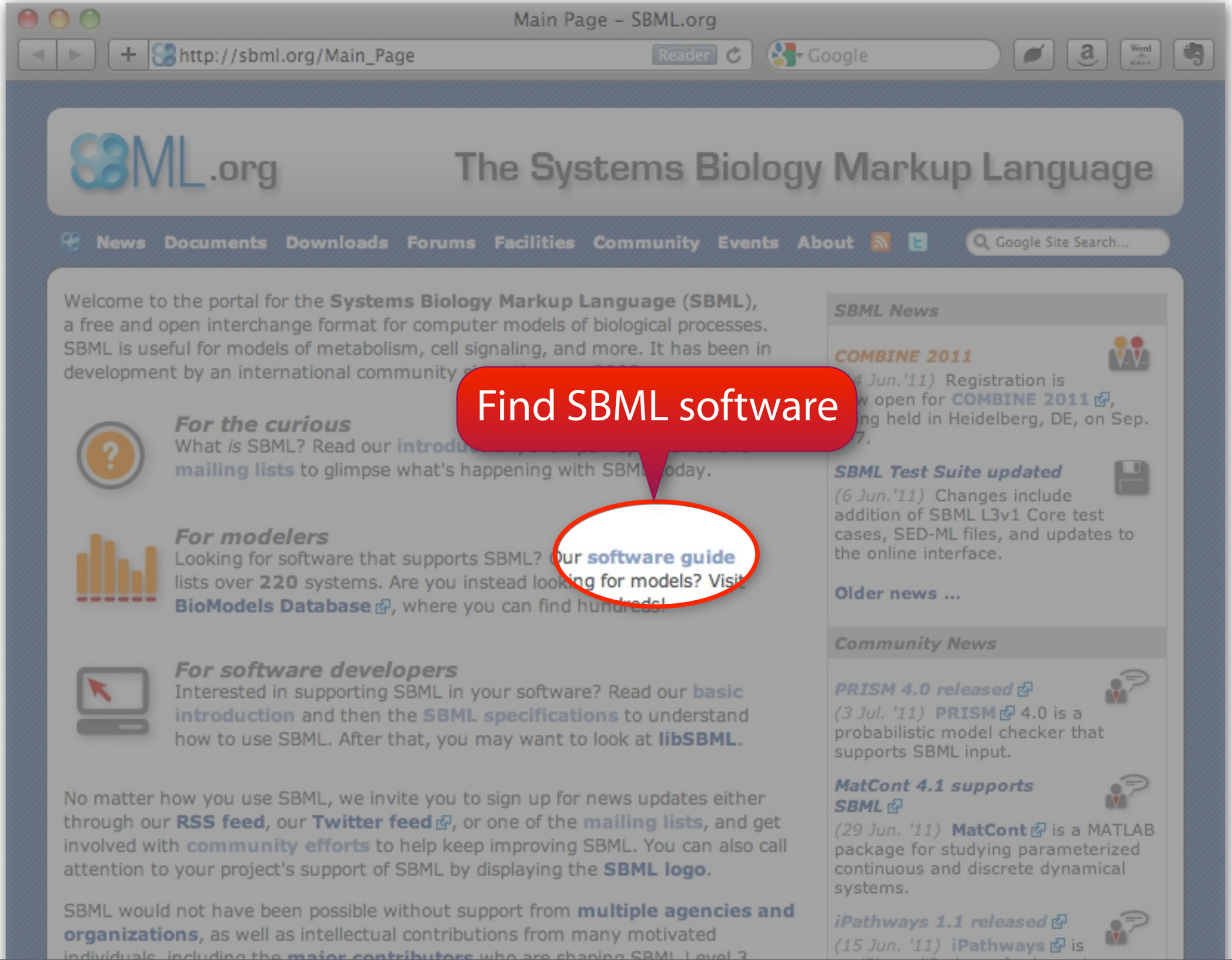
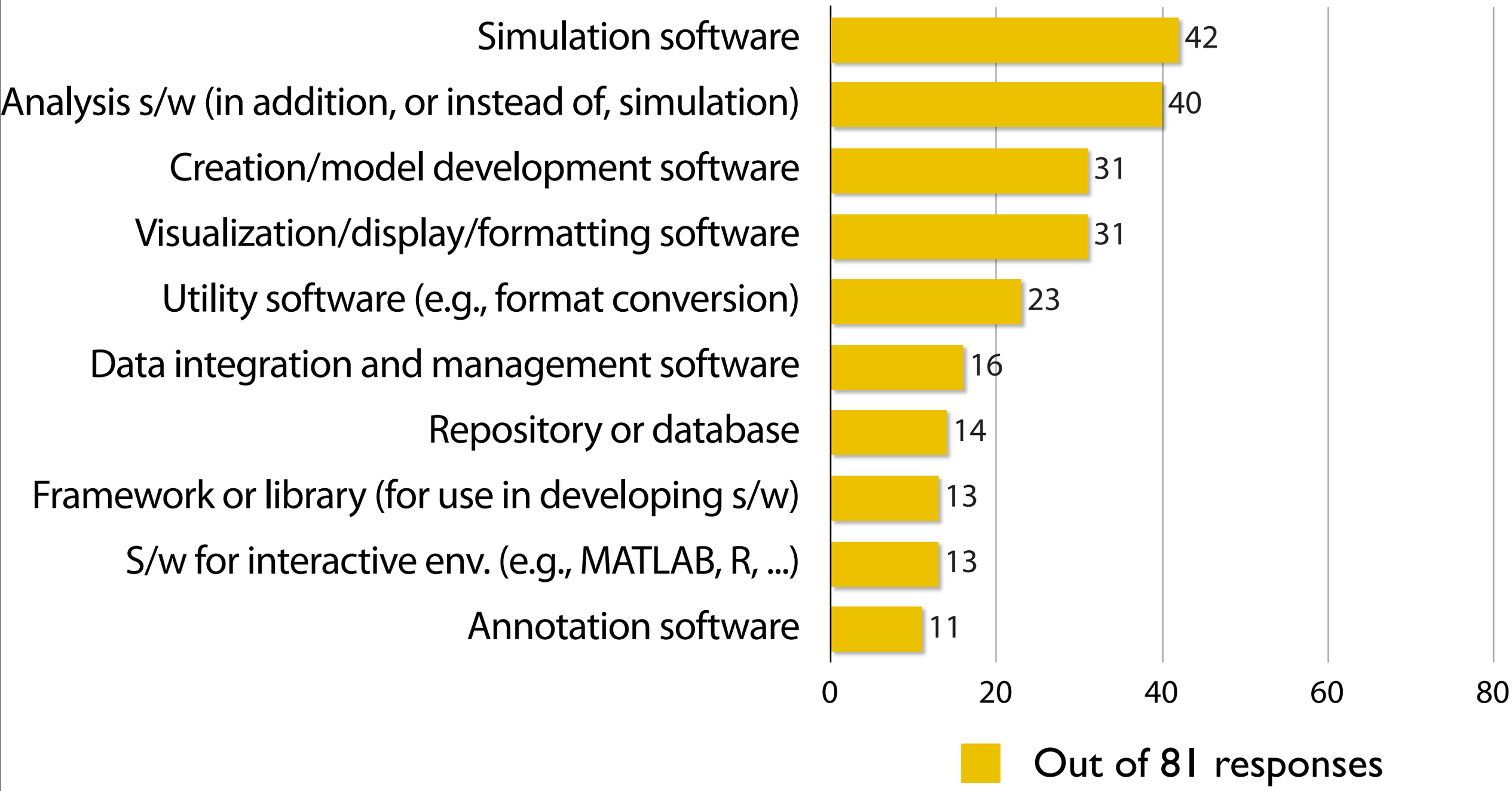
