Living Systems Institute

Morphomechanics Group
Shaping Growing Tissues

PhD Project

Modelling Shape Generation by the Basement Membrane

Supervisors: **Dr. Stefan Harmansa** and **Dr. David Richards**, Living Systems Institute

Morphogenesis is the process that generates three-dimensional tissue and organ shape during embryonic growth. The major building blocks of our organs are epithelial cells, which form sheet-like tissues that are deformed in a controlled manner to form the complex 3D morphologies of functional organs. Epithelia are coated by a specialised extracellular matrix, the basement membrane (BM, Cruz Walma *et.al*. 2020). The BM acts as a structural base for epithelial cells and its mechanical properties (such as stiffness) directly influence cell and tissue shape (Bonche *et.al*. 2022, Crest *et.al*. 2017).

Excitingly, we have recently demonstrated that the interplay between epithelial and BM growth is instructive in guiding cell and tissue morphology (Harmansa *et.al*. 2023). However, we still lack conceptual understanding of (1) the complex mechanical interplay between tissue and BM growth, (2) how stresses accumulate in growing tissues and (3) how such stresses integrated with the local mechanical properties of the BM are transformed into morphological shape changes.

During this PhD project you will establish a novel mathematical modelling framework to simulate how growth dynamics and mechanical properties of tissues and their BM interact and guide organ morphology. You will combine a 2D/3D cellular vertex model with a lattice coarse-graining of the underlying basement membrane layer. This will involve a combination of modelling (e.g. dynamical systems analysis) along with computational simulation (e.g. in MATLAB or C++). You will also use the fruit fly *Drosophila melanogaster* as a model system and work in close collaboration with both experimentalists and theoreticians.

Given the interdisciplinary and collaborative nature of the project, you will have the excellent opportunity to be trained and mentored in both the theoretical and experimental aspects of modern research, offering excellent future career prospects. Ideally you will have a theoretical background and a strong interest in biology, good communication skills and share our excitement to work in an interdisciplinary environment addressing fundamental scientific questions.

Details: This project is advertised within the framework of the 2024 Living Systems Institute PhD Programme. The suitable candidate will obtain support for applying to the LSI PhD programme and mentoring to prepare for the selection interviews. LSI PhD studentships are fully funded for 3.5 years (tuition fees, a personal stipend and a training budget).

For details on the programme see https://www.exeter.ac.uk/study/funding/award/

For further details on the project and to apply please contact Stefan Harmansa (s.harmansa@exeter.ac.uk) or David Richards (David.Richards@exeter.ac.uk) including a **letter of motivation** and your **CV** with the contact details of **two references**.

Application Deadline: Contact us as soon as possible to ensure sufficient time to prepare for the official LSI PhD programme deadline (midnight 8th January 2024).

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