Single cell encapsulation in droplet microfluidics

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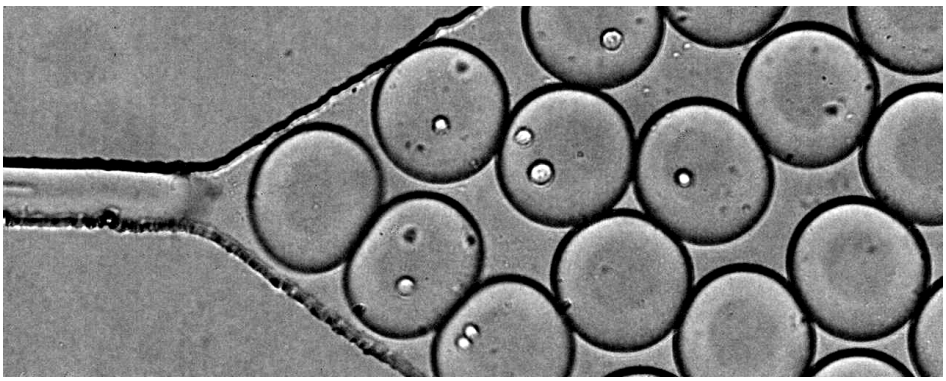
Expected profile Master in engineering (biomedical, physics, mechanics)

The Laboratory of Developmental and Tumor Biology investigates the progression of tumors, and among others circulating tumor cells (CTCs). CTCs are released from the primary tumor during metastatic spread. Their survival in the blood and the formation of pre-metastatic nests in the capillaries of the colonized organs involve close interactions with both inflammatory cells and the endothelial cells of the capillaries. Literature also suggests a pro-metastatic role of molecular actors of the coagulation cascade. So the formation of a fibrin network around CTCs could possibly modulate their interactions with inflammatory and endothelial cells, thereby promoting their survival in blood stream the formation of pre-metastatic nests [1,2].

Droplet microfluidics is a new technology that aims at miniaturizing assays in life science (Lab-on-a-Chip). Each assay is compartmentalized in an aqueous droplet of micrometric size embedded in an immiscible oil phase [3] and manipulated with high throughput. Droplet microfluidics is promising for the study of cell behavior, in particular when cell availability is limited (e.g. cancer cells). It may help quantifying the interactions between CTCs, endothelial cells and specific inflammatory cells. In the longer term, it may also allow to study the impact of anti-coagulant molecules on these interactions in a systematic and efficient way.

In this master's thesis, the student will build a microfluidic chip that encapsulates thousands of single cells in droplets. The chip will merge droplets three by three, in such a way that some resulting droplets contain one cell of each kind. These latter are incubated on-chip before the cell interactions are quantified through microscopy. Each module will first be designed, microfabricated and tested separately.



References

[1] J.S. Palumbo *et al.*, *Fibrinogen is an important determinant of the metastatic potential of circulating tumor cells*, **Blood** 96, 3302-9 (2000)
[2] A.M. Gil-Bernabe *et al.*, *Recruitment of monocytes/macrophages by tissue factor-mediated coagulation is essential for metastatic cell survival and premetastatic niche establishment in mice*, **Blood** 119, 3164-75 (2012)
[3] E. Brouzes *et al.*, *Droplet microfluidic technology for single-cell high throughput screening*, **PNAS** 106 (34), 14195-200 (2009)