Workspaces, exposures, and multiscale modelling

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Te Whare Wānanga o Tāmaki Makaurau

PMR2

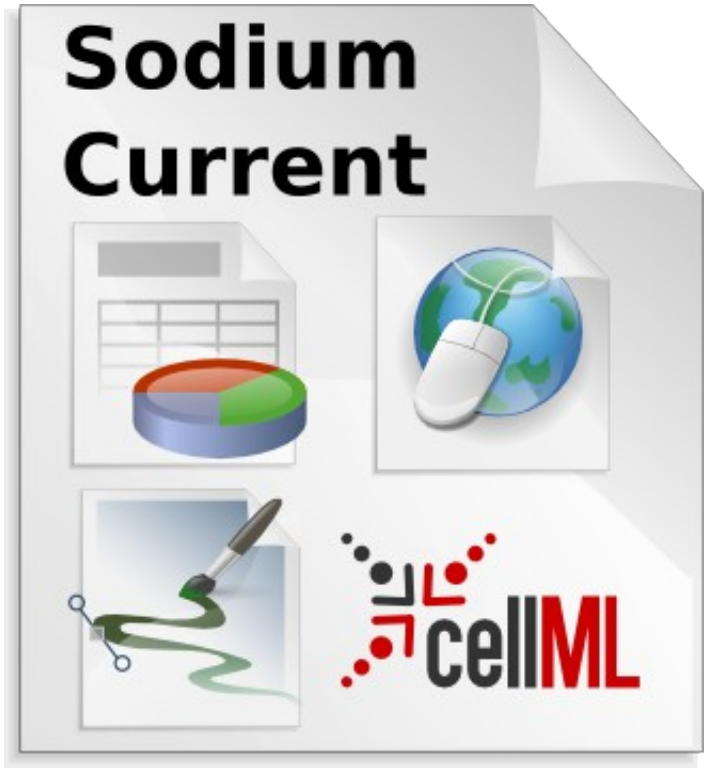
- Workspace – data agnostic mercurial repository
- Changeset – a representation of a single revision of the content of a workspace
- Exposure – a permanent link to a specific changeset with data rendered for the web
- Exposure plug-ins – an extensible framework for rendering workspace content for web presentation
- Plone CMS – workflow manager; user access controls; web presentation; etc.

An example from computational physiology

- Build up a multiscale model of the renal nephron
  - ion transporters, cellular models, segmental models, whole nephron...
- Share the various models with collaborators
- Publish the model along the way

