

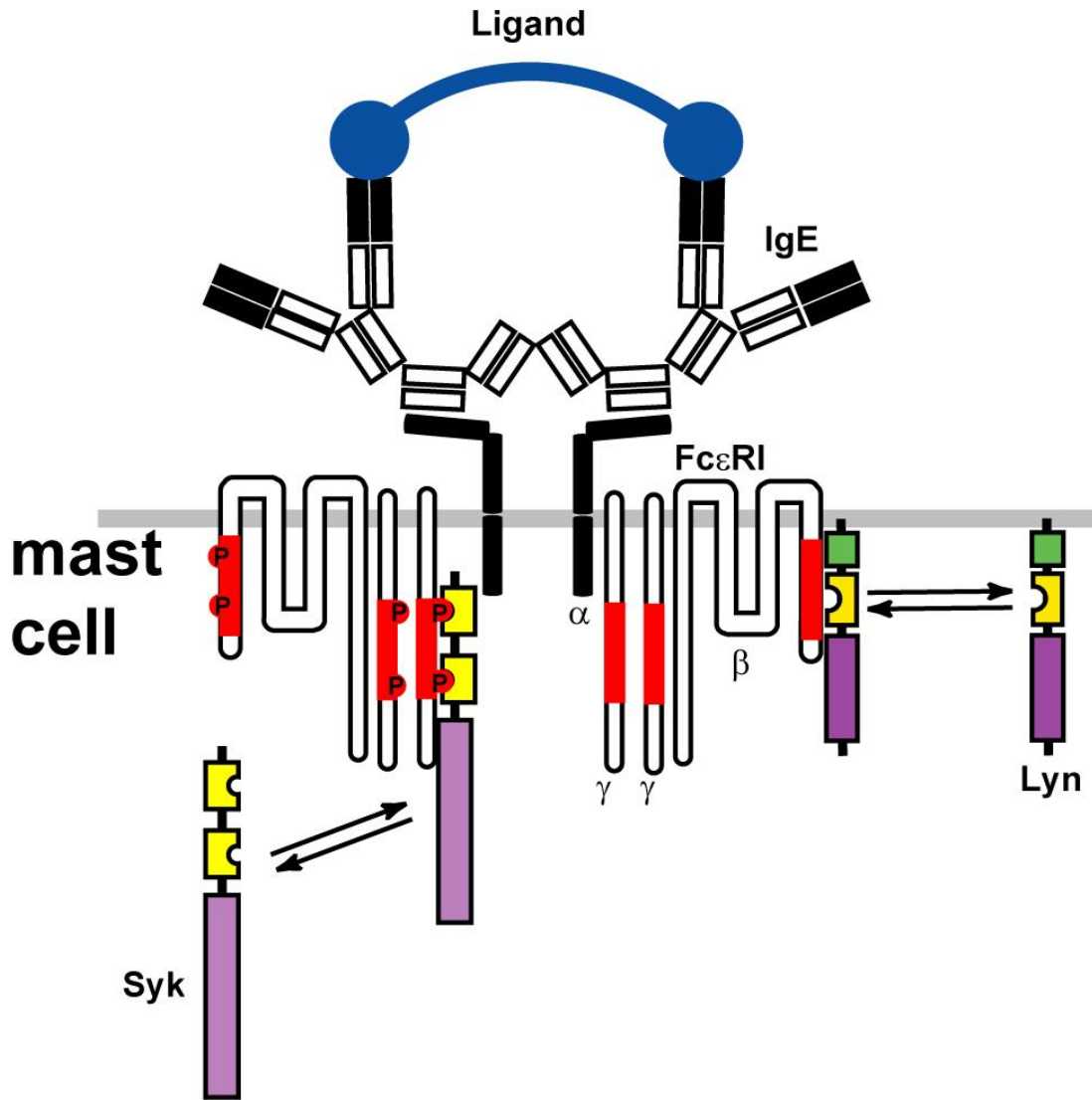
SBML level3: rule-based, graph-based, domain-based

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<http://cellsignaling.lanl.gov>



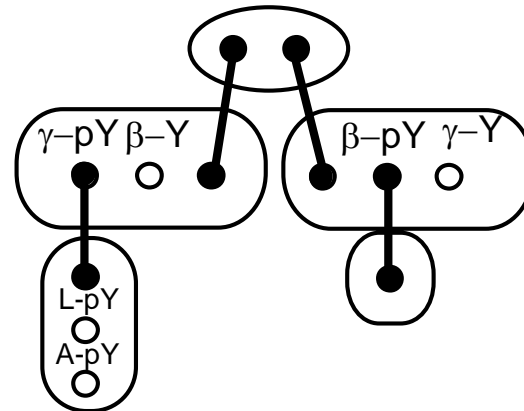
- Multi-state multi-component species
- Interactions specific to specific domains and sites of proteins
- Specifications of reactants and contents
- Species located in several compartments

