Biomechanics and the VPH/Physiome Project

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ABSTRACT

Multi-scale models of all twelve of the body's organ systems are being developed under the umbrella of the Physiome Project of the International Union of Physiological Sciences (IUPS) and the Virtual Physiological Human (VPH) project funded by the European Commission. These computational physiology models deal with multiple physical processes (coupled tissue mechanics, electrical activity, fluid flow, etc.) and multiple spatial and temporal scales [1–4]. They are intended both to help understand physiological function and to provide a basis for diagnosing and treating pathologies in a clinical setting. Some of these models are illustrated in Fig. 1. Most use high order finite element techniques to represent spatial fields.

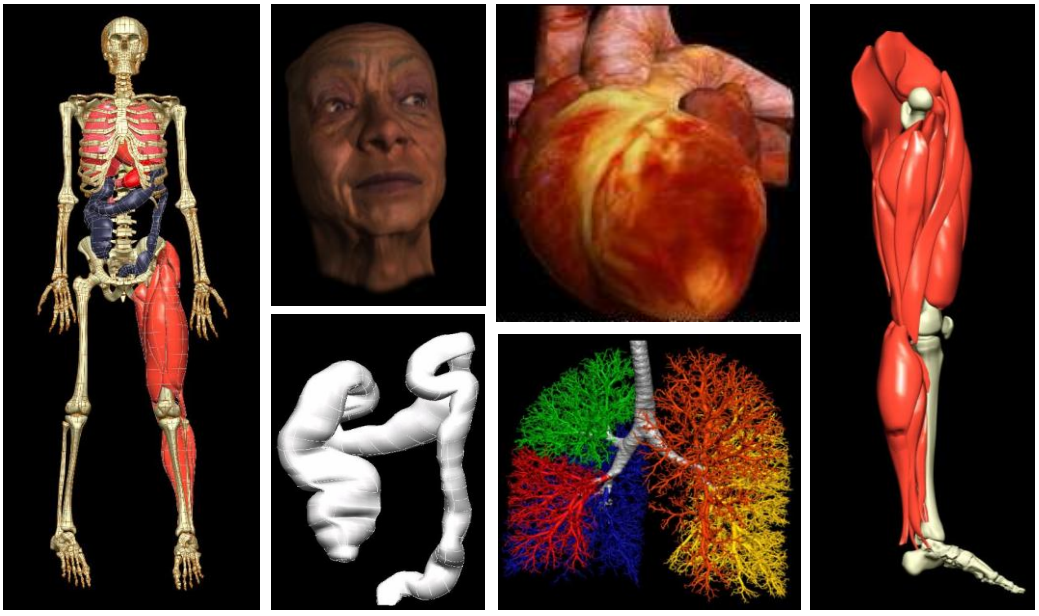

Figure 1: Illustrations of computational models being developed for the VPH/Physiome project.

A major goal is to use computational modeling to analyze integrative biological function in terms of underlying structure and molecular mechanisms. The project is therefore establishing web-accessible physiological databases dealing with model-related data at the cell, tissue, organ and organ system levels. Some of the cell level models dealing with molecular mechanisms are illustrated in Fig. 2.

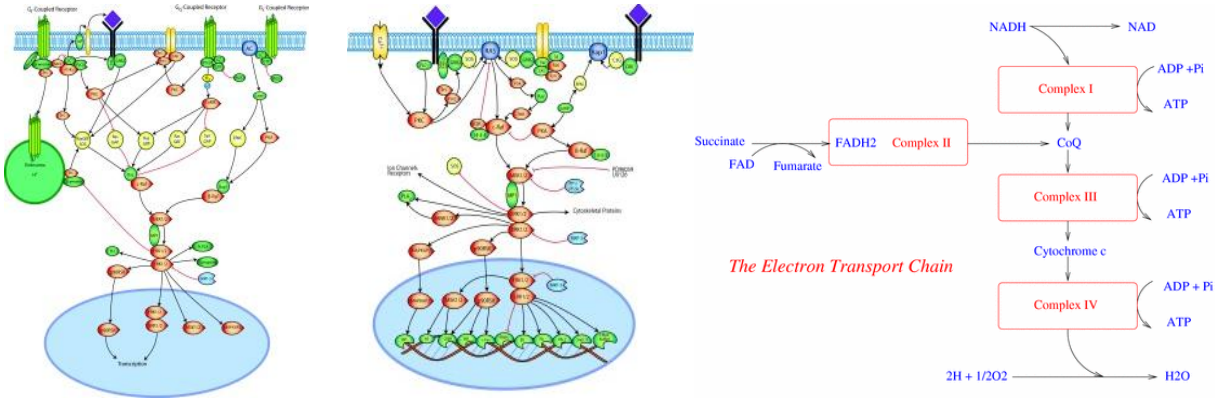

Figure 2: Illustrations of CellML models being developed for the VPH/Physiome project.

This talk will discuss some of the modelling and computational challenges and the current state of the standards, databases and software being developed to support robust and reproducible multi-scale models for the VPH/Physiome project. These standards include CellML and FieldML for encoding models and BioSignalML for encoding time-varying signal data, together with model repositories and software tools for creating, visualizing and executing the models based on these standards [5, 6].

References

[1] P.J. Hunter and T.K. Borg, Integration from proteins to organs: the Physiome Project. *Nat. Rev. Mol. Cell Biol.* 4:237-243, 2003.

[2] E.J. Crampin, M. Halstead, P.J. Hunter, P.M.F. Nielsen, D. Noble, N.P. Smith and M. Tawhai, Computational physiology and the Physiome Project. *Exp. Physiol.* 89:1-26, 2004.

[3] P.J. Hunter and P.M.F. Nielsen, A strategy for integrative computational physiology. *Physiology* 20:316-325, 2005.

[4] P.J. Hunter, Modeling living systems: the IUPS/EMBS Physiome Project. *Proc. IEEE* 94:678-691, 2006.

[5] `www.cellml.org`

[6] `www.fieldml.org`