

## PhD project LSI

### **,Mechanical modelling of matrix dynamics during organ morphogenesis‘**

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How multicellular tissues acquire their shape during development remains a fundamental question in biology. Morphogenesis emerges from the interplay of cellular forces, material properties, and geometry. While often viewed as a passive scaffold, the extracellular matrix (ECM) is now recognised as an active regulator of tissue shape through growth, remodelling, and cell–matrix interactions. However, the nonlinear coupling between these processes makes morphogenesis difficult to predict. Our recent work demonstrated that anisotropic matrix growth can directly tune tissue architecture (Harmansa et al. 2023 and 2026), raising the question of how matrix growth mechanically programmes morphogenesis.

This project will use the *Drosophila* wing imaginal disc to investigate how differential Collagen IV integration guides epithelial morphogenesis. The core aim is to develop a computational framework, informed by experimental observation, that captures how new matrix material is incorporated into an existing polymer network and how this process shapes tissue mechanics.

The project will use discrete network models of the ECM, explicitly representing fibres and crosslinks to identify mechanistic rules for spatially and anisotropically controlled matrix growth (with Tsaneva group and Dr. Peyman Shadmani). These models will enable direct computation of emergent mechanical properties and their impact on tissue deformation, with iterative experimental validation (with Harmansa group). Building on this, the project aims to develop hybrid multiscale frameworks that couple discrete ECM descriptions to vertex-based models of epithelial tissues, linking polymer-level growth to cell-level mechanics and tissue-scale morphogenesis.

This interdisciplinary PhD project will establish a predictive, data-informed modelling framework to uncover how matrix growth governs tissue shape. This interdisciplinary approach will reveal conserved principles of BM-mediated morphogenesis, offering insights with broad impact on matrix-related diseases and future applications in tissue engineering.