1) Project title
Live Modelling the Vertebrate Presomitic Mesoderm

2) Title, name, department, and email address of project supervisor
Dr Ben Steventon (Department of Genetics, University of Cambridge). bjs57@cam.ac.uk

3) Contact details of any co-supervisors:
Mathmatical Modelling: Dr Berta Verd (Department of Zoology, University of Oxford)
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Wet Lab: Mr Tim Fulton (Department of Genetics, University of Cambridge)
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4) Project Description (500 words max)
Embryos are required to undergo both cell fate decisions whilst also moving in order to create the embryo's final shape. These two processes must be tightly coordinated in order to ensure that cells make the correct cell fate decision with spatial coordination. Conventionally, the process of cell fate decision making is studied using dynamical systems modelling and this approaches has been very successful in studying how patterns are produced across field of cells. This project will build on the successes of modelling gene regulatory networks in this way by attempting to simulate them on tracks obtained from real cell movements captured by in toto live imaging of the developing embryo. Through the simulation of GRNs on tracking data, we hope to be able to investigate how dynamic GRNs function when challenged with real cell movements.

In addition to studying the real cell movements, this project will consider how the pattern changes when we disrupt morphogenesis by inhibition of cell movements. By making live movies of our drug treated embryos and simulating the same GRN within each cell, we hope to establish the role that morphogenesis plays in pattern formation. Using quantitative in situ hybridisation chain reaction, we can compare the predictions of our simulations to real in vivo data to further validate our models.

Finally, using the embryos from the Cichlid fish, where the pattern formed across the presomitic mesoderm is very similar to zebrafish, yet the overall embryo has significantly different morphogenesis, we hope to generate live imaging datasets. These Cichlid tracking datasets will allow us to investigate the role of changes in the morphogenesis and to begin asking the question of how changes in morphogenesis can be buffered by dynamic GRNs in order to generate an evolutionary conserved pattern.

This project has the potential to be both experimental, allowing the student significant hands on time within the lab, or worked on remotely from home, depending on the current covid regulations. The Steventon (Cambridge) and Verd (Oxford) Groups are both highly interdisciplinary groups with specialisms in the live imaging of developing organisms, quantitative measurements of cell states and mathematical modelling of dynamical systems. A student on this project will gain experience in all of these fields and will be contributing to an active line of research.

5) Short summary (max 80 words) along with key aims/tasks of the project

Pattern formation in tissues also undergoing morphogenesis requires a cell to dynamically update its identity with respect to its changing position. The aims of this project are to:

1. Investigate how morphogenetic perturbation of embryos, through inhibition of cell movements, results in changes to the patterns produced both experimentally and in silico.
2. Investigate the translatability of a conserved gene regulatory network onto tracks from related species (Cichlids)

6) Specific details for your project/specific skills required

The student requires no previous skills as everything required will be taught however some knowledge of coding using Python would be a significant advantage for the student. Any lab techniques will be taught and no previous lab experience is required.

This project is intended to be highly flexible and, if permitted, we intend for the student to get hands on laboratory experience. If this is not possible, the entire project can be adapted for a working from home style project.

Duration: 8 weeks