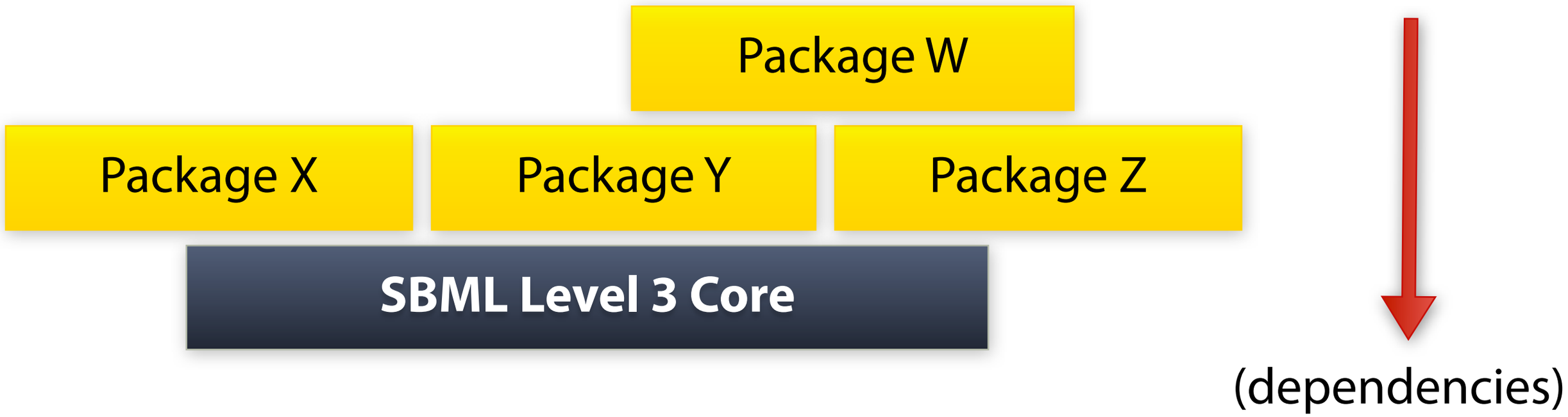