SBML level 3 goal

- Chemical reactions model is a set of biophysical transformations among individual chemical species, as in SBML 2.
- SBML 3 has a goal to describe system in order to be able to generate a model.
- Not all simulation parameters must be defined in SBML level 3 to allow for model generation/simulation

Basic definitions

A species - a graph



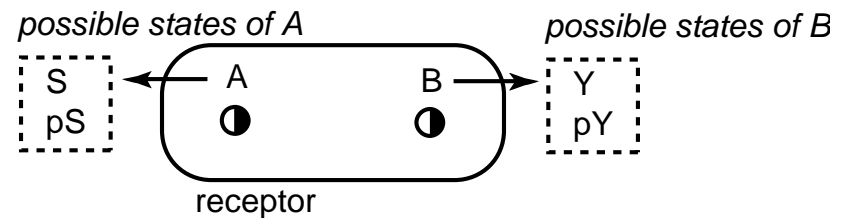
Nodes: Components, having attributes

Component: ITAM
 ComponentState: Y, pY



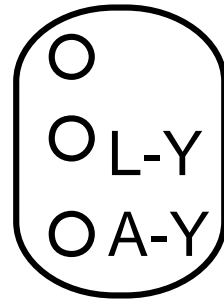
ComponentConnectivity: bound unbound unspecified
 ComponentCompartment: extracellular, intracellular

Partition: Molecules

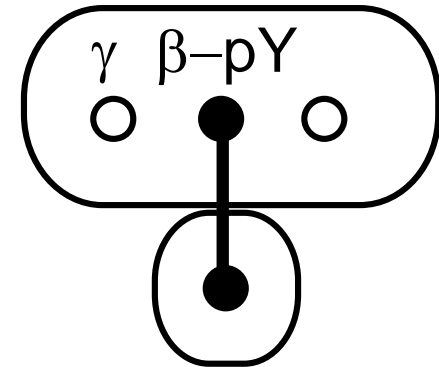


Species: fully defined (not necessary fully connected) graph

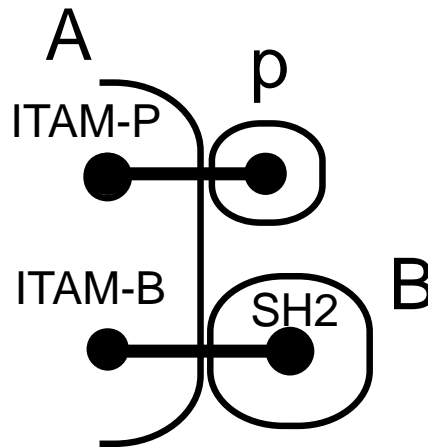
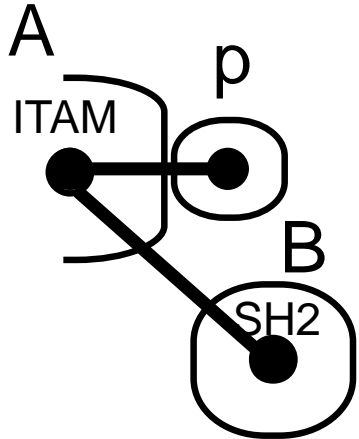
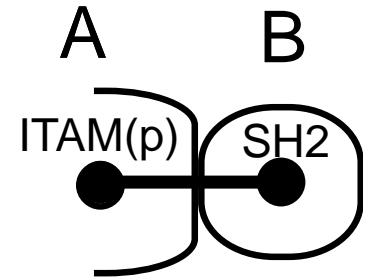
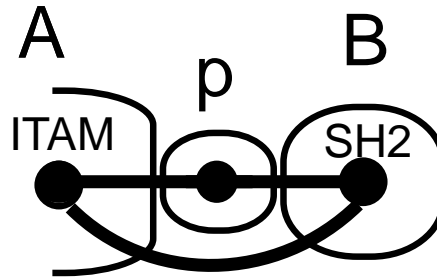
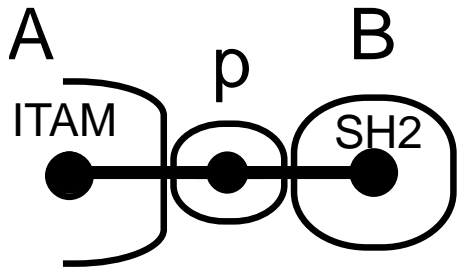
SykPS