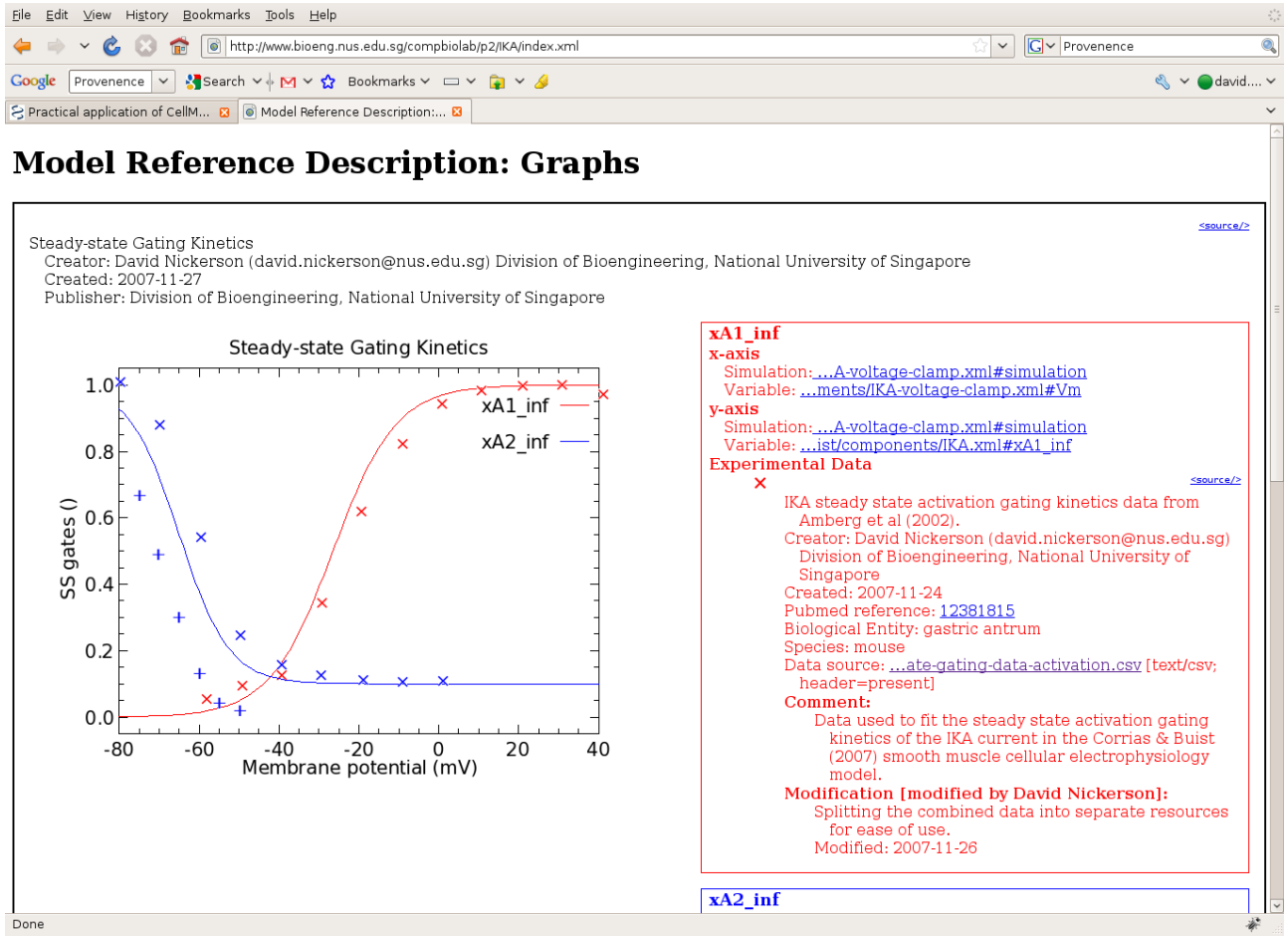
- Disclaimer: not all the following features are implemented/integrated in either language specifications and/or supporting software tools – and such features may change considerably before they are supported.

Membrane transporters



(Workspace)

Membrane transporters



File Edit View History Bookmarks Tools Help

Constituents of the Renal Nephron

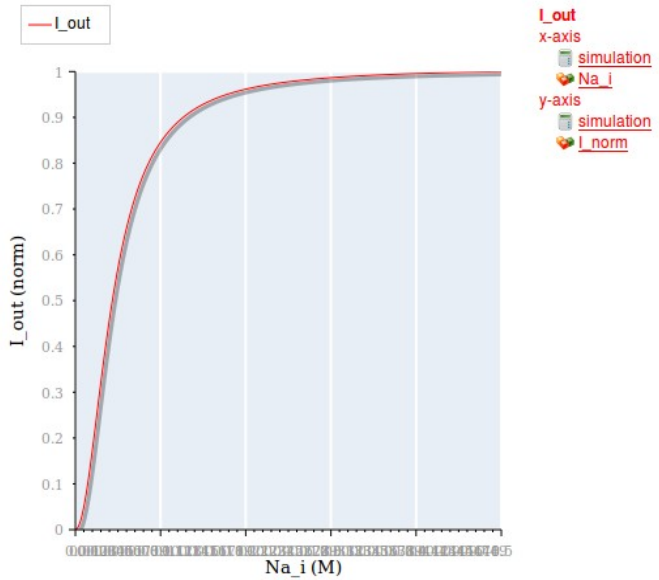
Constituents of the Renal Nephron

David Nickerson (2010-04-19)

Help

- Constituents of the Renal Nep
  - Eskandari et al (2005)
    - Eskandari et al (2005)
      - Figure 2(b)
    - Eskandari et al (2005)
      - Figure 3(a)
      - Figure 3(b)
    - Eskandari et al (2005)
      - Figure 4
  - Mackenzie et al (1996)
    - Figure 3(a)
    - Figure 3(b)
    - Figure 3(c)
    - Figure 3(d)

Reproduction of figure 4 from Eskandari et al (2005).



