Bridging data and modeling communities

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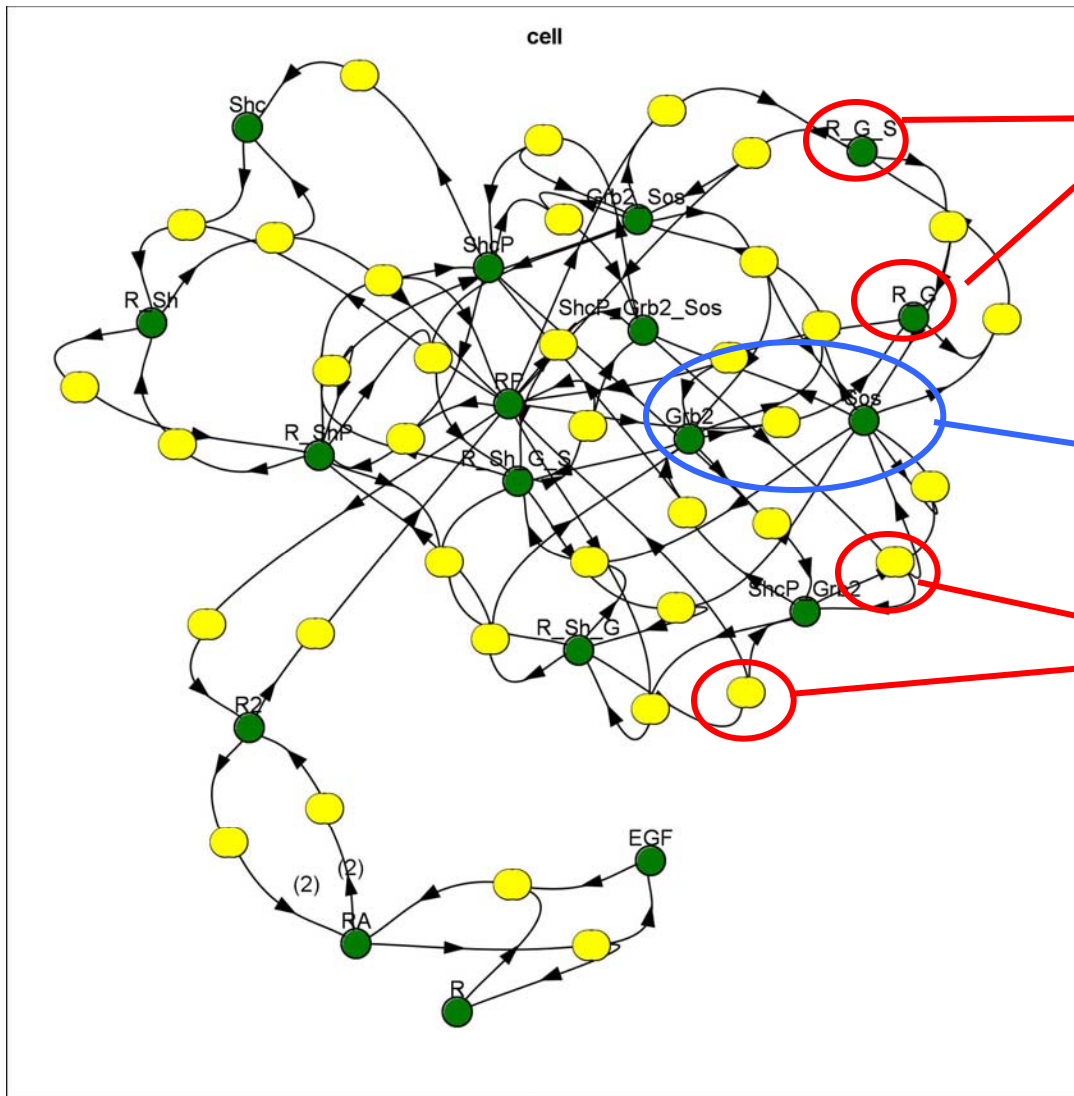
BioPAX and BioPAX OBO groups

