

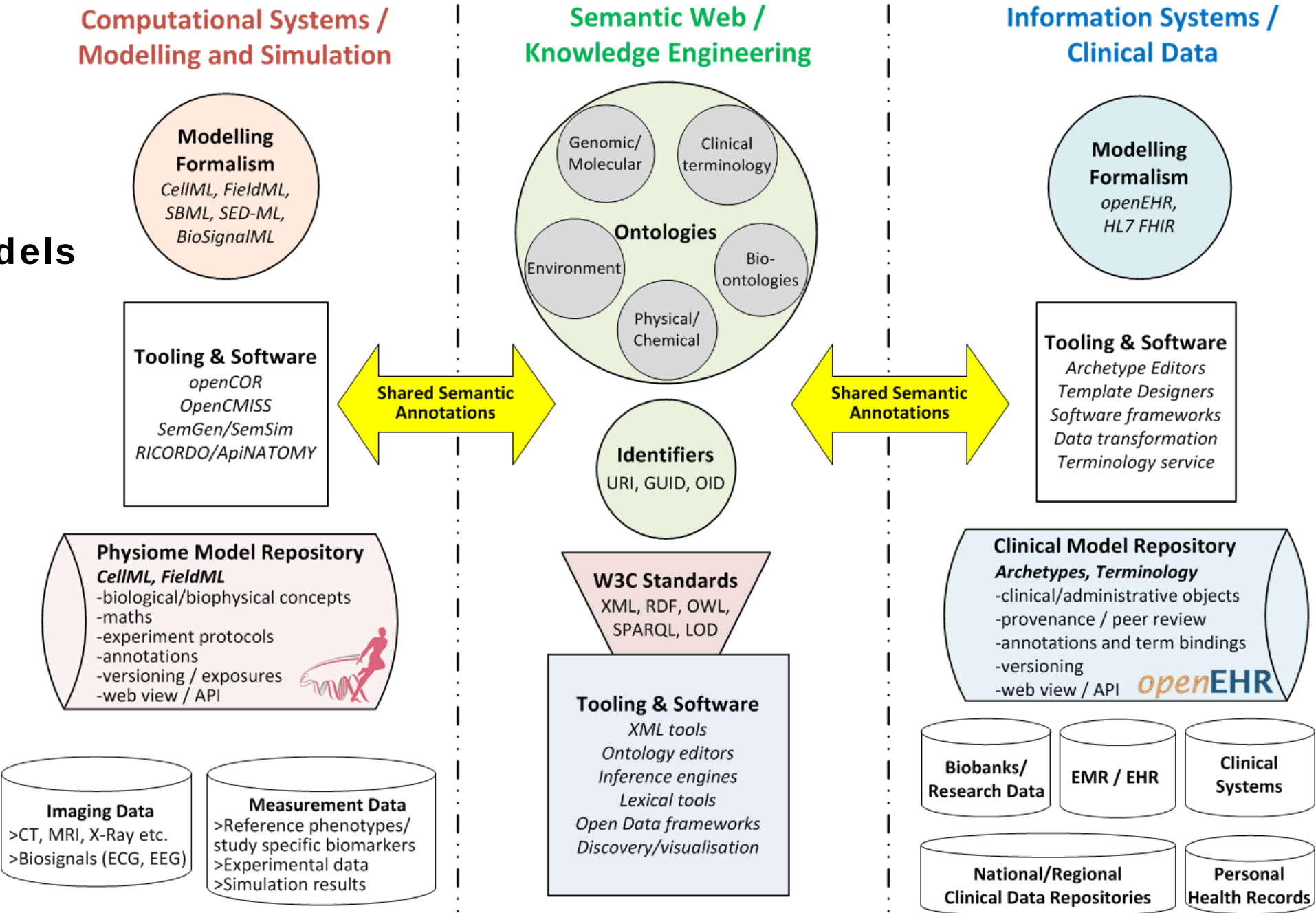
Model semantics for discovery, composition, and personalisation