I_out
x-axis
simulation
Na_i
y-axis
simulation
I_norm

I_norm

Units: dimensionless
Defined in math container: Na_i

Na_i

+ Created: 2010-04-21, David Nickerson

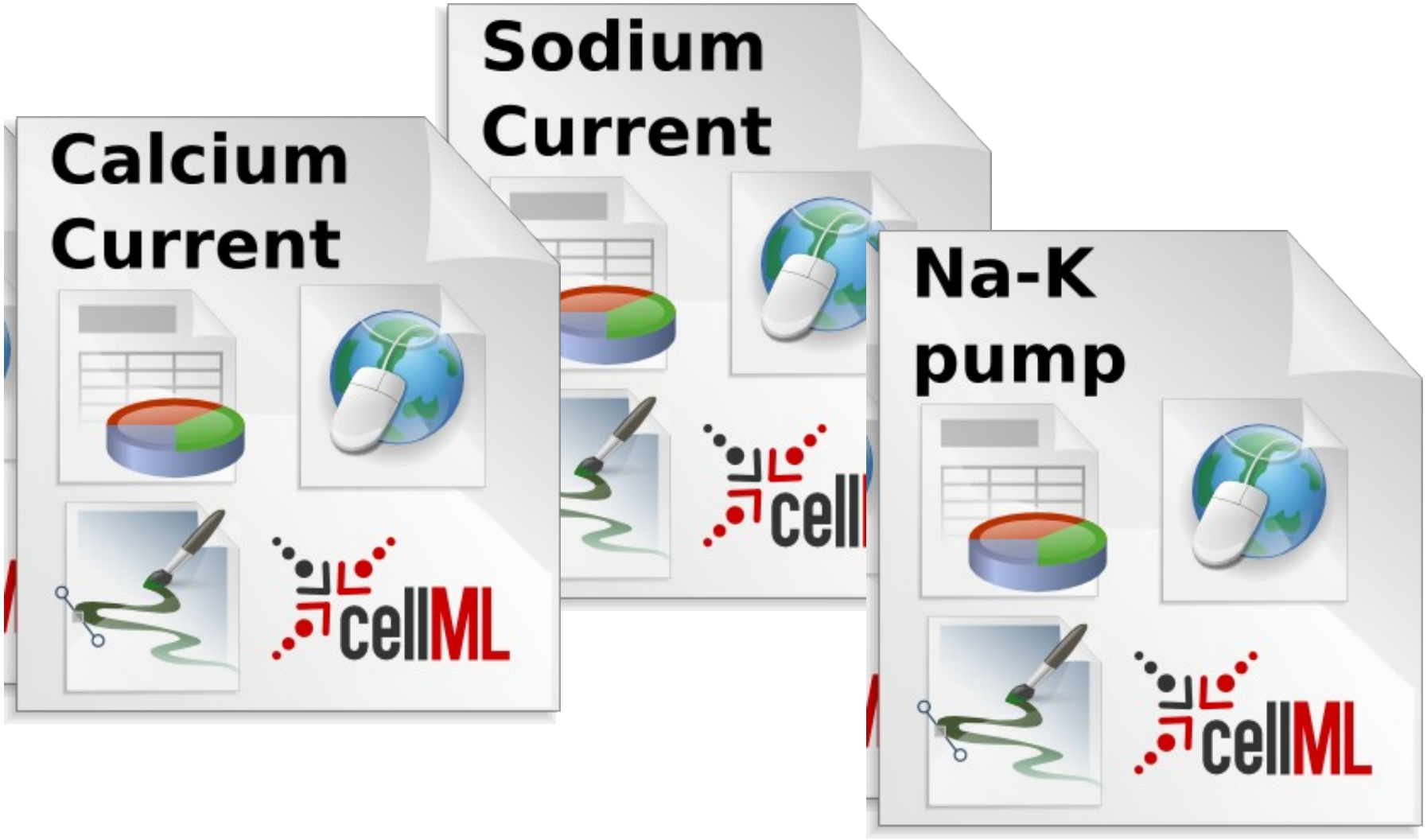
$$\frac{dNa\_i}{dtime} = [1.0e\text{-}3 M\_per\_second]$$