NRCAM meeting
February 23rd , 2009

The Virtual Cell representation of chemical reactions

Species: One for every possible modification state of every complex

Reactions: One for every transition among species
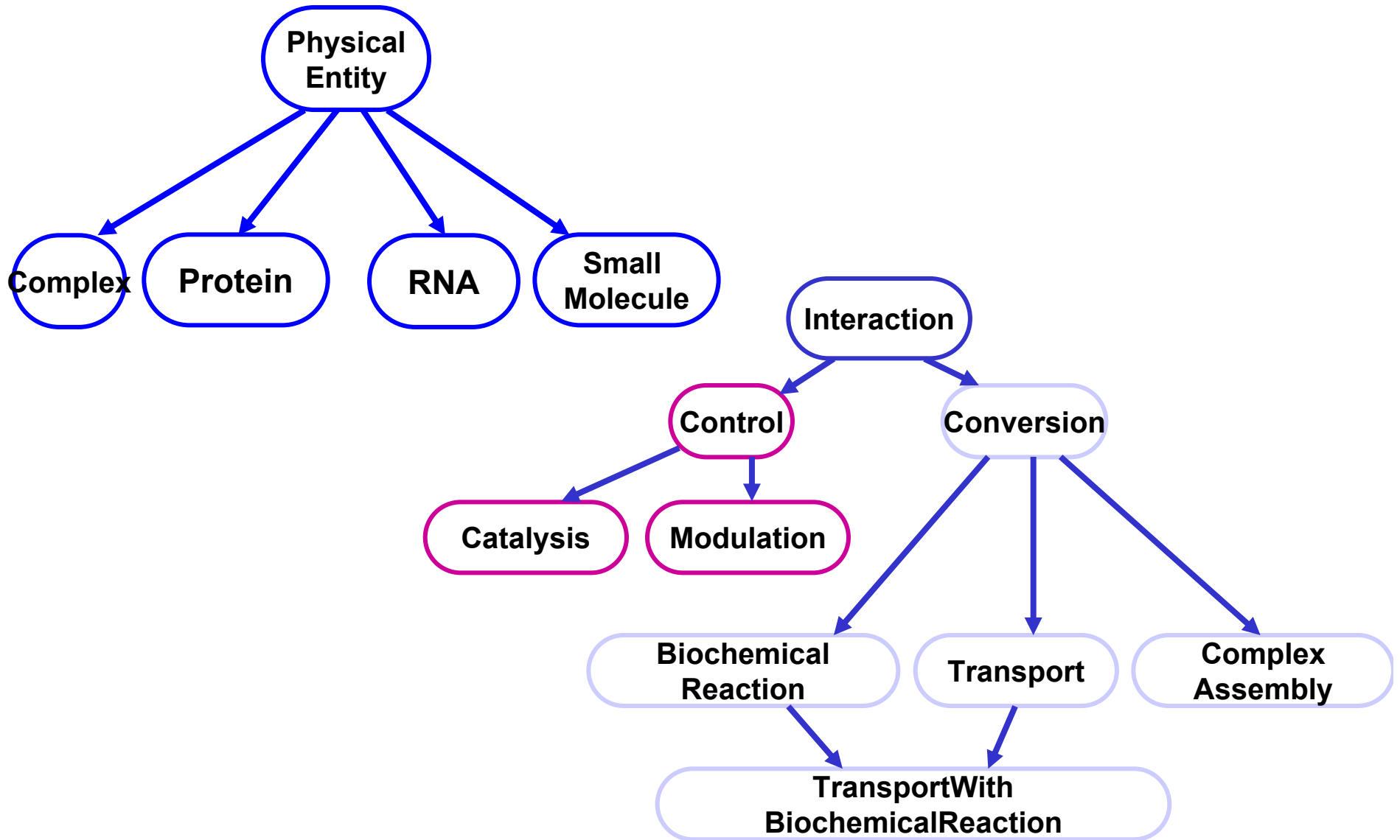
Better and reusable representation

Different types of species: proteins, small molecules, complexes.

User-specified grouping: ligand-binding module, Grb2 interactions

Different types of reactions: biochemical reaction, complex assembly

Model is abstraction of knowledge

World of models

- Over 100 software tools support import and/or export of models in SBML format

- Database of models in SBML format http://BioModels.net contains more than 200 curated models

- VCell database contain more than 600 publicly available models including about 50 curated models. Many of them can be exported to SBML.

