M2/PhD project

Laboratoire Physique des Cellules et Cancer
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Team: Biology-inspired Physics at MesoScales (https://institut-curie.org/teams/buguin_silberzan)
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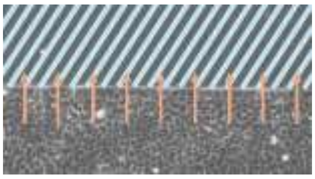
Kinetically locked-in cell transport on micro-patterned substrates



Emerging collective behaviors observed in biological tissues are largely controlled by the structure of the underlying extracellular matrix (ECM) and its interactions with the cells. Notably, cells can deposit oriented fibrous ECM which then acts as a guiding cue for neighboring cells. In cell populations, this trail of ECM acts as an effective "memory" between cells not only at the single cell level but also in cell populations. In confluent monolayers, it contributes to large correlation lengths in the supracellular organization of the cells and in their collective migration.

Our team has recently shown that ECM on a surface can be mimicked by synthetic subcellular micro-patterns such as grooves. Cell collective migration is well-controlled and oriented by using the so-called barrier assay which is a variation of the wound-healing assay and where the migration of the cells is triggered in a controlled way by the release of a barrier. In the absence of grooves, the direction of migration is perpendicular to the initial barrier. Patterning the substrate with microlines at a finite angle relative to this direction results in a conflict of orientations. The collective behavior of the monolayer is then either dominated by the initial barrier direction, by the grooves' direction, or results from a compromise. We can also imagine other geometries such as a regular array of obstacles that define an easy axis at n angle with the migration direction. These structures map an energy landscape in which collectively migrating cells may be kinetically locked-in. The corrugation of the energy landscape can be tuned by the depth of the micropattern.

These experiments will be interpreted with our colleagues from the theory group of the laboratory. They will shed light on the behavior of cell populations in complex environments.

Recent relevant references of the group (selection)

- Lacroix M et al.: *Emergence of bidirectional cell laning from collective contact guidance.* Nature Physics **20**, (2024) 1324
- Sarkar T. et al.: *Crisscross multilayering of cell sheets,* PNAS Nexus, **2**, (2023), pgad034
- Yashunsky V et al : *Chiral Edge Currents in Nematic Cell Monolayers* Physical Review. *X* **12**, (2022), 041017.
- Duclos G et al.: *Spontaneous shear flow in confined cellular nematics*, Nature Physics. **14**, (2018), 728.
- Duclos G et al.: *Topological defects in confined populations of spindle-shaped cells.* Nature Physics **13**, (2017), 58.