$$I\_norm = I\_NaGl\_SS / [6.29510065e\text{-}06 uA]$$

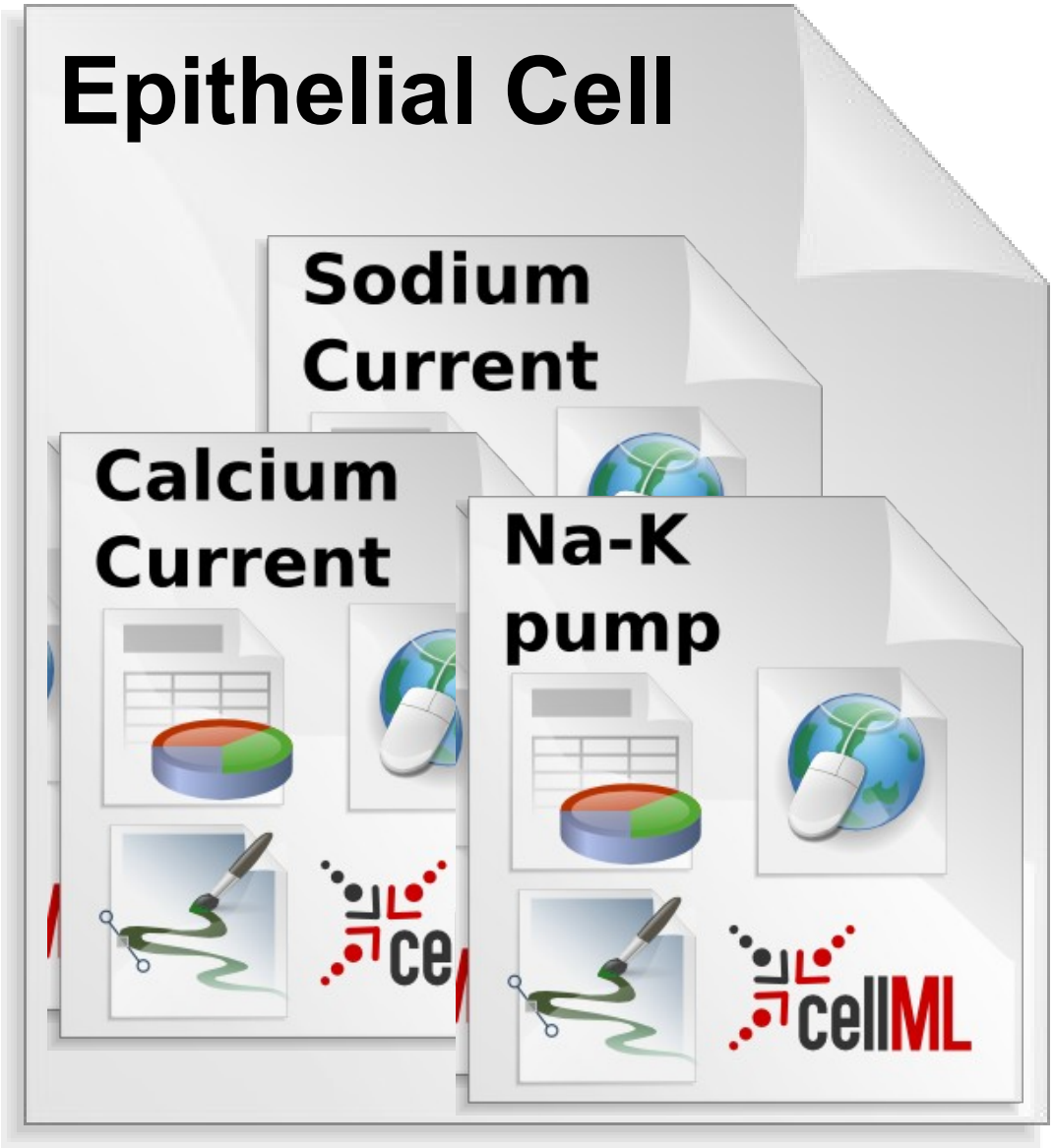
Generated by: CellMLSimulator (version: CellMLSimulator 0.3.0-devel-json - revision 221M - Sat Apr 17 13:07:26 NZST 2010) at Thu 22 Apr 2010 07:56:51 SGT

javascript:;

