Title of Project: 'Forces in the Matrix: Developmental Biophysics Across Species'

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Project

How do tissues bend, fold and sculpt themselves into functional organs? This central question in developmental biology lies at the heart of morphogenesis, where mechanical forces and extracellular structures work together to shape tissues. The basement membrane (BM) is a specialised extracellular matrix that not only supports epithelia but also actively drives their form. Its major structural component, Collagen IV, builds a crosslinked network essential for stability, growth and signalling. Mutations in Collagen IV compromise BM integrity, leading to developmental defects and human diseases, including eye malformations, kidney disorders and vascular pathologies. Despite this broad relevance, the mechanical role of the BM in shaping organs is still poorly understood.

This PhD project will investigate how Collagen IV organisation and BM dynamics generate mechanical stress and drive morphogenesis across species. Two powerful *in vivo* models, the *Drosophila* wing disc and the zebrafish optic cup, provide complementary systems in which epithelial sheets bend into dome-like shapes. Both processes critically rely on BM mechanics, yet the underlying principles remain unclear. Building on our recent discovery that BM growth drives stress accumulation and tissue bending in the fly wing (Harmansa et al., Nat. Commun., 2024), we will test whether similar mechanisms govern vertebrate eye development.

The candidate will combine cutting-edge genetics (CRISPR-Cas9), advanced live and super-resolution imaging, and biophysical techniques (atomic force microscopy, laser ablation, rheology) with theoretical modelling. This interdisciplinary approach will reveal conserved principles of BM-mediated morphogenesis, offering insights with broad impact on collagen-related diseases and future applications in tissue engineering.