



# SBO

# Systems Biology Ontology

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Okinawa, Jan 2008



- List of indexed terms (with definition)
- Qualified relationships between terms (“is\_a”, “part\_of”, ...)
- Examples:
  - Gene Ontology
  - ChEBI
  - ...





- Initiative of the BioModels.net project
- Classification of concepts used in quantitative modelling
- Identify each model component
- and the relationship between it and the model structure





- “A Simple Proposal for Indicating Modeling Framework Assumptions Underlying an SBML Model”
- Computing resources developed at the EBI
- Inclusion in SBML
- Several resources use SBO terms in their annotations
- ...



Composed of 5 controlled vocabularies:

- quantitative parameter
- participant
- modelling framework
- mathematical expression
- event



## Controlled vocabulary for parameter roles

### Examples:

- forward unimolecular rate constant
- Michaelis constant
- total concentration of enzyme
- pKa
- ...



# Taxonomy of the roles of reaction participants

## Examples:

- catalysis
- competitive inhibitor
- protein
- enzyme
- ...



List of modelling frameworks (specifies how to interpret a mathematical expression)

Examples:

- continuous
- discrete
- logical framework
- ...



# Classification of mathematical expression used in biochemical modelling

## Examples:

- mass action kinetic
- Henri-Michaelis-Menten kinetics
- ...



# Classification of events represented by biochemical models

## Examples:

- binding
- transport
- phosphorylation
- ...





<http://www.ebi.ac.uk/sbo/>

- browser
- editor
- exports (OBO flat file, XML and OWL)
- Web Services

<http://sourceforge.net/projects/sbo/>

- term request (via tracker)
- source code





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- Home
- Browse
- Edit tree
- Download
- Web Services

- FAQ
- Term request
- Sourceforge project
- SBO mailing-list
- Search
- Contact

BIOXMODELS.NET



EBI > SBO > Browsing

## SBO::Systems Biology Ontology



[Refresh tree](#)

### sbo

- ▣ [quantitative parameter](#)
  - ▣ [delay](#)
  - ▣ [number density](#)
    - ▣ [concentration](#)
      - ▣ [specific concentration](#)
  - ▣ [density](#)
    - ▣ [volume density](#)
    - ▣ [area density](#)
    - ▣ [linear density](#)
  - ▣ [physical characteristic](#)
    - ▣ [thermodynamic temperature](#)
    - ▣ [temperature difference](#)
    - ▣ [electrical resistance](#)
    - ▣ [conductance](#)
    - ▣ [capacitance](#)
    - ▣ [voltage](#)
    - ▣ [pressure](#)
  - ▣ [biochemical parameter](#)
    - ▣ [kinetic constant](#)
      - ▣ [unimolecular rate constant](#)
        - ▣ [forward unimolecular rate constant](#)
          - ▣ [forward unimolecular rate constant, continuous case](#)
            - ▣ [catalytic rate constant](#)
              - ▣ [product catalytic rate constant](#)
              - ▣ [substrate catalytic rate constant](#)
              - ▣ [total catalytic efficiency](#)
            - ▣ [forward unimolecular rate constant, discrete case](#)







http://www.ebi.ac.uk - SBO::Systems Biology Ontology - Mozilla Firefox

Close

**SBO:0000195 Hill equation, microscopic form**

■ Definition

Hill equation rewritten by creating a pseudo-microscopic constant, equal to the Hill constant powered to the opposite of the Hill coefficient.

■ MathML

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
<semantics definitionURL="http://biomodels.net/SBO/#SBO:0000062">
  <lambda>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000186">Vmax</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000010">R</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000194">K</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000190">h</ci></bvar>
    <apply>
```

$$\lambda(V_{\max}, R, K, h) = \frac{V_{\max} \times R^h}{K^h + R^h}$$

■ Comment

■ Parent(s)

SBO:0000192 Hill equation (is a)

■ Children

Terminé

zotero N/A





http://www.ebi.ac.uk - SBO::Systems Biology Ontology - Mozilla Firefox

Close

Edit Term View Term

Term modifications

Submit Changes Cancel Changes

**MODIFY SBO:0000198**

Hill equation, reduced form

■ Definition

Hill equation rewritten by replacing the concentration of reactant with its reduced form, that is the concentration divide by a pseudo-microscopic constant, equal to the Hill constant powered to the opposite of the Hill coefficient.

■ MathML

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
<semantics definitionURL="http://biomodels.net/SBO/#SBO:0000062">
  <lambda>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000186">Vmax</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000197">R</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000190">h</ci></bvar>
    <apply>
      <divide/>
```

$$\lambda(V_{max}, R^o, h) = \frac{V_{max} \times R^{o,h}}{1 + R^{o,h}}$$

■ Comment

■ Parent(s)

SBO:0000192 Hill equation (is a)

■ Children

General modifications

Add a synonym

Enter a new synonym

Add a child

Choose an existing term

Add a new child

Terminé

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■ MathML

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    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000190">h</ci></bvar>
    <apply>
      <divide/>
```

$$\lambda(V_{max}, R^o, h) = \frac{V_{max} \times R^{o,h}}{1 + R^{o,h}}$$

■ Comment

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Terminé



## MathML equations rendering

- mathematical expression

- rate law

- mass action kinetics

- Hill equation

- Hill equation, microscopic form

- Hill equation, reduced form

SBO:0000195

$$\lambda(V_{\max}, R, K, h) = \frac{V_{\max} \times R^h}{K^h + R^h}$$

■ MathML

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
<semantics definitionURL="http://biomodels.net/SBO/#SBO:0000062">
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    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000015">S</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000020">I</ci></bvar>
    <bvar><ci definitionURL="http://biomodels.net/SBO/#SBO:0000027">Ks</ci></bvar>
  </lambda>
</semantics>
</math>
```

$$\lambda(k_{\text{cat}}, E_t, S, I, K_s, K_i, a, r) = \frac{k_{\text{cat}} \times E_t \times S}{K_s \times \left(1 + \sum_{i=1}^n \left(\frac{I_i}{K_i}\right)\right) + S \times \left(1 + \frac{I_i}{a_i \times K_i}\right)}$$




# Dynamic editing interface

rate	Add this child
unimolecular <b>rate</b> constant (SBO:0000016)	
bimolecular <b>rate</b> constant (SBO:0000017)	
trimolecular <b>rate</b> constant (SBO:0000018)	
forward unimolecular <b>rate</b> constant (SBO:0000022)	
forward bimolecular <b>rate</b> constant (SBO:0000023)	
forward trimolecular <b>rate</b> constant (SBO:0000024)	
catalytic <b>rate</b> constant (SBO:0000025)	
reverse unimolecular <b>rate</b> constant (SBO:0000032)	
reverse bimolecular <b>rate</b> constant (SBO:0000033)	
reverse trimolecular <b>rate</b> constant (SBO:0000034)	



models + SBO terms  $\Rightarrow$  ?





## Semantic layer:

- link between models encoded in SBML and graphical notations (such as SBGN)
- conversion to semantically enriched computing formats (such as BioPAX)
- translation of models between *continuous deterministic frameworks* and *discrete stochastic framework*
- merging/integration of models
- ...



Thank you for your attention