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Tommy Yu, Peter Hunter



**AUCKLAND
BIOENGINEERING
INSTITUTE**

Big Picture:
Linking
Computational Models
to
Data

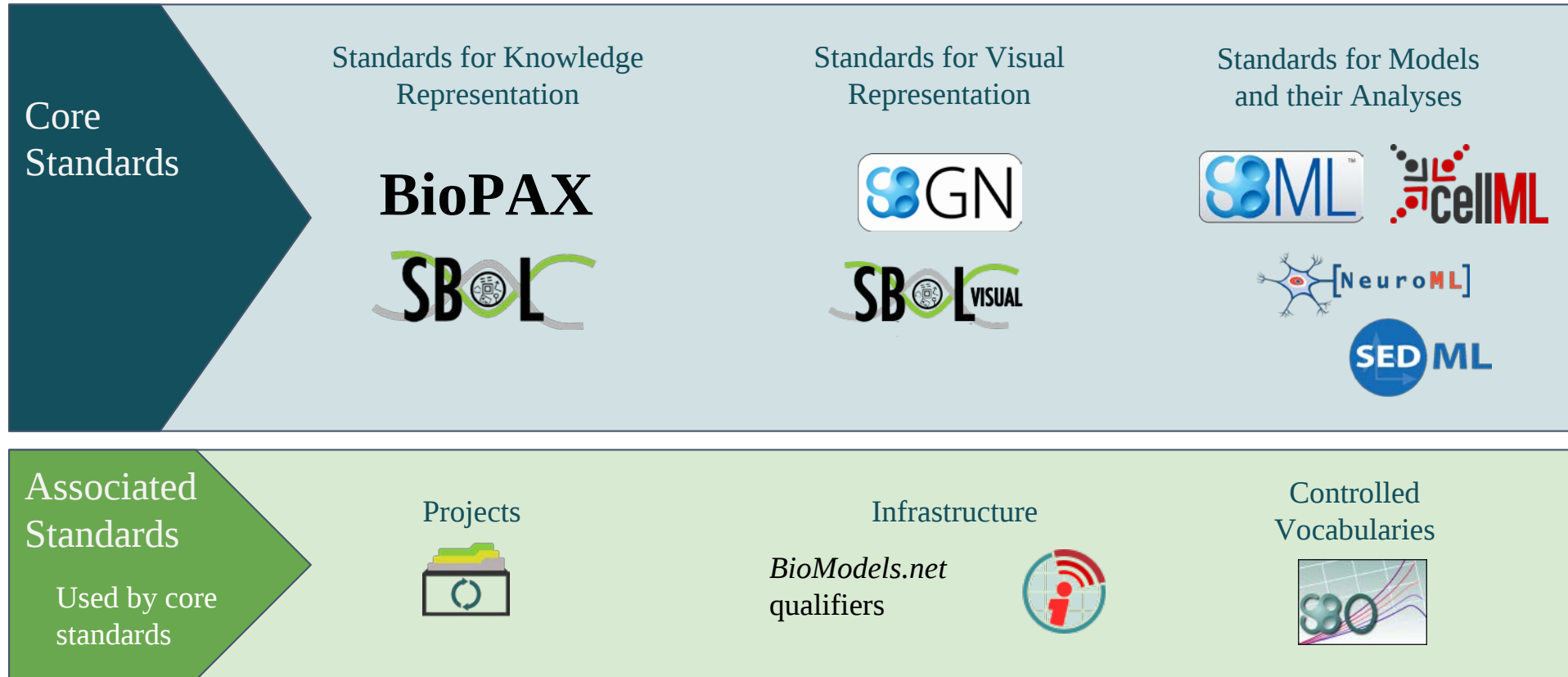


Standards

- Sharing, archiving, reuse, reproducibility



- Bond graph-based modelling frameworks
 - going beyond the math, capture the physics
 - essential for cross-domain modelling

