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MULTISCALE MODELLING IN MECHANOBIOLOGY: FROM LOWER SCALE INTERACTIONS TO MACROSCALE TISSUE FUNCTION AND REGULATION

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ABSTRACT

The behaviour of biological tissues is finely tuned by the translation of nanoscale properties into specific microscale ultrastructure and multiphysics properties, shaping functional macroscopic responses to external perturbations. The proper function of these multiscale interactions, however, requires maintenance of the extracellular matrix by cells that are both chemo- and mechano-sensitive. In particular, cells non-affinely respond to external perturbations depending on mesoscale deformation fields that might result from intricate interplays among organ structure, tissue composition and ultrastructure. Combining experimental /clinical evidences with multiscale models and simulations has already pointed out mechanisms through which these interplays influence multiphysics signal transduction and cell behaviour [1,2,3].

Strategies to treat degenerative tissue diseases or trauma need to include the effects of mechanical loads from the whole organ, tissue and cellular /molecular scales. While this need is especially strong to manage musculoskeletal disorders, it also emerges to cope with other diseases such as cancer. Computational modelling is the cornerstone of the integration of biological and mechanical effects into comprehensive mechanobiological mechanisms for tissue function regulation over several scales, in health and disease. Accordingly, important research challenges, today, include:

1) Tissue modelling, including functional anisotropy, scale effects, large deformations, and multiphysics behaviours;
2) Coupling of biomechanical models to systems biology models, e.g. for bottom up approaches of complex tissue regulation processes; and
3) Large-scale simulations for top-down quantification of the effects of external perturbations on the structural scale.

This mini-symposium aims to gather presentations from worldwide specialists in the simulation of biomechanics- and mechanobiology-related mechanisms involved in tissue homeostasis regulation and/or in the pathophysiology of specific disorders. It will offer a unique room for integrated discussions towards tackling the aforementioned challenges in computational multiscale biomechanics and mechanobiology.

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