DECIPHERING MECHANICAL HOMEOSTASIS WITH MODEL EXPERIMENTS

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LEVEL : M1 / M2 / L3
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KEYWORD(S) : Finite Element modeling / Mechanical homeostasis / Nonlinear Mechanics

SCIENTIFIC CONTEXT :

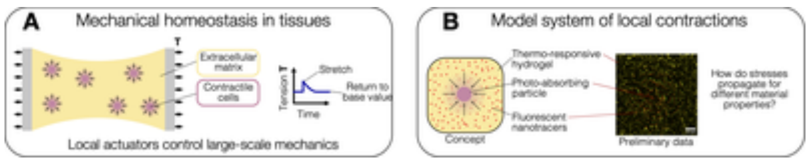

Fig. 1. Overview of the proposed project. Sorry it's blurry, I can email you a better version!

When stretched, most elastic materials develop mechanical stresses. Independently of the material composition, a larger stretch usually produces larger stresses. In active materials such as living tissues, however, things can differ. For instance, **micrometric fibroblasts** in the extracellular matrix contract and relax, thereby maintaining nearly constant mechanical stresses over **centimetric scales**, even when the matrix is stretched [1, 2]. This phenomenon, called mechanical homeostasis, has been extensively studied in tissue equivalents, such as collagen gels seeded with living cells, and is understood as arising from the interplay between actuators that locally contract and a soft matrix that transfers forces over large distances (Fig. 1A) [2, 3]. The biological limitations of tissue equivalents, in which one cannot vary all parameters independently, however prevent a detailed comprehension of the underlying physics [1, 4, 5]. It is, for instance, very difficult to vary the matrix composition or the imposed stretch without changing how much the cells contract. **A precise comprehension of how local contractions propagate to the large scales in mechanical homeostasis is therefore still lacking, despite its potential use in soft robotics and tissue engineering.**

MISSIONS :

n this project, we will conduct model experiments of local contractions, and evaluate how stresses propagate as a function of material properties (Fig. 1B). We will trigger the local contractions by illuminating photo-absorbing microparticles inside a thermo-responsive hydrogel. Upon illumination, the particles heat up and makes the hydrogel contract. To characterize the contraction, we will seed the hydrogel with fluorescent nanotracers and image the deformations under a confocal microscope.

OUTLOOKS :

The opportunity to continue as a Ph.D. student can be considered.

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