R-Lyn

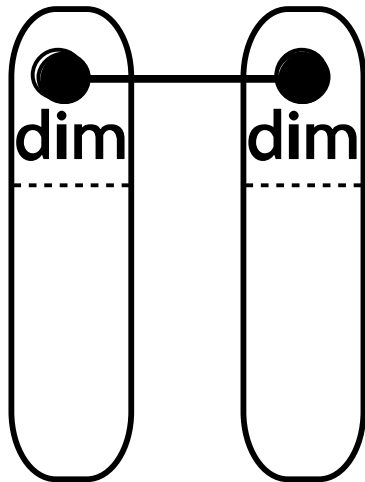


Attributes: states

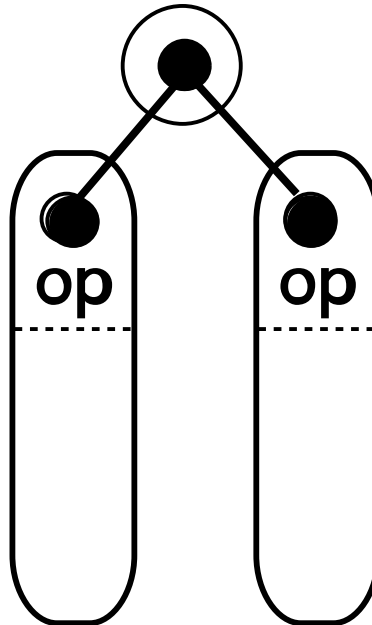


Attributes: states

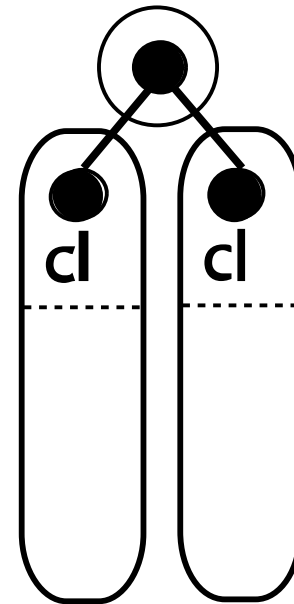
Open dimer



Open dimer
with ligand



Closed dimer
with ligand



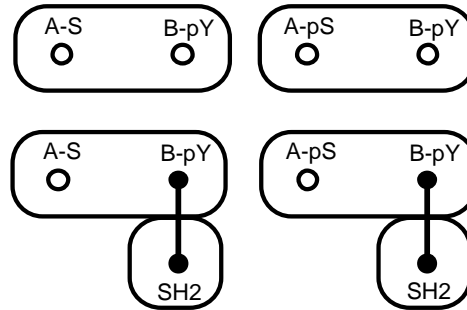
Attributes: connectivity + speciesGroups

SpeciesGroup

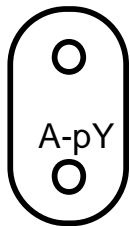
species in group



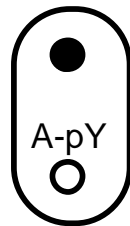
binding and internal states of A are unspecified



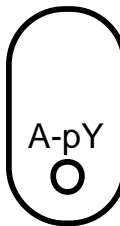
(a)



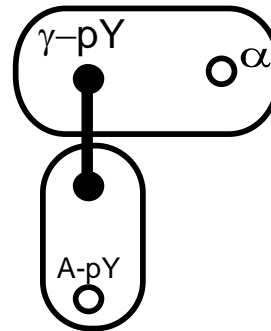
(b)



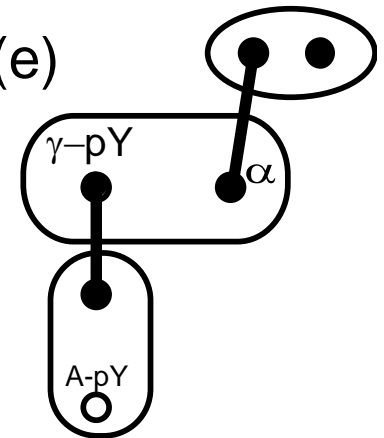
(c)



(d)