World of pathway databases

Data Source	Protein(SwissProt)	Coverage (SwissProt)	Interaction	Citation
Reactome	1229 (1194)	5% (8%)	21394	Vastrik *et al*, 2007
Panther	2997 (1670)	12% (12%)	75694	Mi *et al*, 2007
CellMap	567 (567)	2% (4%)	1195	cancer.cellmap.org
INOH	719 (711)	3% (5%)	11759	Kushida *et al*, 2006
NCI-Nature	593 (592)	2% (4%)	2900	pid.nci.nih.gov
NCI-BioCarta	936 (936)	4% (6%)	4752	pid.nci.nih.gov
KEGG	2033 (1947)	8% (13%)	11144	Kanehisa *et al*, 2004
Total	**5283 (3847)**	**21% (27%)**	**118867**	

World of ontologies

BioPAX = **Bio**logical **PA**thway e**X**change

GO = Gene Ontology

ChEBI = Chemical Entities of Biological Interest

RO (OBO) = Relation Ontology (Open Biomedical Ontologies)

SBO = Systems Biology Ontology

BFO = Basic Formal Ontology

Two worlds

Modeling Community

- Do the math so that it can be calculated
- Quantities
- Simulate and fit
- Data models

SBML

- **S**ystem **B**iological **M**arkup **L**anguage
- Quantitative information
- XML
- http://www.sbml.org/

Pathway Community

- Link information so that it can be found
- Relationships
- Reason and query
- Ontologies

BioPAX

- **Bio**logical **PA**thway e**X**change
- Qualitative, no kinetics
- RDF / OWL
- http://www.biopax.org/

Can BioPAX and SBML work together?

Conversions

- Binom (Cytoscape)
- Sbml2biopax

Annotation

- Use BioPAX for annotations in SBML
- Add dummy elements to SBML to describe BioPAX features