Membrane transporters



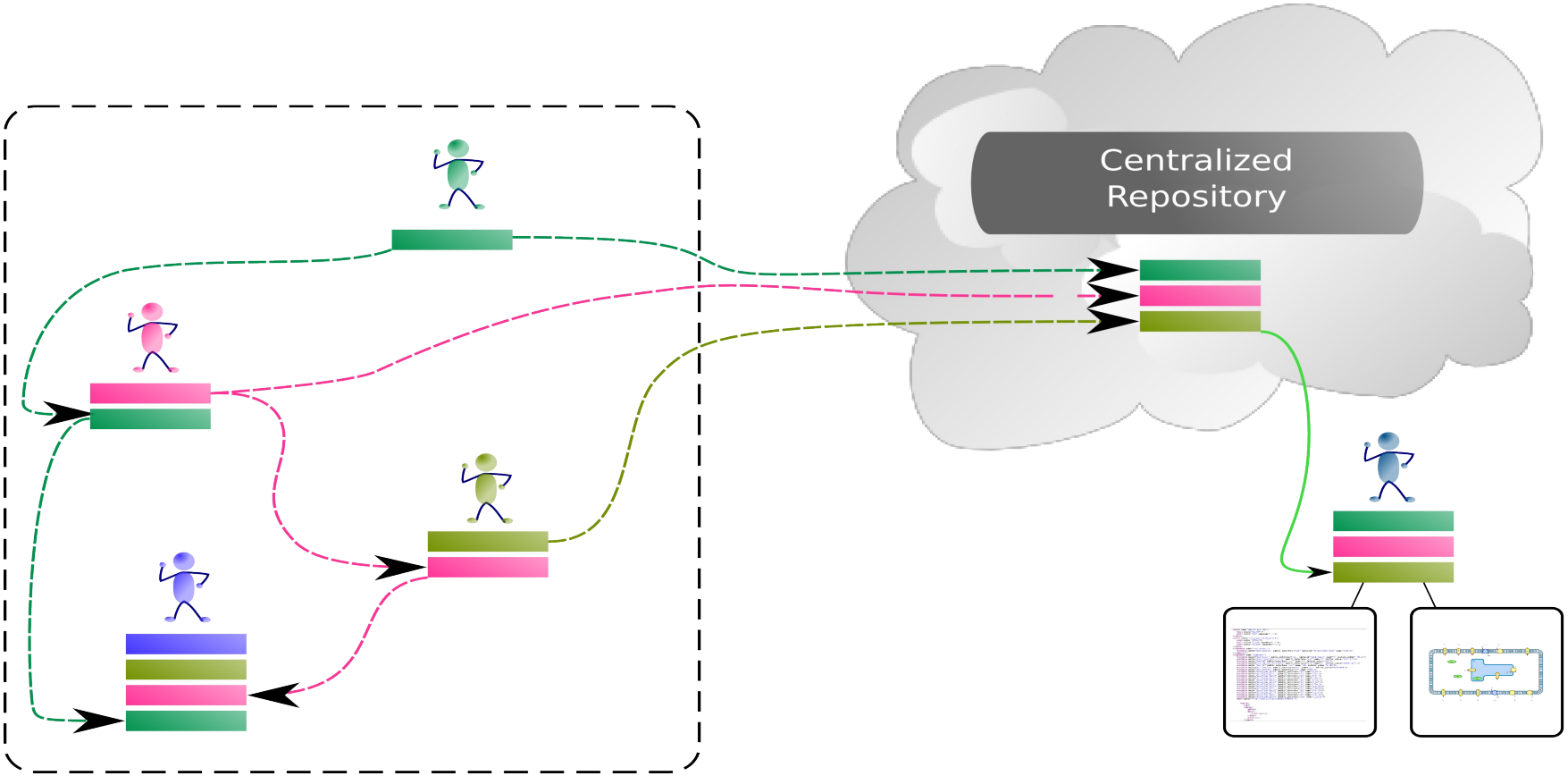
Assemble a cell model



Embedded workspaces

- Intended to manage the separation of modules which are integrated to create a model
- Facilitate the sharing and reuse of model components independently from the source model
- Enables the development of the modules to proceed independently, thus the version of the workspaces embedded is also tracked
- Allows authors to make use of relative URIs when linking data resources providing a file system agnostic method to describe complex module relationships in a portable manner

