Master 2 Project in Biophysics

How deformable is a red blood cell?

Molecular rotors to probe cell mechanics in health and disease

WHERE
Laboratoire Matière et Systèmes Complexes (MSC), UMR7057 CNRS & Université Paris Cité

COLLABORATIONS
Laboratoire Biologie Intégrée du Globule Rouge (BIGR), UMR_S 1134 CNRS & INSERM, and Necker Hospital

SUPERVISORS
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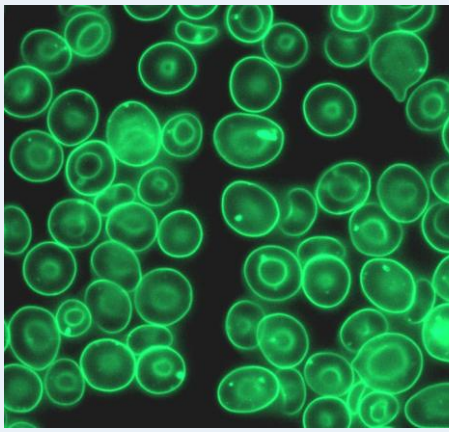
KEYWORDS
red blood cells, molecular rotors, nanorheology, sickle-cell anemia, spherocytosis, diagnostics



Red blood cells observed by fluorescence microscopy.

Description

To flow through the smallest capillaries, red blood cells must be highly deformable. In pathologies such as sickle cell anemia and spherocytosis, this ability is altered. Cell deformability is therefore a relevant parameter to diagnose and monitor these diseases, but how can it be measured? We use molecular rotors, fluorescent probes whose signal depends on local viscosity [1], to measure the mechanical properties of single cells [2-3]. The challenge is a physical one: understanding how the rotors interact with the cell [4], and relating their fluorescence signal to well-defined physical parameters.

What you will do

- Understand how molecular rotors interact with red blood cells
- Relate the rotor fluorescence signal to quantitative physical parameters
- Compare healthy and pathological cells to identify mechanical signatures of disease
- Build your own Python pipeline to turn fluorescence images into quantitative measurements

Why it matters

Current clinical methods cannot sensitively detect the altered deformability of red blood cells in disease. Your physical measurements could provide new biomarkers for patient monitoring.

What you will learn

Quantitative fluorescence microscopy, image analysis and statistical data analysis, and how to take a physical measurement from the bench to a biological question.

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Candidate profile

Master's student with a taste for soft matter, statistical physics or biophysics, and for experiments. Programming skills (Python or MATLAB). No background in biology required.

Outlook

This internship can lead to a PhD thesis.

> **To apply:** send your CV to Dr. Bérengère Abou: berengere.abou@gmail.com

References

1. F. Di Scala, A. Briole, V. Myndrul, T. J. Cleij, H. Diliën, B. Abou & B. van Grinsven, Molecular rotors: from Newtonian fluids to functional materials as viscosity and temperature sensing tools, Adv. Funct. Mater., e77541 (2026).
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3. 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 (2025).
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