The role of cell and tissue architecture in the dispersal of patterning signals

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Project ID: 2228cd1395 (You will need this ID for your application)

Research Theme: Physical Sciences

UCL Lead department: London Centre for Nanotechnology (LCN)

Department Website

Lead Supervisor: Zena Hadjivasiliou

Project Summary:

This multidisciplinary project combines biology, physics, engineering, and mathematics to determine how signalling molecules regulate tissue morphogenesis and patterning. Biological tissues often assume complex shapes and spatial cellular architecture. Recent studies show that tissue architecture plays a role in the dispersal of signalling molecules in developing tissues. Thus, material properties of developing tissues impact the function of biochemical signals. In this project we will combine tissue engineering with theoretical modelling to address how tissue and cell architecture affect the formation of signalling gradients in tissues.

The student will build on theoretical tools developed in the Hadjivasiliou lab to make predictions about how cell size and packing impacts the shape and range of morphogen gradients in 2D epithelia and in tissues that undergo 3D morphogenetics movements like invagination. The student will learn how to perform reaction-diffusion simulations coupled with algorithms that follow individual cell shape and size.

The student will use cells that are synthetically engineered to secrete GFP to test and challenge the predictions of the theoretical model. This will involve growing spherical organoids using GFP secreting cells and engineering 3D micropattern matrices to control the size and shape of the organoids. Live-microscopy and quantitative assays such as FRAP (Fluorescence Recovery After Photobleaching) will be applied to organoids of varying size and morphologies to analyse i) how local cell area is coupled to tissue curvature and ii) how molecular dispersal is impacted by cell and tissue morphology.

The primary and secondary supervisor will support the student through regular meetings. Postdocs in the Hadjivasiliou and Elosegui-Artola lab will provide training in Matlab and C++ based code for the computational analysis and to perform the experiments described above.

The student will benefit from support by the Making Lab at the Francis Crick Institute where the Hadjivasiliou group is currently seconded.