Results of 2011 survey of SBML-compatible software

Question: *Which of the following categories best describe your software? (Check all that apply.)*



SBML Level 3: Supporting more categories of models



An **SBML Level 3 package** adds constructs & capabilities

- Models declare which packages they use
- Applications tell users which packages they support

Package development can be decoupled

Development process described at **http://sbml.org/Documents**

SBML Development Process

Level 3 package	What it enables
Hierarchical composition	Models containing submodels
Flux balance constraints	Flux balance analysis models
Qualitative models	Petri net models, Boolean models
Spatial	Nonhomogeneous spatial models
Multicomponent species	Entities with structure & state; rule-based models
Graph layout	Diagrams of models
Graph rendering	Diagrams of models
Distribution & ranges	Nonscalar values
Annotations	Richer annotation syntax
Groups	Arbitrary grouping of model components
Dynamic structures	Creation & destruction of model components
Arrays & sets	Arrays or sets of entities

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New table & status pages for package *specifications*

Documents/Specifications – SBML.org

http://sbml.org/Documents/Specifications

At this time, only *Version 1 Core* of SBML Level 3 has been released. Definitions of packages to go with Version 1 Core are expected in the very near future. When the specifications become available, they will be listed below. For now, you can find information about the ongoing activities in the **community wiki**.

[**edit**] ***SBML Level 3 Version 1 Core***

The most recent release of SBML Level 3 Version 1 Core is **Release 1**.

