HYDRA MORPHOGENESIS THROUGH RHEOLOGY, ACTIN NEMATICS AND GENETICS

LABORATORY : Institut Lumière Matière

LEVEL : M2
TEAM(S) : BIOPHYSIQUE

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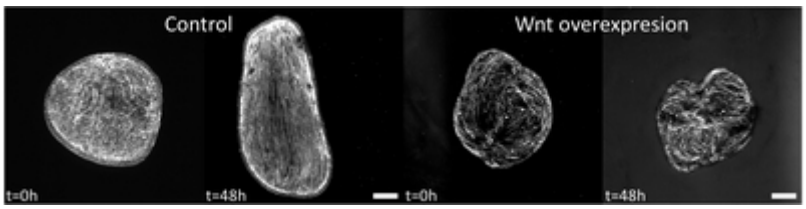
KEYWORD(S) :

SCIENTIFIC CONTEXT :



Actin fibers during regeneration in control conditions (left) and under Wnt activation (right)

Hydra vulgaris is a freshwater polyp capable of whole body regeneration, i.e. any piece cut from the animal can reform an entire functional organism. This process goes through a series of steps to define a new head-to-tail axis before morphogenesis occurs allowing it to retrieve its final shape. Recent results from our group (1) suggest that their morphogenesis relies on a complex interplay between changes in mechanical properties, the activity of actin fibers displaying a nematic order and molecular signaling put in place during patterning. In this project, we propose to question these hypotheses and determine which aspects are the key determinants of Hydra morphogenesis. To do so, we will develop quantitative pipelines to quantify proper and improper morphogenesis from 3d confocal images. Then, we will perturb the ingredients at play using different drugs targeting actomyosin contractility, rheological properties or Wnt signalling. For example, preliminary results show that perturbing this key patterning pathway has an impact on both actin alignment and the outcome of morphogenesis (Fig 1). We now want to standardize and quantify these types of experiments.

MISSIONS :

Hydra care: The student will learn how to maintain, grow and use Hydra populations for experiments. Particular care will be given to the available transgenic lines.

Microscopy, image and data analysis: Fluorescent spinning disk microscopy will be used to image the reaction of the samples to different perturbations. Image analysis tools will be developed to reconstruct their 3d shapes. From these, curvature will be measured and various metrics will be envisioned to quantify the outcome of morphogenesis.

Modelling: Possibility to get involved in the modelling aspects of the project using a finite element framework to simulate morphogenesis from all different ingredients and recapitulating the experimental observations.

OUTLOOKS :

Possibility to apply for funding for a PhD.

BIBLIOGRAPHY :

1. Perros, T., Joly, S., Mbaye, A., Marcq, P. & Cochet-Escartin, O. Wnt signaling modulates tissue mechanics, actin order, and regeneration in Hydra vulgaris. bioRxiv 2025.09.02.673719 (2025) doi: 10.1101/2025.09.02.673719.

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