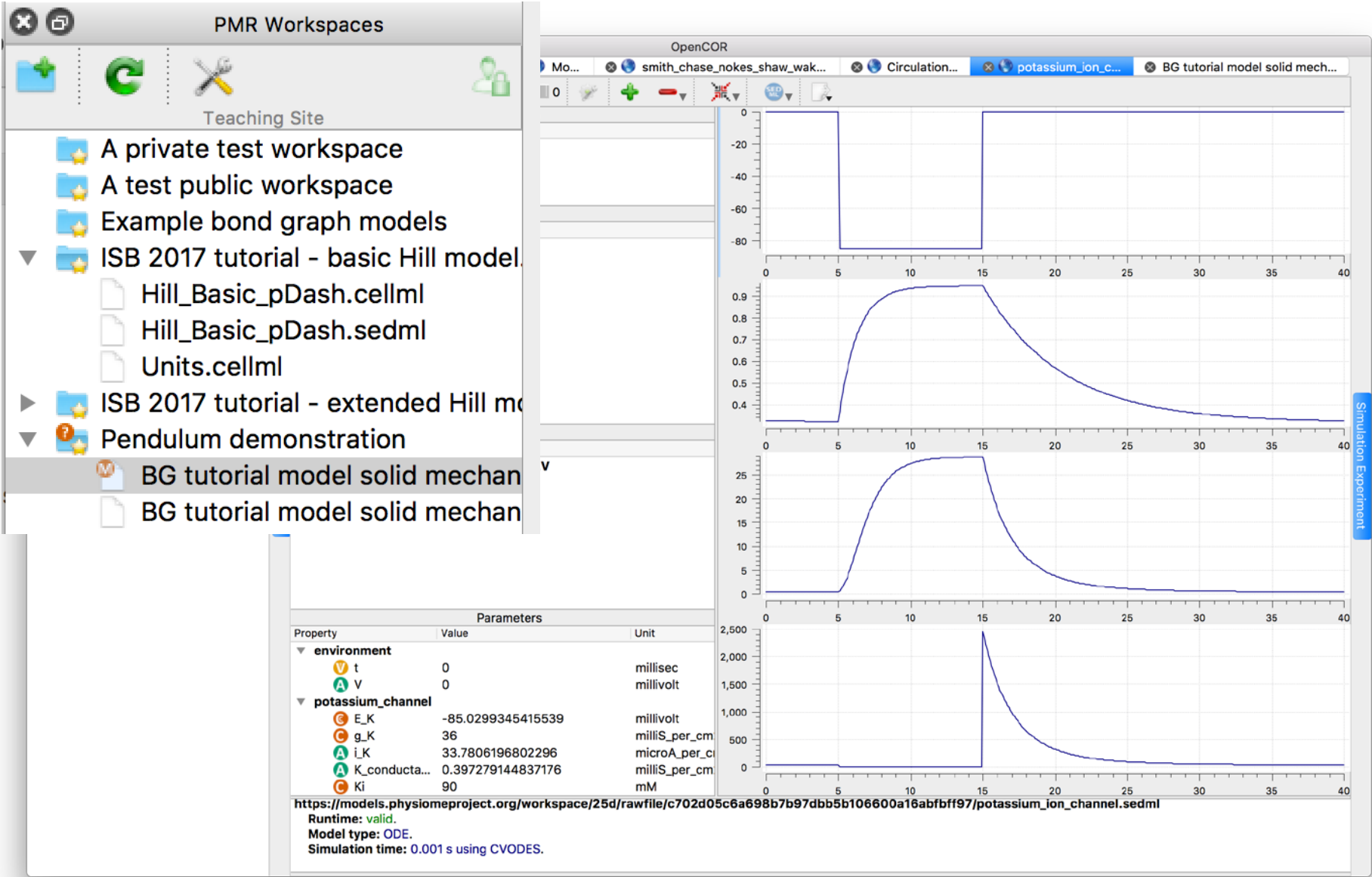


<http://co.mbine.org/>

Meeting in Boston this October: http://co.mbine.org/events/COMBINE_2018
(travel grants available for US-based students!)

Collaboration & comprehension

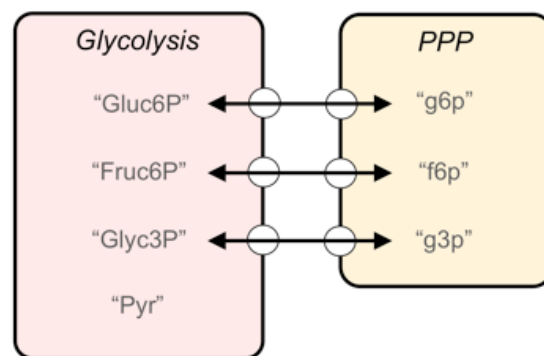
- Modularity and reuse
- Versioning, provenance, capturing key decisions
- Describing the model
- Common approaches for annotation – speak the “same” language
 - cross-repository discovery
 - cross-standard reuse and merging
 - common software tools
- Discovering relevant information



