Laboratoire Physico-Chimie Curie

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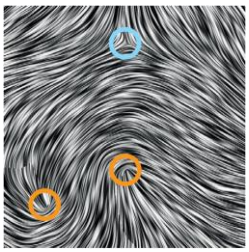
TITRE DU STAGE : ARCHITECTURES AND DYNAMICS OF ACTIVE NEMATIC TISSUES

DIRECTEUR de Stage : Pascal Silberzan

Ce stage peut être poursuivi en thèse : OUI

Si oui, la thèse est-elle financée : NON

SUJET de la thèse :



The behavior of a biological tissue results from the coordinated actions of the cells that constitute it. *In vivo*, these cell populations cope with their microenvironment, including physical and biochemical cues exerted by the extracellular matrix but also by neighboring cells. Therefore, experiments aiming at mimicking these situations *in vitro* must include such passive or active boundaries and confinement.

In the last years, we have addressed different aspects of collective behaviors of cells with a physics approach. In particular, we have recently shown that spindle-shaped cells tend to adopt a common orientation amounting to a so-called "nematic" order. When confined in well-defined domains of various shapes, monolayers adapt their architecture to accommodate both the long-range orientation order favored by the cells, and the geometry of the confining domain. These model systems mimic the *in vivo* architectures found in some physiological tissues such as muscles or in the vicinity of tumors. They highlight the emergence of organizations and dynamics characteristic of populations of active cells, and the critical importance of defects in these architectures.

In particular, when plated on a stripe much wider than a cell size, these cells spontaneously orient with a well-defined angle with respect to the stripe direction and exhibit a shear flow close to its edges. We understand these behaviors at the light of a continuous theory of active matter but there remain several observations addressing important biological questions that deserve a better understanding. This is the case for instance for the formation of well-defined tridimensional cell cords resulting from a combination of directed flows and cell proliferation and that plays a crucial role in the subsequent differentiation steps.

To address these questions practically, we combine microfabrication, micropatterning and innovative microscopy techniques with cell biology techniques. To realistically model these situations, physical quantities such as the flows of cells within the monolayer or the mechanical forces developed on the substrate are quantitatively measured at all scales in parallel with cellular biological activity.

This interdisciplinary project is developed in close collaboration with groups of biologists and theoreticians at Institut Curie and ENS.

Recent references (selection)

- Duclos G., Blanch-Mercader C., Yashunsky V., Salbreux G., Joanny J.-F., Prost J., Silberzan P.: *Spontaneous shear flow in confined cellular nematics*, Nat. Phys. **14**, (2018), 728.
- Duclos G., Erlenkämper C., Joanny J.-F., Silberzan P.: *Topological defects in confined populations of spindle-shaped cells.* Nat. Phys. **13**, (2017), 58.
- Hakim V., Silberzan P.: *Collective cell migration: a physics perspective.* Rep. Prog. Phys. **80**, (2017), 076601