Internship proposal – Master 2
Spring 2020
Mapping mechanical stresses in living tissues using soft elastic microcaptors

Contacts : François Gallet (*francois.gallet@univ-paris-diderot.fr*)
François Graner (*francois.graner@univ-paris-diderot.fr*)
Laboratoire Matière et Systèmes Complexes - UMR 7057 - Université Paris Diderot

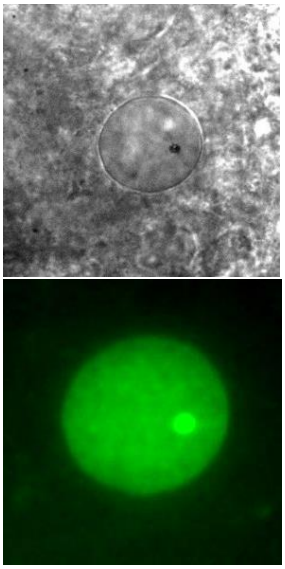

Image of a microcaptor inserted in a CT26 cellular aggregate ; top : bright field ; bottom : fluorescence.

Tissue development processes are based on changes in the size, shape, number and position of the cells, coordinated over time. They are regulated under the dual control of genetics and mechanics, which mutually feed back on each other. Any quantitative study about the impact of mechanical effects on morphogenesis requires a precise knowledge of the distribution of mechanical stresses, from the subcellular scale to the tissue scale, and of its temporal evolution. To access this distribution, we have developed a technique consisting in using mechanical sensors dispersed in the tissue. These micro-captors are spheres of cellular size, made of a soft deformable elastic gel (PDMS). They are generated through a microfluidic device, fluorescently labeled, and coated to ensure a good insertion in the tissue. Using confocal or bi-photonic microscopy, the 3D shape of the beads can be reconstructed in situ, and the shear stress tensor can be locally deduced from the strain tensor. The technique has been successfully tested in reconstituted cellular aggregates and the next step is to focus on data acquisition and result analysis, in vitro and in vivo.

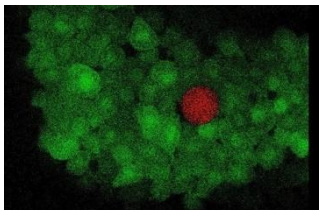

Image of a microcaptor (red) inserted in zebrafish embryo (green).

In reconstituted aggregates, the goal of the internship will be to establish the spatial and temporal map of mechanical stresses either in free suspended aggregates, or during their spreading on an adhesive substrate. In vivo studies will also be made in zebrafish embryos, in collaboration with a group at Ecole Polytechnique : the deformation of a microcaptor inserted in the placode will be followed during the embryo development, and the stresses will be correlated to the local expression of mechanically active proteins, like actin and myosin.

For this internship, the student is expected to be rapidly autonomous to master some current lab techniques, such as cell culture, microfluidics, confocal microscopy, image processing and analysis. Thus a previous experience in laboratory work will be required.

The internship duration may be modulated from 3 to 6 months. A following PhD on a similar subject might be discussed.