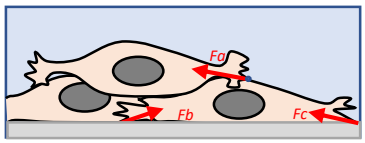
Master 2 internship 2024-2025 in Biophysics/Computer Modelling: Cell automaton-based simulation of tissue migration in early embryonic development

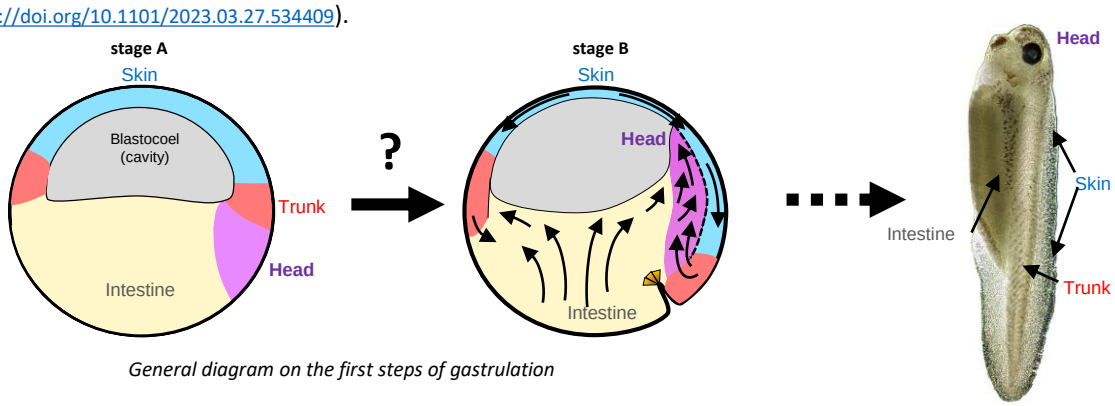
We are looking for a **highly motivated, science-driven student** to participate in a project on biophysics of embryonic development. This new project is a multidisciplinary collaborative effort between internationally renown teams in Biophysics (Francois Graner, MCS, University Paris-Diderot, http://francois.graner.name/en/research/) and in Cell Developmental Biology (Francois Fagotto, CRBM, Montpellier, https://www.crbm.cnrs.fr/francois-fagotto/?lang=en). The internship duration may be modulated from 3 to 6 months. A following PhD on a similar subject might be discussed.

Background

Embryonic development involves large scale tissue remodelling in order to build the body structures. One of the major event is gastrulation, in particular the translocation of the mesoderm tissue (purple and red in the diagrams below) inside the embryo in an orientation that will produce the head-trunk organisation of the future animal (here an amphibian, but the same process also takes place all animals, incl. humans).



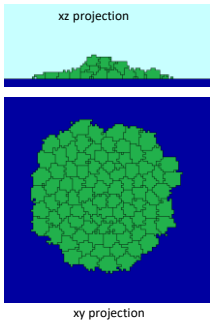
These movements are driven by the activity of the individual cells that compose each tissue, and are largely determined by the physical properties of these cells (stiffness, adhesiveness, motility), which are being experimentally measured by the Fagotto team (Kashkooli et al, https://doi.org/10.1371/journal.pbio.3001060, Rozema et al, https://doi.org/10.1101/2023.03.27.534409).



General diagram on the first steps of gastrulation

Aim

This internship project will aim at building a first basic model to simulate the onset of gastrulation (transition between stage A and B in the diagram). For this purpose, the candidate will exploit an open-source software called CompuCell3D (https://compucell3d.org/). This software allows cell automaton-based modelling, also called "Cellular Potts Model", where different cell types are implemented with parameters corresponding to various biophysical properties.



Example of simple simulation of spreading of a tissue with high collective motility capacity (Aslemarz et al, https://www.biorxiv.org/content/10.1101/2022.10.03.510449v4)
Additional examples can be found on https://compucell3d.org/

Requirements

High academic record in biophysics or equivalent, good computer coding skills.
No prerequisite of knowledge on embryonic development.

Application shall be sent to: francois.graner@univ-paris-diderot.fr and francois.fagotto@crbm.cnrs.fr