Proposal for an interdisciplinary M2 internship in Engineering and Cell biophysics

Coupling microfluidics and magnetic fields for heterogeneous tissues

The goal of this internship is to apply microfluidics and magnetic trapping to obtain insight on cell responses to external magnetic fields in a heterogenous tissue.

Laboratory:
Lyon Institute of Nanotechnology (Institut des Nanotechnologies de Lyon, INL)
6 rue Ada Byron, 69622 Villeurbanne, France
Team: Devices for Health & Environment
Group: Lab-On-a-Chip & Instrumentation
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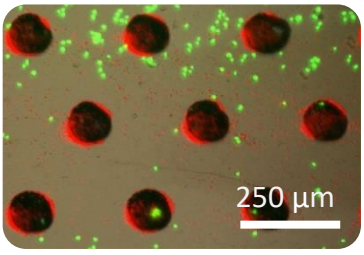
Organs are formed from the deformation of cell layers called epithelia. The epithelium of the intestinal barrier is particularly heterogeneous along its topography[1]: on the top (the villi), it mainly contains enterocytes cells, whereas on the bottom (the crypts), it represents a reservoir of stem cells. Despite extensive studies have been carried out to understand the biochemical pathways ruling the separation of these two important domains in the gut, very little is known about how geometrical parameters contribute to tissue functionality. Adjusting these properties in *in vitro* microsystems would give access to simple models to better understand cell growth in heterogeneous tissues, which are, however, still poorly reproduced in controlled devices.

To overcome this limitation, we propose a device where the cells are selectively trapped on hydrogels functionalized with magnetic particles. The aim of the project is to optimize the magnetic functionalization and trapping of the cells on the substrate[2,3], as well as the surface chemistry in order to achieve cell monolayers with a controlled spatial distribution of the cells (see figure). Then, cell growth will be characterized by video microscopy.



Magnetic pillars trapping red particles in a microfluidic channel with non-magnetic cells (in green).

The duration of the internship is of **5-6 months**, starting from **March-Avril 2022**.

Collaborative network - The student will work at the INL in the team "Devices for Health & Environment" and will be supervised by Caterina Tomba. The magnetic traps will be developed in collaboration with Anne-Laure Deman in the same team and Damien Le Roy at the ILM (Institut Lumière Matière, Lyon); the intestinal model will be developed in collaboration with Delphine Delacour from the team Cell Adhesion and Mechanics at the Jacques Monod Institute (Paris).
Local environment - The student will benefit from the technological infrastructures of the INL with 100m² of clean room and 40m² of cell culture.
Candidate background - We are looking for a student with a strong motivation for microfabrication tools, bio-imaging and cell growth. A good background in physics or polymer chemistry would be appreciated. The student needs to have good communication skills required for a team and interdisciplinary project.
Keywords - Microfabrication, biophysics, magnetic traps, image analysis, intestinal cells.

To apply, please **send a CV with cover letter, possibly with the names of referees familiar with your work to Caterina Tomba: caterina.tomba@univ-lyon1.fr**.

1. Barker, Nick. "Adult intestinal stem cells: critical drivers of epithelial homeostasis and regeneration." *Nature reviews Molecular cell biology* 15.1 (2014): 19-33.
2. Dempsey, N. M., et al. "Micro-magnetic imprinting of high field gradient magnetic flux sources." *Applied Physics Letters* 104.26 (2014): 262401.
3. Faivre, Magalie, et al. "Magnetophoretic manipulation in microsystem using carbonyl iron-polydimethylsiloxane microstructures." *Biomicrofluidics* 8.5 (2014): 054103.