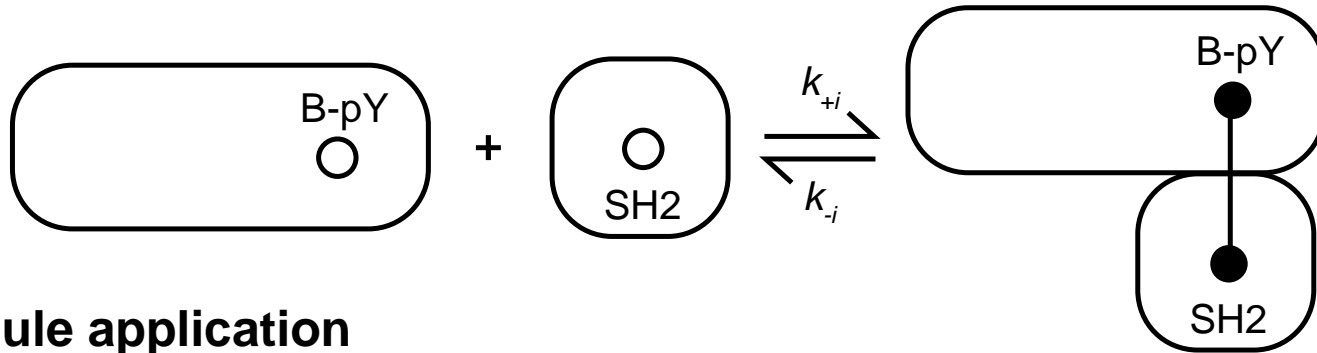


(e)