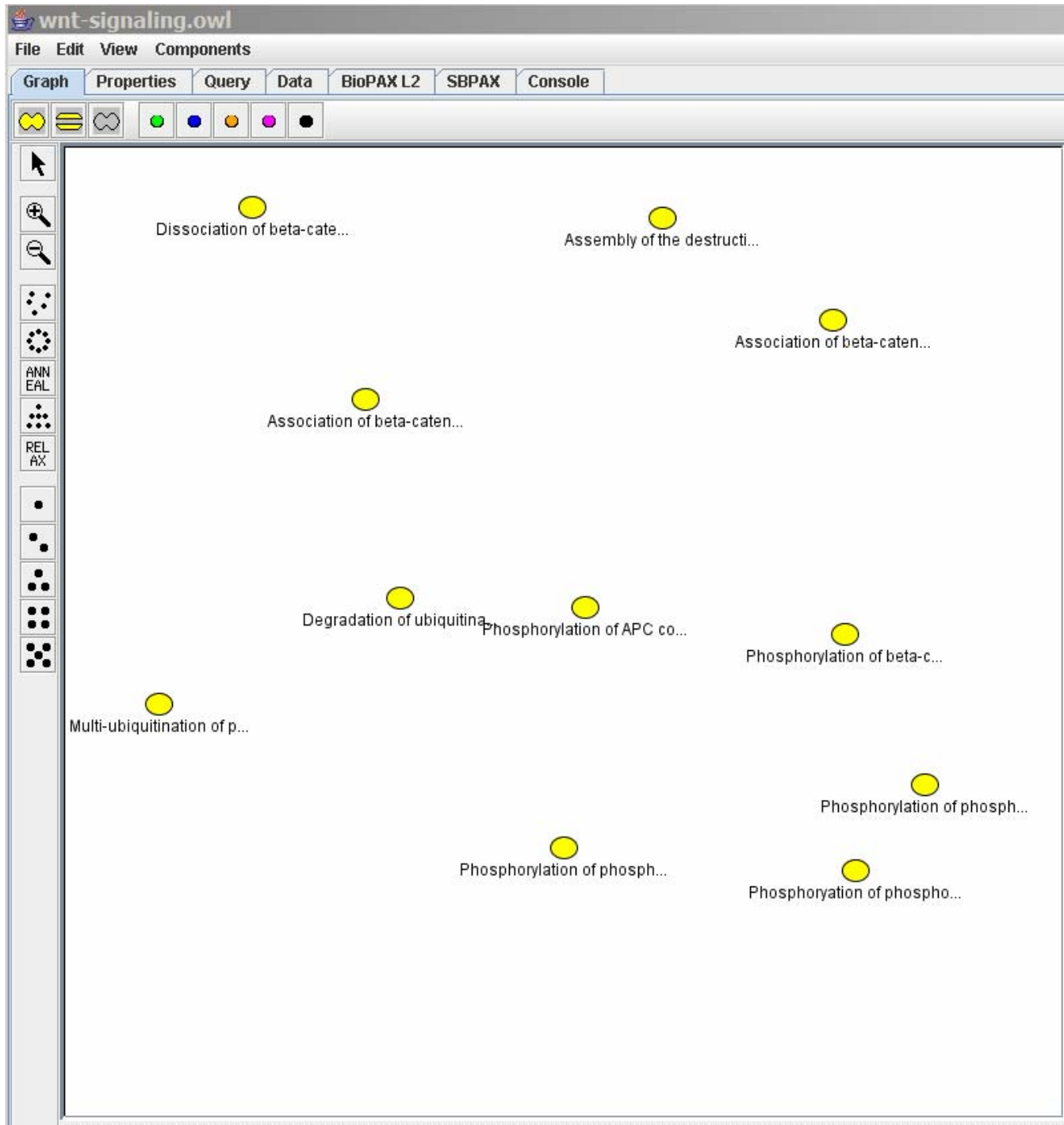# Direct conversion may be impossible

- An entity in BioPAX corresponds to multiple species in SBML (e.g. a protein in varying phosphorylation states)
- A species in SBML corresponds to multiple entities in BioPAX (e.g. generic participants in transport, translation and transcription)

Systems Biology Linker (SyBiL)

- http://vcell.org/biopax
- SyBiL provides capabilities for:
  - Visualizing, analyzing and querying pathway data represented in BioPAX
  - Creating computational model (SBML) from qualitative description (BioPAX)
  - Converting, gluing and merging data and models about pathways coming from different sources, such as BioPAX and SBML.
  - Intelligent visualizing and modular presentation of VCell model.

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Selected Nodes

Resources
Multi_ubiquitination_of_phospho_beta_catenin_by_SCF...
Assembly_of_the_destruction_complex
Association_of_beta_catenin_with__the_SCF_beta_TrC...

Node Multi_ubiquitination_of_phospho_beta_catenin_by_SCF_beta_TrCP1:

Property	Value
type	biochemicalReaction
NAME	Multi-ubiquitination of phospho-beta-catenin by SCF-beta-TrCP1
SHORT-NAME	Multi-ubiquitination of phospho-beta-catenin by SCF-beta-TrCP1
COMMENT	Authored: Kimelman, D, 2007-04-03
COMMENT	Beta-catenin is ubiquitinated by the SCF-B-TrCP1 complex.
COMMENT	Edited: Matthews, L, 2007-04-03
COMMENT	Reviewed: Pagano, M, 2007-04-27
DATA-SOURCE	Reactome
LEFT	SCF_beta_TrCP1_complex_associated_with_phosphorylated_beta_catenin__cytosol_2
LEFT	ubiquitin__cytosol_
RIGHT	ubiquitinated_phospho_beta_catenin_SCF_beta_TrCP1_complex__cytosol_
XREF	Pubmed_12820959
XREF	REACT_10082.1
XREF	Reactome195279

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File   Edit   View   Components

Data   **BioPAX to SBML Conversion**   Advanced

Conversion Criteria   Reactions and Participants   Compartments

Criteria for conversion of BioPAX data to SBML model

Here you can select which Physical Entities Participants in BioPAX file will be converted
to separate speciesTypes in SBML file. Depending on whether location is the same or different,
Physical Entity Participants are assigned the same or different species.
Below you can select assumptions about generic conversion. Later you can override these assumptions.

