ParisTech ESPCI PARIS | PSL

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Biology, Biophysics and Bio Chemistry

Subfield: Biophysics, Soft-Matter, Synthetic Biology, Chemistry, Applied Physics

Title: A microfluidic reactor for the emergence, assembly and evolution of life's biopolymers and cellular structures

ParisTech School: ESPCI Paris | PSL

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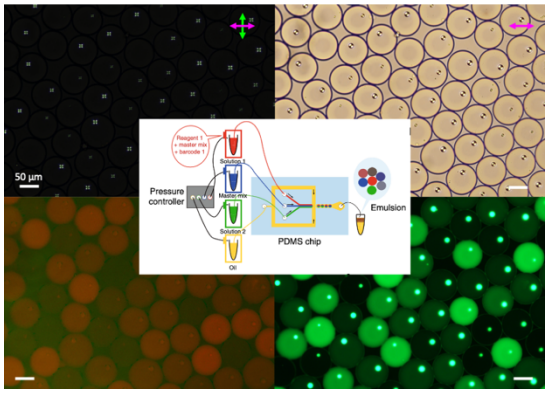
Short description of possible research topics for a PhD:

It remains unknown how biological building blocks can polymerize and self-organize into compartmentalized reaction networks capable of evolution, thus making the bridge between physico-chemistry and biology. Solving this problem requires considering the self-assembly of such molecules into phases typical of soft-matter, such as liquid crystals and coacervates[1,2]. Indeed, these phases have been shown to template polymerization[3] and allow evolution through compartmentalization[4,5].

We will set-up an experiment to test for the emergence, assembly and evolution of life's biopolymers and cellular structures in complex mixtures of biomolecular building blocks (RNA, peptides, lipids) submitted to cyclical variations of different physico-chemical conditions (concentration, temperature, pH, ionic strength and valence). To achieve this goal, this project exploits cutting-edge optical microscopy techniques coupled to innovative microfluidic platforms allowing the high throughput screening of reaction conditions in parallel.



Liquid crystal coacervates produced with a high-throughput multi-parameter automated titration method based on microfluidics

Required background of the student:
Supramolecular chemistry or Biochemistry or Soft-Matter Physics or Biophysics

A list of 5 (max.) representative publications of the group:

1. Fraccia, T. P.; Jia, T. Z. Liquid Crystal Coacervates Composed of Short Double-Stranded DNA and Cationic Peptides. *ACS Nano* **2020**, *xxx*, xxx–xxx, doi:10.1021/acsnano.0c05083

2. Smith, G. P.; Fraccia, T. P. & al. Backbone-free duplex-stacked monomer nucleic acids exhibiting Watson–Crick selectivity. *Proc. Natl. Acad. Sci. U. S. A.* **2018**, *115*, E7658–E7664, doi:10.1073/pnas.1721369115.
3. Todisco, M.; Fraccia, T. P. & al. Nonenzymatic Polymerization into Long Linear RNA Templated by Liquid Crystal Self-Assembly. *ACS Nano* **2018**, *12*, 9750-9762, doi:10.1021/acsnano.8b05821.
4. Matsumura, S. & al.Transient compartmentalization of RNA replicators prevents extinction due to parasites. *Science* **2016**, *354*, 1293-1296, doi:10.1126/science.aag1582.
5. Blokhuis, A. & al. Selection Dynamics in Transient Compartmentalization. *Phys. Rev. Lett.* **2018**, *120*, 158101, doi:10.1103/PhysRevLett.120.158101.