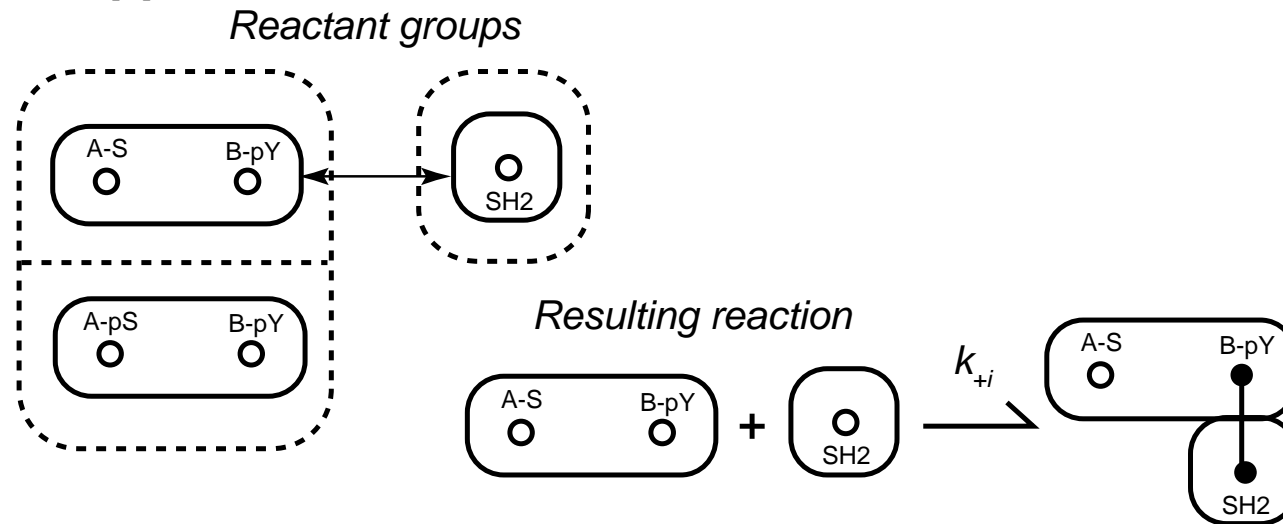


Reaction rules

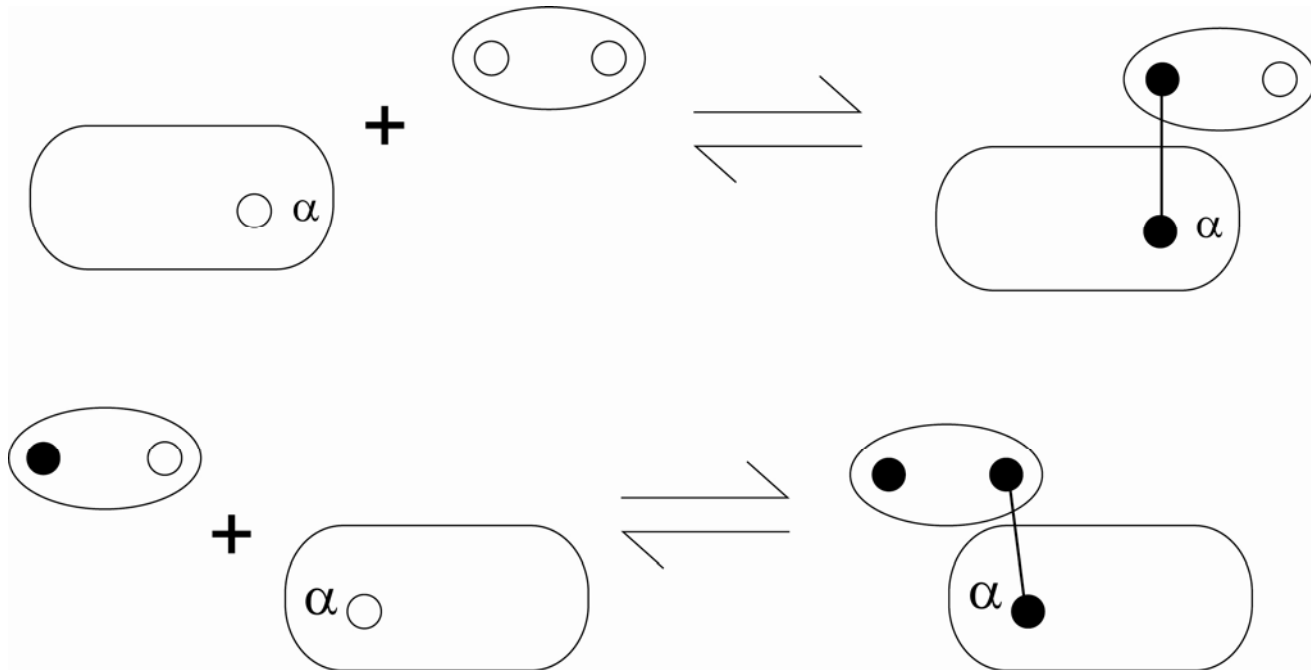
Reaction rule



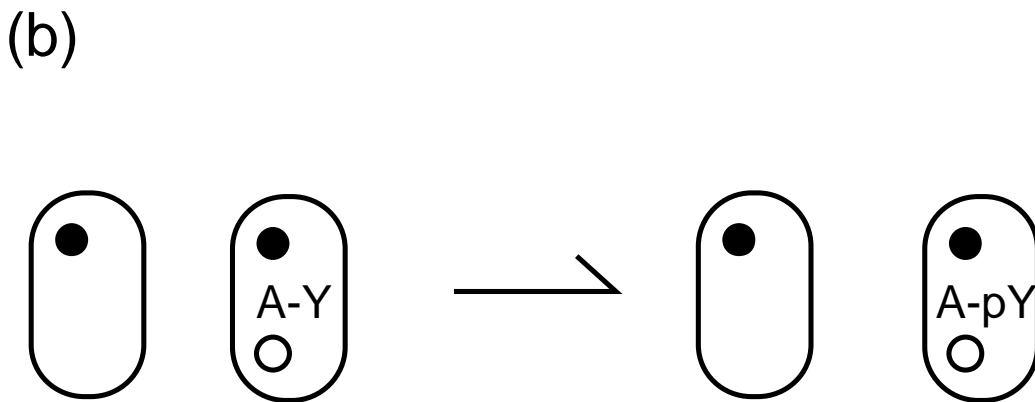
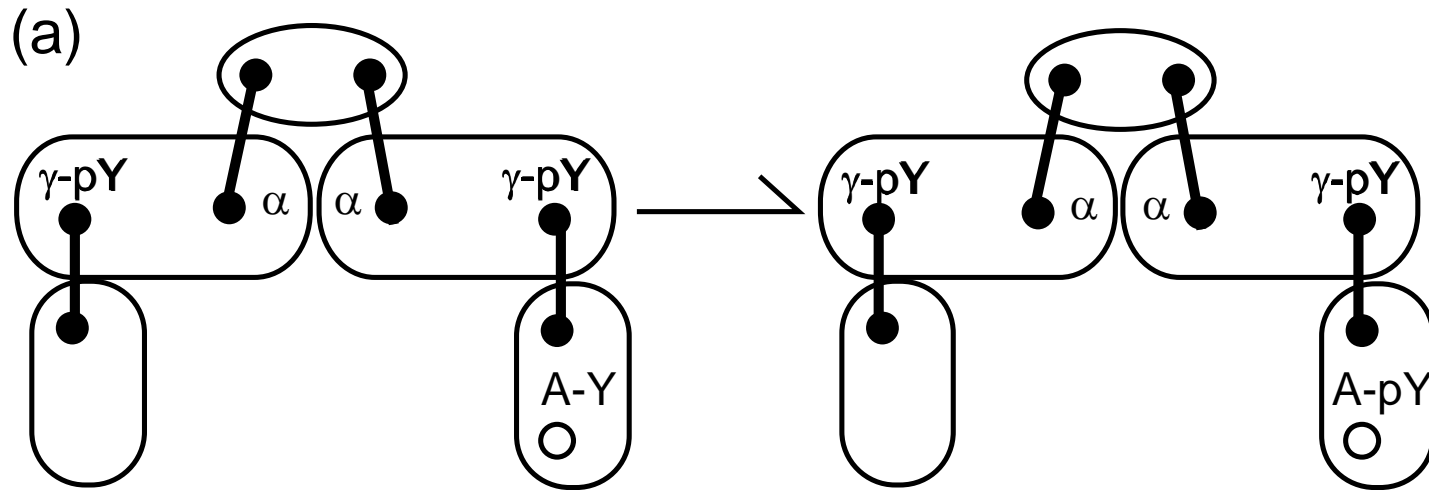
Rule application



