Proposal for an interdisciplinary PhD in cell biophysics and diagnostics

Advanced Nanorheology for Clinical Impact: Molecular rotors as diagnostic tools for red blood cell pathologies

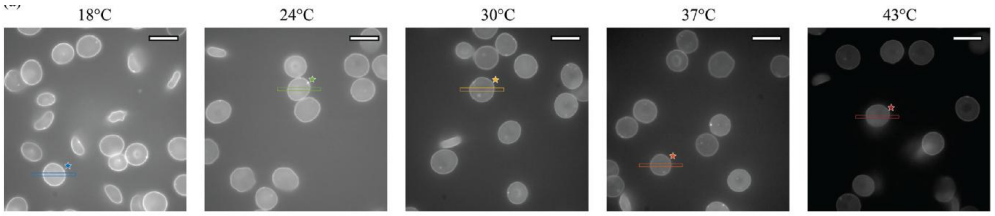
Keywords : red blood cells, molecular rotors, rheology, sickle-cell anemia, spherocytosis, diagnostic
Where : Laboratoire Matière et Systèmes Complexes (MSC), UMR7057 CNRS & Université Paris Cité
Collaboration : Laboratoire Biologie Intégrée du Globule Rouge (BIGR, INSERM) and Necker Hospital
Supervisor : Bérengère Abou (MSC)

Join our research project at the interface of physics, biology and clinical practice, studying pathologies that affect red blood cell deformability

This project investigates the clinical potential of intracellular nanorheology—an innovative approach developed at MSC laboratory [1-2]—for monitoring and characterizing red blood cell pathologies. These diseases are characterized by loss of red blood cell deformability, leading to clinical complications that require regular monitoring. Our approach uses molecular rotors, fluorescent probes sensitive to viscosity, to quantify red blood cell rheology and detect loss of deformability. We will evaluate how nanorheology compares to current clinical techniques for monitoring erythrocyte pathologies (sickle cell anemia, spherocytosis) and develop new rheological indicators for patient monitoring.

You will be based at Matière et Systèmes Complexes and work closely with the Biologie Intégrée du Globule Rouge laboratory (UMR_S 1134 CNRS & INSERM) and Necker Hospital. The MSC team specializes in rheology and micro-rheology of complex and biological fluids, while BIGR focuses on red blood cell pathologies. This collaboration provides access to both fundamental research expertise and clinical validation.

The project applies advanced physics techniques and skills (fluorescence microscopy, microfluidics, AI-based image analysis) to medical challenges through strong collaboration with biologists and clinicians for clinical translation.



Images of red blood cells incubated with the DASPI molecular rotor at increasing temperature (scale bar: 10 μm). The rotor fluorescence signal increases with RBC rigidity as temperature decreases.

Candidate profile: Strong motivation for cell experiments, bio-imaging and image analysis. Background in physics or biological physics preferred. Interest in interdisciplinary work with good communication and analytical skills.

To apply: Send your CV and motivation letter to Bérengère Abou: **berengere.abou@gmail.com**

1. A. Briole, T. Podgorski & B. Abou, Molecular rotors as intracellular probes of red blood cells rigidity, Soft Matter 17, 4525 (2021).
2. A. Briole, M. Marin, C. Le Van Kim & B. Abou, using molecular rotors to investigate hemoglobin concentration and heterogeneity in red blood cells, J. Rheol. 69, 463–474 (2025).