More about conversion criteria	More about BioPAX and SBML

○ **None**   - None of Physical Entity Participants is assigned a separate SpeciesTypes.
           Manually assign species to each Physical Entity on the next screen.

◉ **Some**   - Some types of PhysicalEntities are directly converted to speciesTypes.

☐ Substance   ☑ rna   ☑ dna   ☑ smallMolecule   ☑ protein   ☐ complex

○ **All**   - All Physiscal Entity Participants are converted to a separate SpeciesType.

↺ Reset	→ Process and Proceed

File   Edit   View   Components

| Data | BioPAX to SBML Conversion | Advanced |

| Conversion Criteria | Reactions and Participants | Compartments |

Process (BP)/ Reaction ID (SB)	Participants in BioPAX	Entity (BP)	Entity Class in BioPAX	Stoich. Coef.	SpeciesType ID	Location (BP)/
Phosphorylation of beta-cate...	ATP__cytosol_	ATP	smallMolecule	1.0	ATP	cytosol
Phosphorylation of beta-cate...	beta_catenin_Axin_GSK3_CK1alp...	beta-catenin:Axin:GSK3:CK1alpha:APC...	complex	1.0	[none] ▼	cytosol
Phosphorylation of beta-cate...	ADP__cytosol_	ADP	smallMolecule	1.0	[new]	cytosol
Phosphorylation of beta-cate...	phospho__Ser45__beta_catenin...	phospho-(Ser45) beta-catenin:Axin:GS...	complex	1.0	[none]	cytosol
Phosphorylation of beta-cate...	Phospho__Ser45__Thr41__Ser3...	Phospho-(Ser45, Thr41, Ser37, Ser33) ...	complex	[none]	beta-cateni	cytosol
Phosphoryation of phospho-...	ATP__cytosol_1	ATP	smallMolecule	1.0	ATP	cytosol
Phosphoryation of phospho-...	phospho__Ser45__beta_catenin...	phospho-(Ser45) beta-catenin:Axin:GS...	complex	1.0	[none]	cytosol
Phosphoryation of phospho-...	ADP__cytosol_1	ADP	smallMolecule	1.0	ADP	cytosol
Phosphoryation of phospho-...	phospho__Ser45__Thr41__beta_...	phospho-(Ser45, Thr41) beta-catenin:A...	complex	1.0	[none]	cytosol
Phosphoryation of phospho-...	phospho__Ser45__beta_catenin...	phospho-(Ser45) beta-catenin:Axin:GS...	complex	[none]	[none]	cytosol
Phosphoryation of phospho-...	ATP__cytosol_2	ATP	smallMolecule	1.0	ATP	cytosol
Phosphoryation of phospho-...	phospho__Ser45__Thr41__beta_...	phospho-(Ser45, Thr41) beta-catenin:A...	complex	1.0	[none]	cytosol
Phosphoryation of phospho-...	phospho__Ser45__Thr41__Ser3...	phospho-(Ser45, Thr41, Ser37) beta-ca...	complex	1.0	[none]	cytosol
Phosphoryation of phospho-...	ADP__cytosol_2	ADP	smallMolecule	1.0	ADP	cytosol
Phosphoryation of phospho-...	phospho__Ser45__Thr41__beta_...	phospho-(Ser45, Thr41) beta-catenin:A...	complex	[none]	[none]	cytosol
Dissociation of beta-catenin ...	phospho__Ser45_Thr41_Ser37_...	phospho-(Ser45,Thr41,Ser37,Ser33):A...	complex	1.0	[none]	cytosol
Dissociation of beta-catenin ...	phospho__Ser45_Thr41_Ser37_...	phospho-(Ser45,Thr41,Ser37,Ser33):A...	complex	1.0	[none]	cytosol
Association of beta-catenin ...	phospho__Ser45_Thr41_Ser37_...	phospho-(Ser45,Thr41,Ser37,Ser33):A...	complex	1.0	[none]	cytosol
Association of beta-catenin ...	SCF_beta_TrCP1_complex__cyto...	SCF-beta-TrCP1 complex	complex	1.0	[none]	cytosol