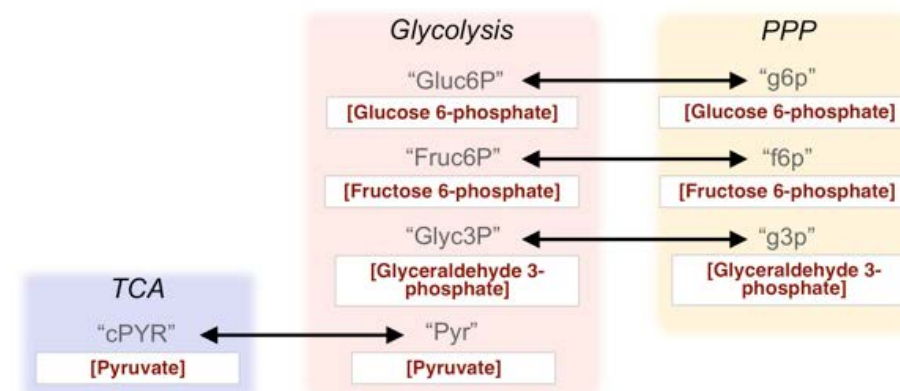
Semantic annotation

From Neal ML *et al.* PLoS Comp Bio, 2014.

A



B



Epithelial Model Platform

flux of sodium

View

Add to Model

Model_entity

☐ mackenzie_1996#NBC_curre

☐ mackenzie_1996#phenomon

☐ mackenzie_1996#ion_concer

☐ mackenzie_1996#rate_const

☐ mackenzie_1996#ion_concer

☐ mackenzie_1996#rate_const

☐ weinstein_1995#NHE3.J_NHE

☐ weinstein_1995#Concentratio

☐ weinstein_1995#NHE3.C_ext

☐ weinstein_1995#Concentratio

☐ weinstein_1995#NHE3.C_int

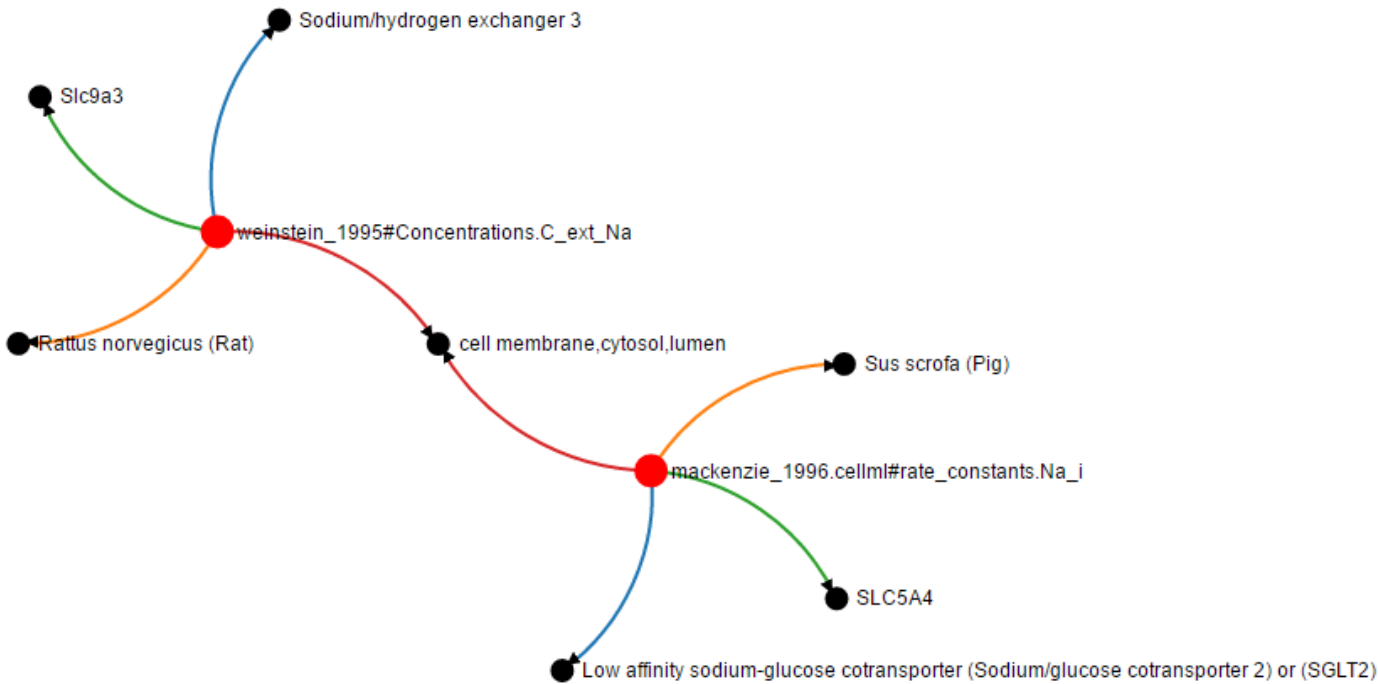
Epithelial Model Platform

Protein

Species

Gene

Compartment



Apical Membrane

Basolateral Membrane

Luminal Compartment

Cytosol Compartment

Interstitial Fluid

Paracellular Pathway

☐ J_mc_Na J_mc_Cl

☐ J_mc_K J_mc_Cl

☐ G_mc_Na channel

☐ G_mc_K channel

☐ G_mc_Cl channel

☐ J_sc_Na J_sc_K

☐ G_sc_Cl channel

☐ G_sc_K channel

☐ G_ms_Na diffusive channel

☐ G_ms_Cl diffusive channel

☐ G_ms_K diffusive channel

norvegicus