The Systems Biology Markup Language (SBML): Language Specification for Level 3 Version 1 Core

Authors: Michael Hucka, Frank Bergmann, Stefan Hoops, Sarah Keating, Sven Sahle, James Schaff, Lucian Smith, and Darren Wilkinson

*This is the final **Release 1** specification of 6 Oct. 2010.*

*The document link refers to the file on SourceForge.net. If you have any problems accessing the PDF file from there, a backup copy of the document is also available **locally from this server**.*

Specification →

Errata →

Submit issue →

Schemas →

Issues with the specification are tracked on the *issue tracker* whose link is indicated above. Accepted issues are periodically collected and listed on the *Errata* page indicated above. Once a general consensus emerges that the known errata warrant a new release of the SBML specification, a new *Release* is made.

[**edit**] ***SBML Level 3 Packages***

Each individual SBML Level 3 package effort has an associated status page. Please follow the relevant links in the table below to find out more about a given package, including any draft specifications that may be available.

Package Name	Label	Description	Specification information page	Status
Arrays and Sets	`arrays`	Support for expressing arrays or sets of things	**Arrays and Sets**	
Annotations	`annot`	Support for richer annotation syntax than the regular annotations in SBML Level 3 Core	**Annotations**	
Hierarchical			**Hierarchical**	

New table & status pages for package *specifications*

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Individual pages for package specification statuses

Documents/Specifications/SBML Level 3/Packages/Hierarchical Model Composition (comp) – SBML.org

http://sbml.org/Documents/Specifications/SBML_Level_3/Packages/Hierarchical_Model_Com

SBML.org The Systems Biology Markup Language

News Documents Downloads Forums Facilities Community Events About Google Site Search

Parent pages: SBML.org / Documents / Specifications / SBML Level 3 / Packages

Hierarchical Model Composition (comp)

SBML Level 3 Package Activity Status Page

Package name:	Hierarchical Model Composition
Package label:	comp
Package purpose:	A means for defining how a model is composed from other models.
Package Working Group mailing list:	sbml-comp
Contact address (where to ask questions):	sbml-comp@lists.sourceforge.net
Specification status:	Draft specification and/or implementations are in development.
Latest specification document:	Version of 30 July 2012
Proposal status:	Proposal approved.
Proposal document:	Proposal version of 18 May 2011
Proposal activity page:	Proposal page for comp
SBML Editor acting as liason:	Lucian Smith

*This table is generated automatically from the data for comp in the **SBML Level 3 Package Status** spreadsheet.*

New status tracking spreadsheet

SBML Level 3 Packages

https://docs.google.com/spreadsheet/ccc?key=0ApbKgxVhXxVydG15WXlIT0JacHhwc0FPemV6bE1aQXc#gid=0