Reaction rules



Reaction rules



Reaction rules

Molecule definitions

Bivalent ligand



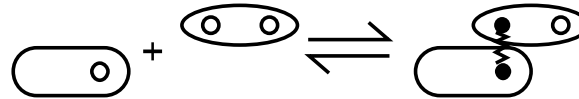
equivalent
binding sites



Bivalent receptor

Reaction rules

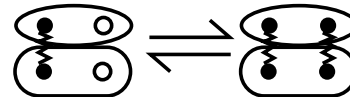
Ligand capture



Receptor chain elongation



Closure of a ring with one receptor



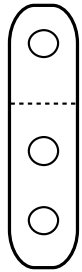
Closure of a ring with multiple receptors



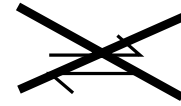
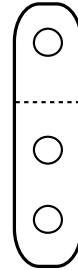
second receptor must be
contained within the same
complex

Compartment attribute

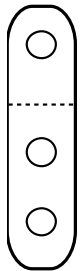
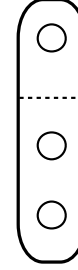
Compartment="intra"



"intra"



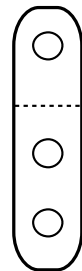
"extra"



Compartment="extra"

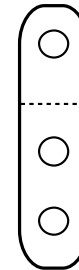
Compartment="membrane"

Compartment="intra"



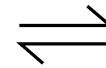
Compartment="intra"

"extra"

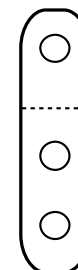


"membrane"

"intra"



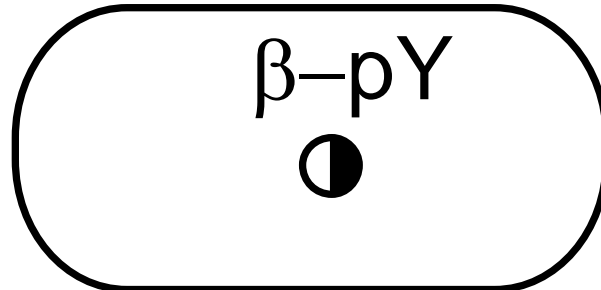
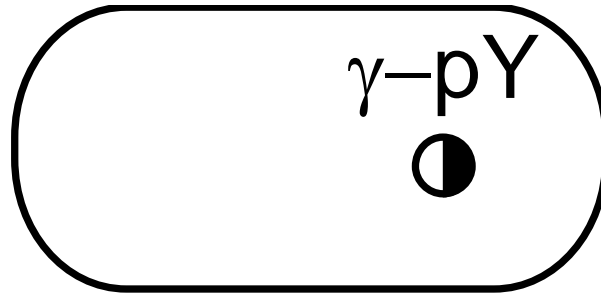
"intra"



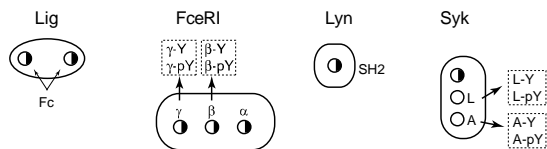
"intra"

"intra"