C_s_Na

Simulation experiments

- Annotate simulation experiments
 - common similarity tools
 - discover suitable protocols to test models
 - “continuous integration”
 - automated model validation?
- Cardiac Electrophysiology Web Lab

Available experiments

Show: [Moderated experiments](#) [All public experiments](#)

This matrix shows the latest versions (visible to you) of the models and protocols in our database, with the corresponding experiments.

Note that you can compare models' behaviours under a particular protocol by viewing the protocol (click on a column heading), selecting the 'Compare models' button, and comparing the experiments using models of interest. The converse comparison (one model, many protocols) is available via viewing a model.

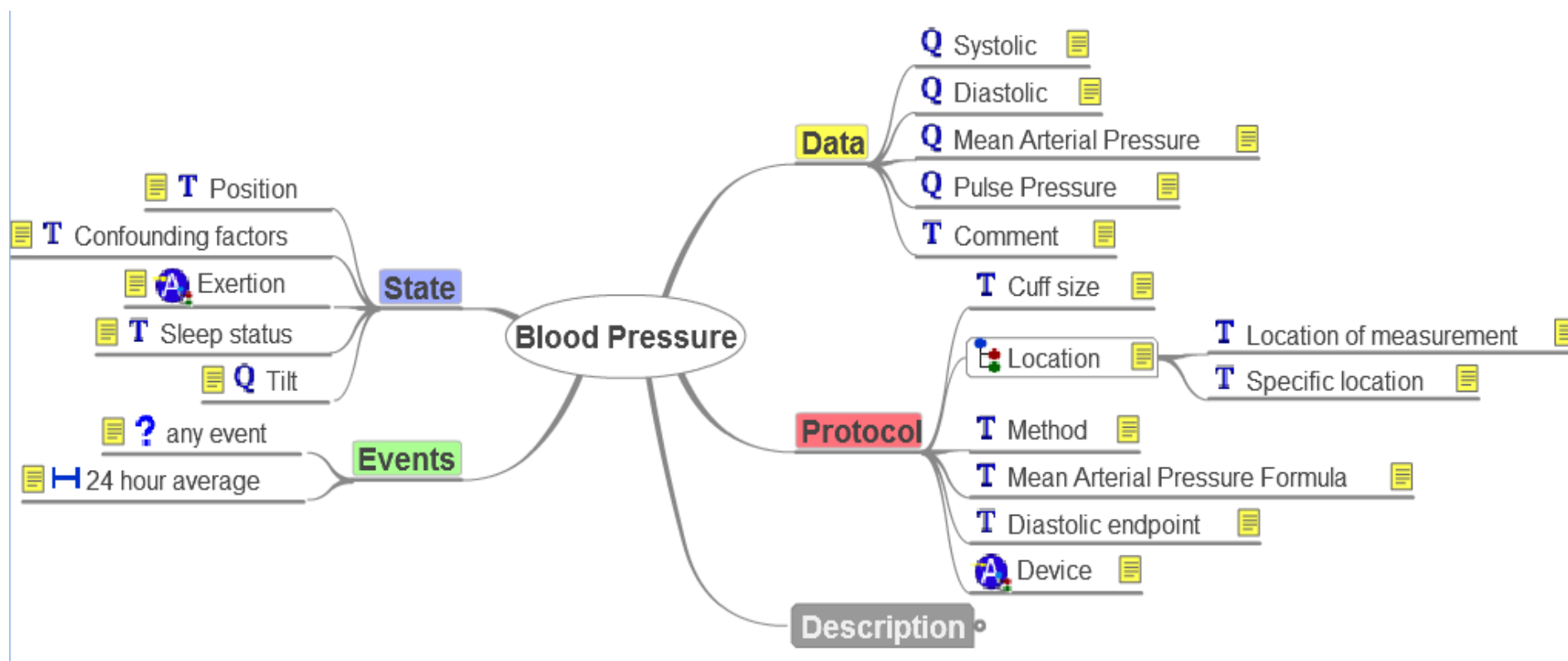
Alternatively, enable 'comparison mode' to allow selecting arbitrary experiments from this matrix view to compare. Click on a column or row heading to select the entire column or row.