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fx Label

	A	B	C	D	E	G	H	J	L	
1	Label	Name	Description		Specification status	Link to specification information page	Link to current specification	Version/date of linked specification	Software implementation status	Progress tow
2	annot	Annotations	Support for richer annotation syntax than the regular annotations in SBML Level 3 Core		Specification work has not started	http://sbml.org/Document	Not yet available	Not yet available	No applications are known to support this yet	Awaiting relea specification d
3	arrays	Arrays and Sets	Support for expressing arrays or sets of things		Specification work has not started	http://sbml.org/Document	Not yet available	Not yet available	No applications are known to support this yet	Awaiting relea specification d
4	comp	Hierarchical Model Composition	A means for defining how a model is composed from other models		Draft specification and/or implementations are in development	http://sbml.org/Document	http://sbml.org/images	30 July 2012	Implementations are known to be in development	Verifying the p draft specificat software imple
5	distrib	Distributions and Ranges	Support for expressing the idea that a given value is not known precisely but falls within some defined distribution or range		Specification work has not started	http://sbml.org/Document	Not yet available	Not yet available	No applications are known to support this yet	Awaiting relea specification d
6	dyn	Dynamic Structures	Support for creating and destroying entities during a simulation		Specification work has not started	http://sbml.org/Document	Not yet available	Not yet available	No applications are known to support this yet	Awaiting relea specification d
7	flux	Flux Balance Constraints	Support for constraint-based (a.k.a. steady-state) models		Draft specification and/or implementations are in development	http://sbml.org/Document	Not yet available	Not yet available	Implementations are known to be in development	Verifying the p draft specificat software imple
8	groups	Groups	A means for grouping elements		Specification work has not started	http://sbml.org/Document	Not yet available	Not yet available	No applications are known to support this yet	Awaiting relea specification d
9	layout	Layout	Support for storing the spatial topology of a network diagram; adjunct to the render package		Draft specification and/or implementations are in development	http://sbml.org/Document	http://otto.bioquant.un	25 May 2011	Implementations are known to be in development	Verifying the p draft specificat software imple
10	multi	Multistate and Multicomponent Species	Object structures for representing entity pools with multiple states and composed of multiple components, and reaction rules involving them		Draft specification and/or implementations are in development	http://sbml.org/Document	http://sbml.org/Comm	14 April 2010	No applications are known to support this yet	Verifying the p draft specificat software imple
11	qual	Qualitative Models	Support for models wherein species do not represent quantity of matter & processes are not reactions per se		Draft specification and/or implementations are in development	http://sbml.org/Document	http://sbml.svn.source	5 November 2011	Two or more implementations have been released	Verifying the p draft specificat software imple
12	render	Rendering	Support for defining the graphical symbols and glyphs used in a diagram of the model; adjunct to the layout package		Draft specification and/or implementations are in development	http://sbml.org/Document	Not yet available	Not yet available	Implementations are known to be in development	Verifying the p draft specificat software imple
13	req	Required Elements	Support for fine-grained indication of SBML elements that have been changed by the presence of another		Specification work has not started	http://sbml.org/Document	Not yet available	Not yet available	Implementations are known to be in development	Awaiting relea specification d

New status tracking spreadsheet

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Label

	A	B	C	D	E	G	H	J	L	
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http://tinyurl.com/sbml-level-3-package-statuses

Several package have made huge progress recently

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What is the SBML Test Suite?

System for testing SBML support in software

- Currently aimed at simulators (easiest to assess)
- Extensible architecture—easy to add more test cases

Components:

- Test models + simulation run parameters + expected results
  - Each case is labeled with tags that indicate tested features
- Online assessment system
- (Updated version forthcoming) Standalone test runner

Latest update

Version 2.1.0 contains **1123** test cases

- Note: tags have been revised—many cases have been retagged

Tested so far by

- iBioSim (Chris Myers)
- RoadRunner (Frank Bergmann)
- LibSBMLSim (Akira Funahashi & Hiromu Takizawa)
- SBMLsimulator (Roland Keller)
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New cases developed by Lucian Smith using Antimony

Test case archive available on SourceForge:

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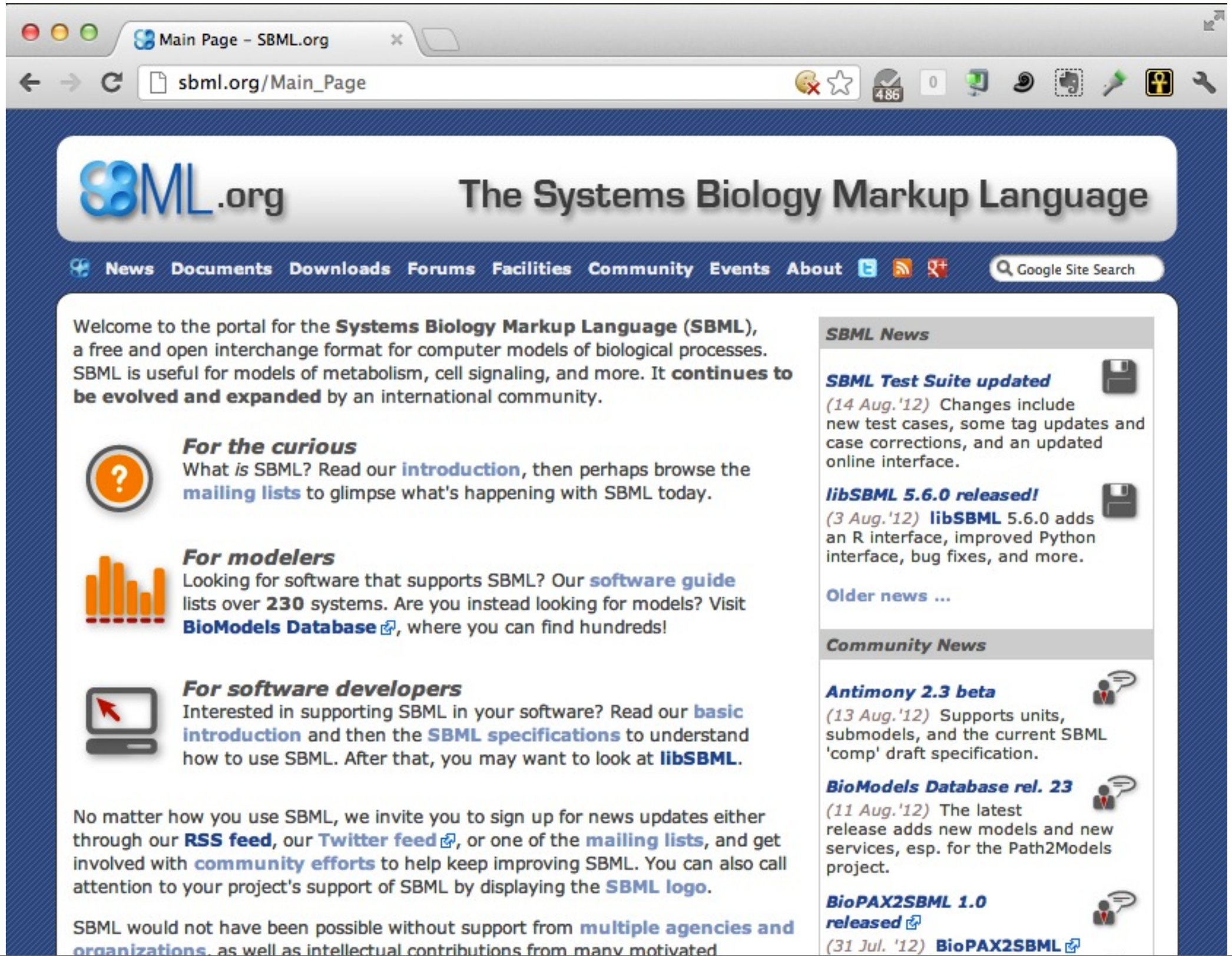
http://sf.net/projects/sbml/files/test-suite

The Online SBML Test Suite



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Attendees at SBML 10th Anniversary Symposium, Edinburgh, 2010

Thanks to everyone for continued support and involvement

SBML was made possible thanks to funding from:

National Institute of General Medical Sciences (USA)

European Molecular Biology Laboratory (EMBL)

JST ERATO Kitano Symbiotic Systems Project (Japan) (to 2003)

JST ERATO-SORST Program (Japan)

ELIXIR (UK)

Beckman Institute, Caltech (USA)

Keio University (Japan)

International Joint Research Program of NEDO (Japan)

Japanese Ministry of Agriculture

Japanese Ministry of Educ., Culture, Sports, Science and Tech.

BBSRC (UK)

National Science Foundation (USA)

DARPA IPTO Bio-SPICE Bio-Computation Program (USA)

Air Force Office of Scientific Research (USA)

STRI, University of Hertfordshire (UK)

Molecular Sciences Institute (USA)

I'd like your feedback!

You can use this anonymous form:

http://tinyurl.com/mhuckafeedback