Association of beta-catenin ...	SCF_beta_TrCP1_complex_asso...	SCF-beta-TrCP1 complex associated ...	complex	1.0	[none]	cytosol
Assembly of the destruction ...	GSK3B__cytosol_	GSK3B [cytosol]	protein	1.0	GSK3B [c...	cytosol
Assembly of the destruction ...	CK1alpha__cytosol_	UniProt:P48729 Casein kinase I, alpha...	protein	1.0	UniProt:P...	[none]
Assembly of the destruction ...	APC__cytosol_	APC [cytosol]	protein	1.0	APC [cyto...	cytosol
Assembly of the destruction ...	Axin__cytosol_	UniProt:O15169 Axin 1 (Axis inhibition p...	protein	1.0	UniProt:O...	cytosol
Assembly of the destruction ...	PP2A__cytosol_	PP2A	complex	1.0	[none]	cytosol
Assembly of the destruction ...	Axin_GSK3_CK1alpha_APC_PP2...	Axin:GSK3:CK1alpha:APC:PP2A complex	complex	1.0	[none]	cytosol
Phosphorylation of APC com...	Phospho__Ser45__Thr41__Ser3...	Phospho-(Ser45, Thr41, Ser37, Ser33) ...	complex	1.0	[none]	cytosol
Phosphorylation of APC com...	ATP__cytosol_4	ATP	smallMolecule	1.0	ATP	cytosol
Phosphorylation of APC com...	phospho__Ser45_Thr41_Ser37_...	phospho-(Ser45,Thr41,Ser37,Ser33):A...	complex	1.0	[none]	cytosol
Phosphorylation of APC com...	ADP__cytosol_4	ADP	smallMolecule	1.0	ADP	cytosol
Phosphorylation of APC com...	Phospho__Ser45__Thr41__Ser3...	Phospho-(Ser45, Thr41, Ser37, Ser33) ...	complex	[none]	[none]	cytosol
Association of beta-catenin ...	Axin_GSK3_CK1alpha_APC_PP2...	Axin:GSK3:CK1alpha:APC:PP2A complex	complex	1.0	[none]	cytosol
Association of beta-catenin ...	beta_catenin__cytosol_	beta-catenin [cytosol]	physicalEntity	1.0	[none]	cytosol
Association of beta-catenin ...	beta_catenin_Axin_GSK3_CK1alp...	beta-catenin:Axin:GSK3:CK1alpha:APC...	complex	1.0	[none]	cytosol
Multi-ubiquitination of phosp...	SCF_beta_TrCP1_complex_asso...	SCF-beta-TrCP1 complex associated ...	complex	1.0	[none]	cytosol
Multi-ubiquitination of phosp...	ubiquitin__cytosol_	UniProt:P62988 Ubiquitin	protein	4.0	UniProt:P...	cytosol
Multi-ubiquitination of phosp...	ubiquitinated_phospho_beta_cat...	ubiquitinated phospho-beta-catenin:SC...	complex	1.0	[none]	cytosol
Phosphorylation of phospho...	ATP__cytosol_3	ATP	smallMolecule	1.0	ATP	cytosol
Phosphorylation of phospho...	phospho__Ser45__Thr41__Ser3...	phospho-(Ser45, Thr41, Ser37) beta-ca...	complex	1.0	[none]	cytosol
Phosphorylation of phospho...	ADP__cytosol_3	ADP	smallMolecule	1.0	ADP	cytosol
Phosphorylation of phospho...	Phospho__Ser45__Thr41__Ser3...	Phospho-(Ser45, Thr41, Ser37, Ser33) ...	complex	1.0	[none]	cytosol
Phosphorylation of phospho...	Phospho__Ser45__Thr41__Ser3...	Phospho-(Ser45, Thr41, Ser37, Ser33) ...	complex	[none]	[none]	cytosol

| → Reset and Save | → Process and Save | → Process and Proceed |

File   Edit   View   Components

| Data | BioPAX to SBML Conversion | Advanced |

| Conversion Criteria | Reactions and Participants | Compartments |

Compartment / Location	Spatial Dims	Surrounding / Outside
cytosol	3	[none] ▼
		[none]
		cytosol

