PhD proposal F/H MATHEMATICAL MODELING OF MUSCLE TISSUE ARCHITECTURE EMERGENCE AND AGEING

SHORT SUMMARY

Tissue architecture, which is closely related to age-related diseases and functional decline of tissue, is continuously challenged throughout life and preserved by repair mechanisms. In skeletal tissue, the most common aged-related diseases, sarcopenia, is characterized by a loss of skeletal muscle function associated with fibrosis, an excess of extracellular-matrix (ECM). It highlights the need for a better understanding of muscle tissue morphegenesis and its maintenance. In this project, we aim to identify key factors of muscle architecture by developing a mathematical model and interfacing this model with in vivo data to facilitate the identification of potential targets for preserving muscle function during aging.

A first step in this PhD is to investigate the mechanism leading to the emergence of muscle spatiotemporal structures by developing an individual-based model composed of a minimal set of heuristic (mechanical) rules to identify the key factors required to recover realistic structured patterns observed. Once calibrated to produce realistic muscle architectures, and validated on experimental data, we will focus on the mechanical characterization of the model. The synthetic tissue at equilibrium will be subjected to traction and compression tests by controlled motion of the boundary, enabling to extract mechanical quantities. Finally, we will take an interest in the robustness and stability of the structures subject to perturbations, to study tissue maintenance, regeneration and ageing by investigate the effect of repeated muscle contraction/relaxation cycles on the stability of the model structures.

The project will be highly interdisciplinary, as the mathematical model will be systematically confronted to experimental data generated by RESTORE (Inserm, Toulouse) and our partners in LGMC (Montpellier).