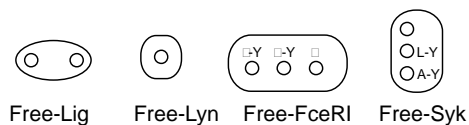
Observables=Macrospecies



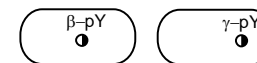
listOfMolecules



listOfSpecies

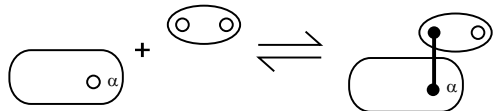


listOfObservables



(b) listOfReactionRules

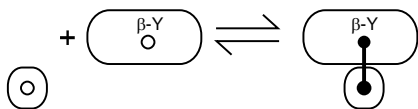
1. Ligand binding



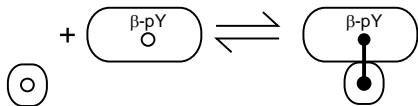
2. Ligand-induced aggregation



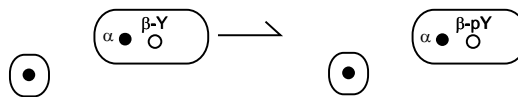
3. Binding of Lyn to unphosphorylated receptor



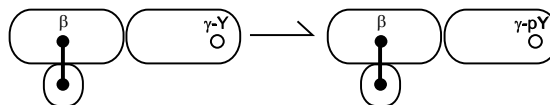
4. Binding of Lyn to phosphorylated receptor



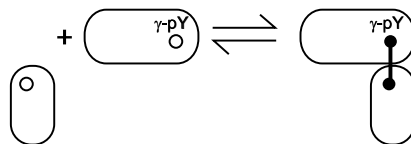
5. Transphosphorylation of β by Lyn



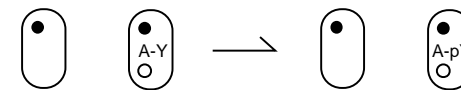
6. Transphosphorylation of γ by Lyn



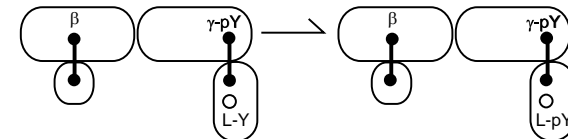
7. Binding of Syk to phosphorylated receptor