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Systems Biology Pathway Exchange (SBPAX)
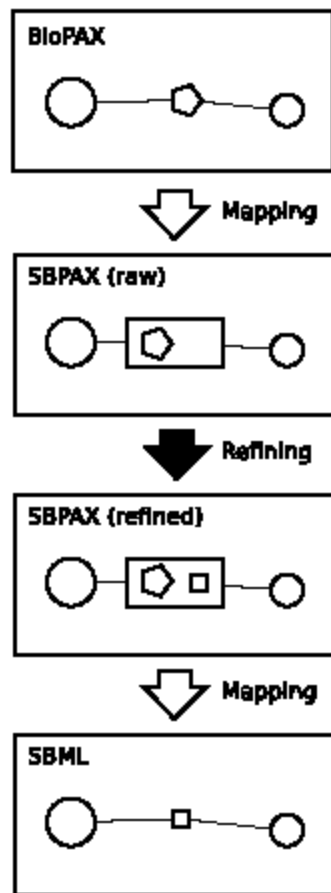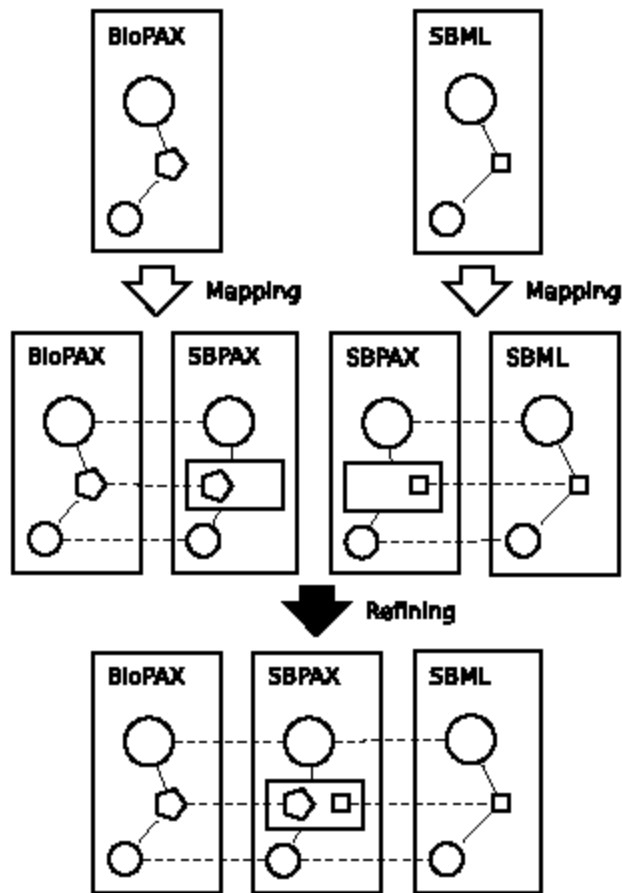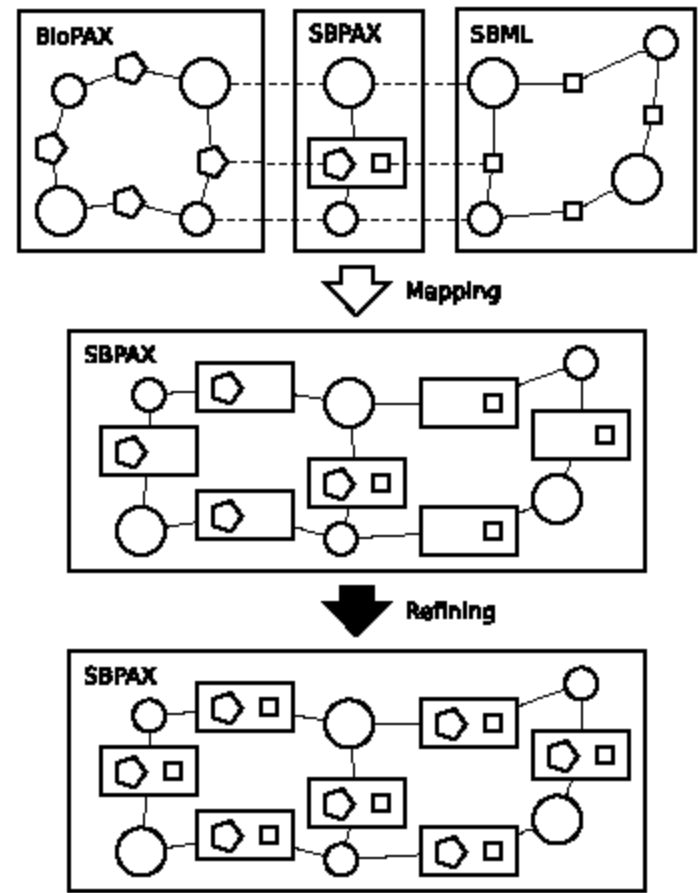
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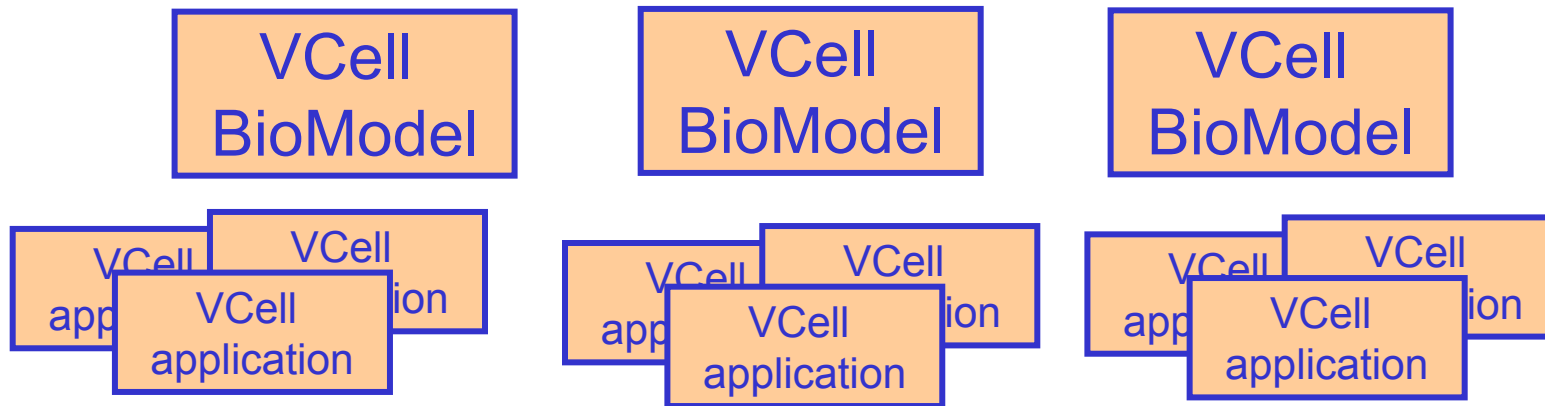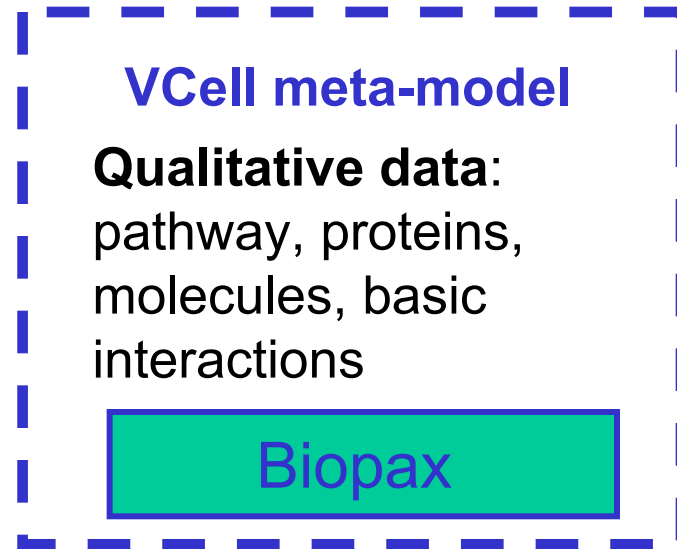
Acknowledgements

BioPAX

- C. Sander (Memorial Sloan-Kettering Cancer Center)
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BioPAX OBO

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- Jeremy Zucker (Harvard)
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