The VPH-Physiome Project:
CellML, FieldML, PMR2
Funding VPH-Physiome infrastructure

Physiome Sciences 1995 - 2002
IUPS Physiome Project 1996 -
Wellcome Trust 2004 - 2009
FRST NERF
NZIMA 2002 - 2010 MWC 2002 -

VPH @neurIST 2006 - 2010

VPH NoE, VPH euHeart 2008 - 2013
eBonz 2009 -
VPH Ricordo 2010 - 2012
VPH MSV 2010 - 2012
IMI PKPD application 2011 - 2015?
Example of clinical workflow

1. Load patient DICOM images
2. Segment images
3. Fit model from virtual population database
4. Compute organ function
5. Derive diagnostic index or treatment strategy

- Image toolkit
- Fitting algorithms
- Model repository
- Visualisation software
- PACS system
- Computational software library
Key requirements

1. Minimum information standards
   (MIRIAM, MIASE)
2. Markup languages for models and data
   (CellML, SBML, FieldML, DICOM, BioSignalML, ...)
3. ML standard for the simulation experiment
   (SED-ML)
4. Models and data repositories
   (CellML, BioModels)
5. Meta data standards & tools for annotating the models
   (RDF, SAINT)
6. Tools for authoring models, running simulations,
   visualising models & data (OpenCell, cmgui, OpenCMISS, ...)
7. Mechanisms for handling the ref description of a model
8. Support for workflows based on web services
The reference description of a model

CellML, SBML, FieldML

Model database

Parameter database

DICOM, BioSignalML

Experimental data

Model simulation

Publication results & validation

SED-ML

Simulation parameters
The main infrastructure projects

Standards, website, model repository, tools, documentation,..
Open source, freely available, community projects

CellML
OpenCell
www.cellml.org

FieldML
Cmgui/Zinc
www.fieldml.org

ModelML (?)
OpenCMISS
www.OpenCMISS.org

PMR2: CellML & FieldML models
Software infrastructure

**Web accessible databases**
- FieldML model repository
- CellML model repository

**Open source libraries**
- XUL, Qt
- Python
- ITK
- OpenGL
- CGUI
- Python
- ITK
- OpenGL
- CGUI

**Computational code library**
- MPI, OpenMP
- PETSC
- PETSC
- LAPACK

**GUI, Visualisation**
- Image processing
- Data fitting
- CGUI, GIMIAS

**Cell/tissue/organ**
- PDE simulation code
- openCMISS
- Continuity
- Virtual Cell

**ODE integrator**
- PCEnv
- COR
- JSim

**Parameters for spatial location**
- V, Ca^{2+}, etc

**Web accessible databases**
- FieldML API (FMA)
- CellML API (GO, BioPax)

**Software infrastructure**
- GCC
- GSL
- CVODE
- ...
RICORDO: A communal annotation strategy that supports the interoperability of VPH data and models across different biological scales

WP6: VPH toolkit organ-level pilot study:
Volumetric data and models

Interoperability requirements for computational heart modelling
Material coordinates locate any material point
Model provides framework for aligning data

Radiological data

Structural data

Molecular data

Mathematical model
Mapping FMA to spatial models

- Myocardial anatomy
- Coronary vasculature
- Purkinje system
- Autonomic nerves

Geometric field

Material coordinates

Entity
Some future requirements

Component annotation – metadata, OBO Foundry, SAINT (very important for returning models from web queries)
Reference descriptions using CellML, SBML, SED-ML (for demonstrated model reproducibility)
More domain-expert curators (Catherine needs a team!)
Parameters with stochastic or population variation (for PKPD and parameter estimation)
Webservices to facilitate use of models in larger workflows
Thanks to Catherine!