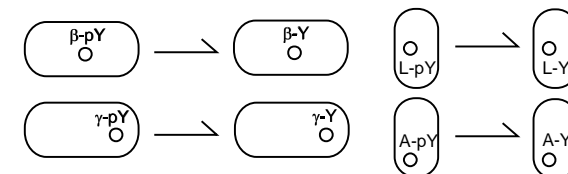
8. Transphosphorylation of Syk by Syk



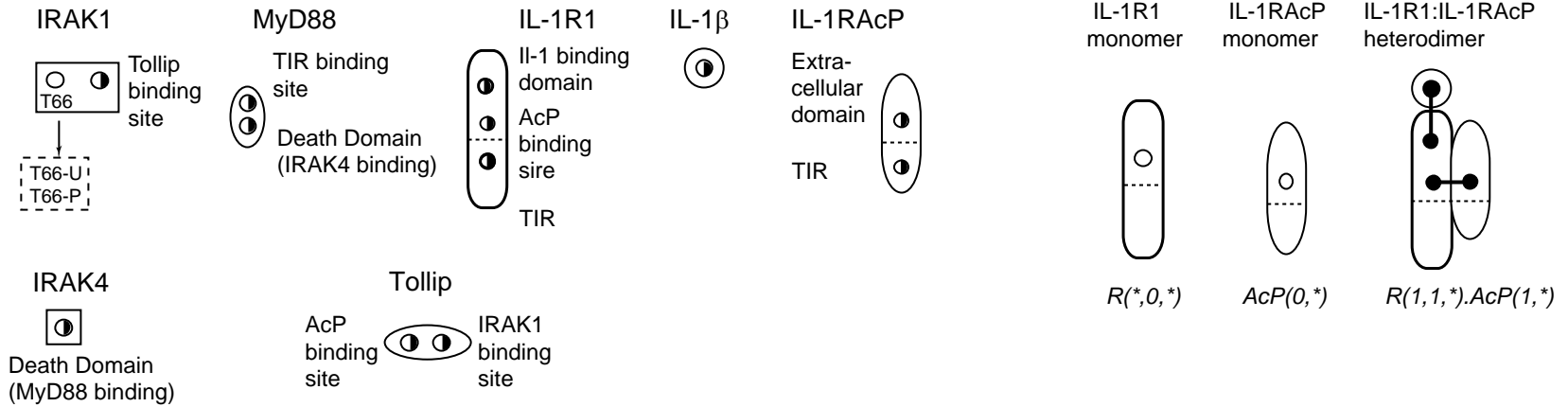
9. Transphosphorylation of Syk by Lyn



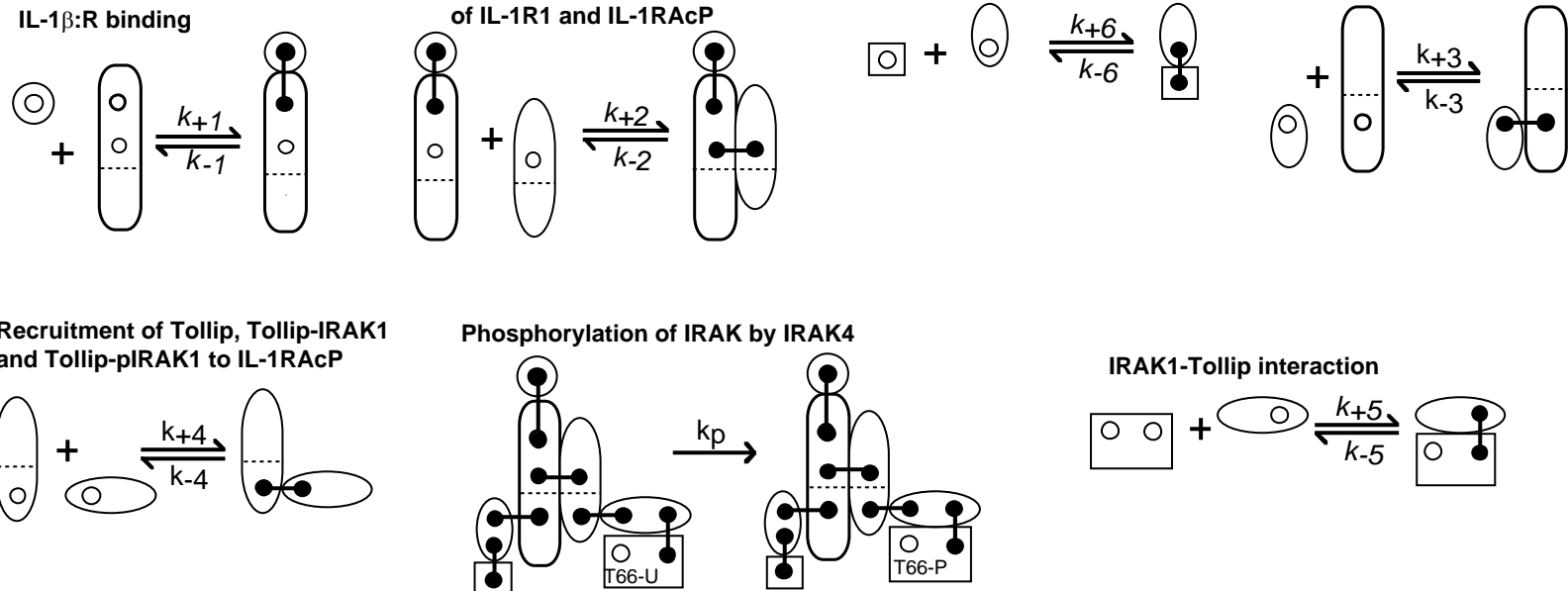
10. Dephosphorylation



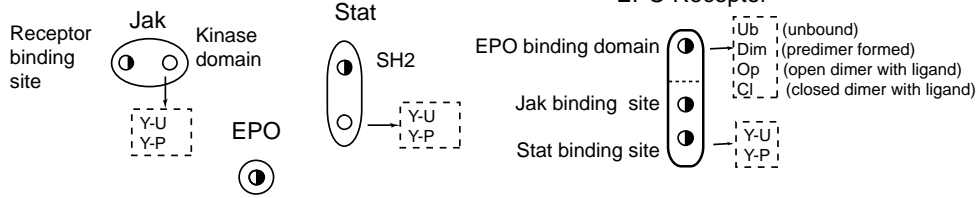
Graphical representation of molecules, their components and possible states of components:



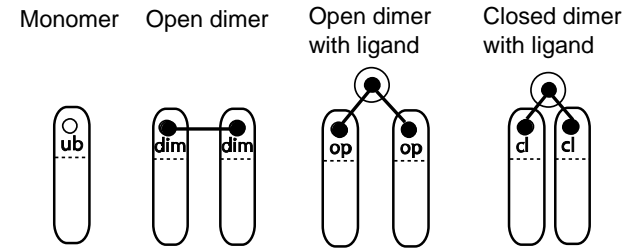
Reactions (103)



Graphical representation of molecules, their components and possible states of components:



Groups of multistate species:



Reactions (1934 reactions)