Comparison mode: [Enable](#)

	Extracellular potassium variation	Graph state	ICaL block	ICaL IV Curve	IK1 block	IK1 IV Curve	IKr block	IKr IV Curve	IKs block	IKs IV Curve	INa block	INa IV Curve	INa late	Ito block	Ito fast block	Ito slow block	NCX block	RyR block	S1-S2 Restitution	Steady state 0.5Hz pacing	Steady state 1Hz pacing	Steady state 2Hz pacing	Steady state 3Hz pacing	Steady state 4Hz pacing	Steady State Restitution
Aslanidi atrial model 2009																									
Aslanidi Purkinje model 2009																									
Beeler-Reuter 1977																									
Benson 2008																									
Bernus 2002																									
Bondarenko 2004 Apical																									
Carro 2011 Endo																									
Carro 2011 Epi																									
Clancy Rudy 2002																									
Courtemanche 98																									
Decker 2009																									
DiFrancesco Noble 1985																									
Earm Noble 1990																									

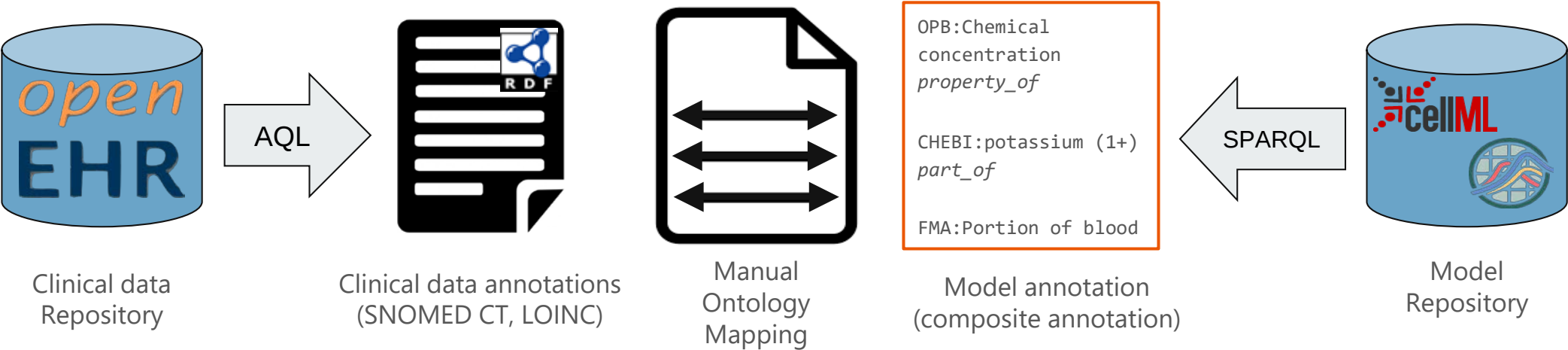
<https://travis.cs.ox.ac.uk/FunctionalCuration/db>

Clinical data annotations



mindmap representation of openEHR Archetype

Clinical data annotations



Result: Experimental & Simulation Data Integration

Extended prototype cardiac electrophysiology web lab to link to experimental data described in an openEHR database.



Acknowledgements



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 - Centre for Reproducible Biomedical Modeling
 - <http://reproduciblebiomodels.org/>
- **Aotearoa Foundation**