Collaborative model development



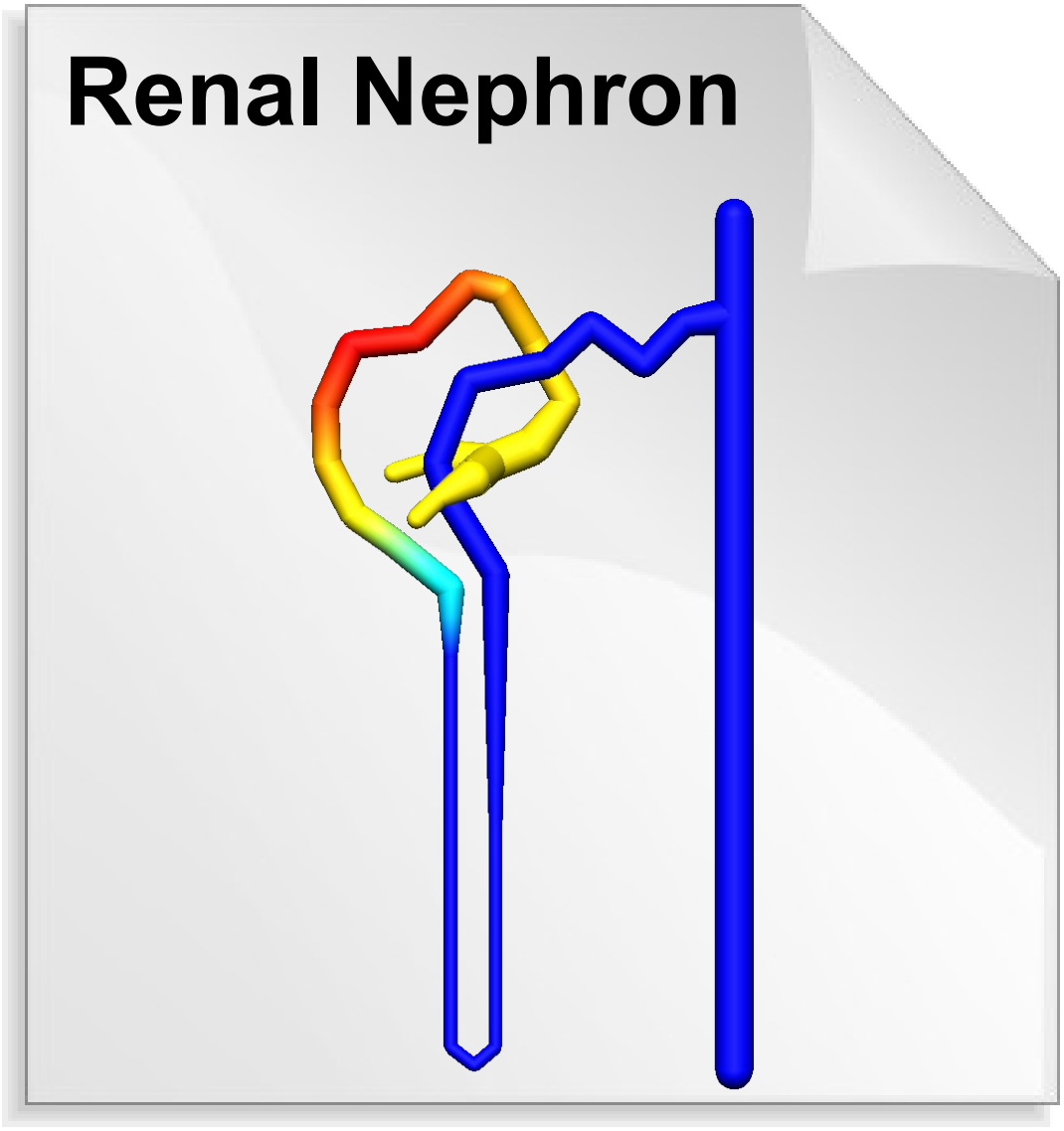
Versioning embedded workspaces

- Workspaces can be embedded at a specific revision or set to track the most recent revision of the source workspace
- Changes made to the source workspace will not affect the embedding workspace until the author explicitly chooses to update the embedded workspace
- Provides the author with the opportunity to review the changesets and make an informed decision regarding alterations to embedded revisions

Data agnostic workspaces

- Generic mercurial repositories
- Can contain any format data (currently relatively unrestricted)
  - CellML, SBML, FieldML, SED-ML, PDF, .doc, ...
- No restriction to models only
  - experimental data, simulation results, generated images, ...

Multiscale models



File Edit View History Bookmarks Tools Help

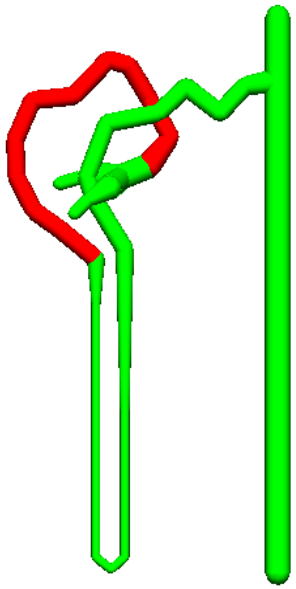
Nephron Interface

The Renal Nephron

Close all

- Nephron
  - Anatomy
    - Efferent Arterio
    - Afferent Arterio
    - Glomerulus
    - Proximal Tubul
      - Proximal Co
      - Proximal Str
    - Loop of Henle
    - Macula Densa
    - Distal Convolut
    - Connecting Tub
    - Collecting Duct
  - Physiology
    - Efferent Arterio
    - Afferent Arterio
    - Glomerulus
    - Proximal Tubul
    - Loop of Henle
    - Macula Densa
    - Distal Convolut
    - Connecting Tub
    - Collecting Duct
  - Modelling Studies
    - SGLT2 Inhibitio
      - Na-glucose
      - Control
      - Inhibited

Input mode: Picking | Reset view | nephron segment cell protein



Proximal Tubule

First of the transporting tubule segments.

From the Bowman's Capsule, the filtered fluid enters the first of the reabsorptive epithelial tubule segments – the proximal tubule. The proximal tubule consists of a convoluted portion and a straight portion. This segment has a high transport activity and is responsible for the bulk of the salt and water reabsorption. Furthermore, the majority of the key organic molecules (glucose and amino acids), as well as other important ions (K, Ca, HCO3), are actively reabsorbed in this segment.

Related CellML models:

- Weinstein et al (2007)
- Thomas and Dagher (1994)

Proximal Convoluted Tubule

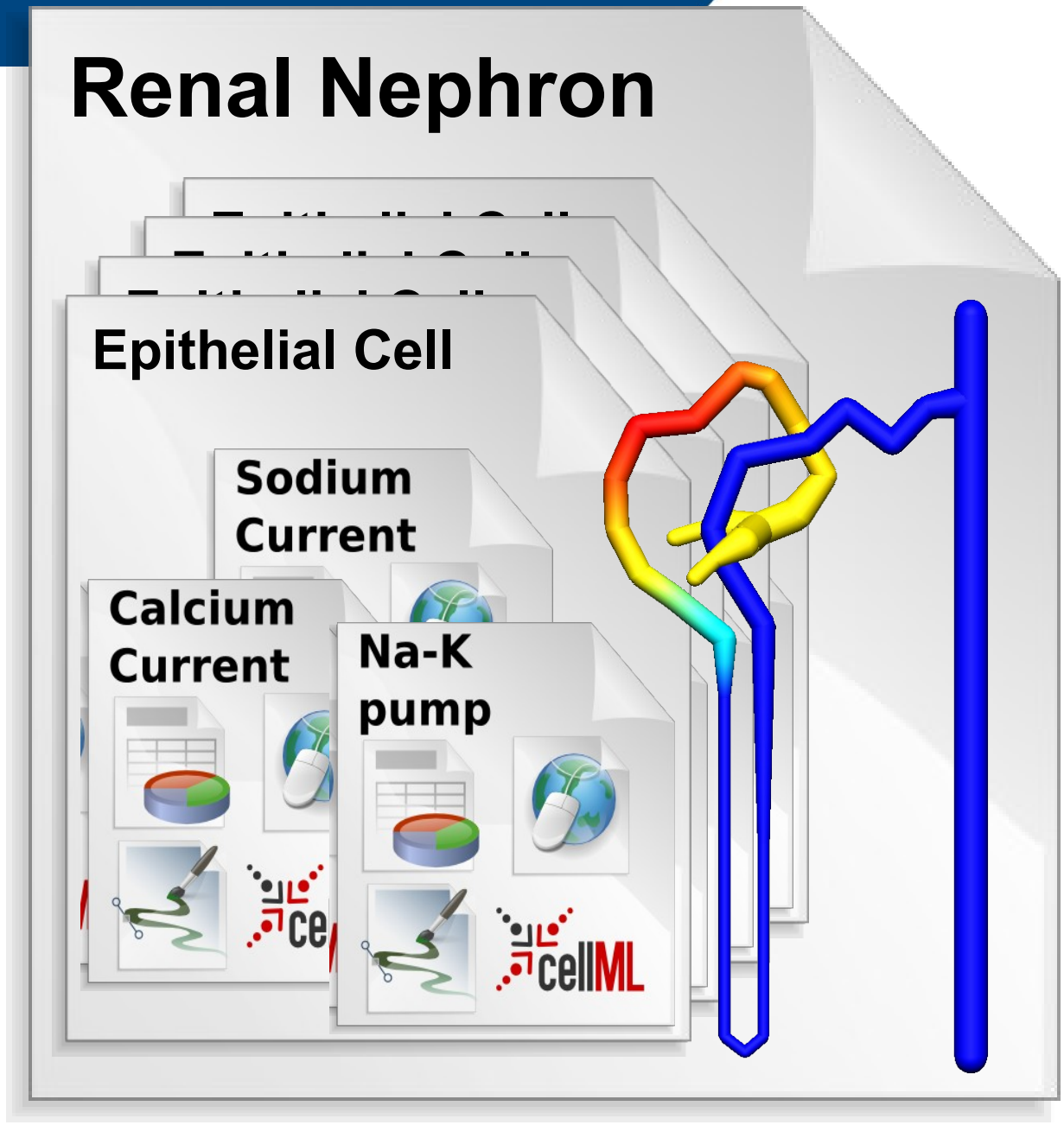
Convoluted portion of the Proximal Tubule.

As its name suggests, the proximal convoluted tubule undergoes a convoluted trajectory through the cortical region of the kidney, primarily the cortical labyrinth.

Nephron

David Nickerson April 2010

Done


Renal Nephron
Epithelial Cell
Sodium Current
Calcium Current
Na-K pump
cellML

OpenCMISS

- Connecting variables in CellML models to field components in a finite element model
  - Prototype for linking CellML and FieldML models?
- Allows information to flow in both directions
  - Field values can be controlled by the CellML model and CellML model variables can be controlled by field components
- Will have the ability to make use of many different CellML models which can be simulated independently
- Each CellML model may be replicated many millions of times for large scale problems
  - Distributed computing, GPUs, FPGAs, ...

Acknowledgements

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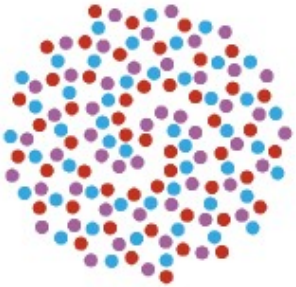
wellcome trust



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