

M2 research internship (2026)

Mechanical Characterization of cells: from Viscoelasticity to Membrane Rupture

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Laboratory: Hydrodynamics Laboratory (LadHyX, <https://www.ladhyx.polytechnique.fr>)
Ecole polytechnique, CNRS, Institut Polytechnique de Paris



Project Overview

This internship is part of an ANR-funded project on ultrasound-mediated drug delivery using microbubbles. Understanding how bubble cavitation induces transient membrane pores is crucial for optimizing therapeutic agent delivery across biological barriers. Despite its clinical promise, fundamental gaps remain in our understanding of cell membrane mechanics and rupture behavior under controlled mechanical stress. This project will use advanced micropipette-based techniques [1-4] to quantify cell viscoelastic properties and membrane rupture thresholds under compression and tension, providing experimental data to validate computational models and optimize treatment parameters.

Objectives and Methods

The internship comprises two complementary objectives:

1. Cell mechanical characterization via microindentation:

- Implement profile microindentation techniques using micropipettes with customizable tips (spherical and needle-shaped)
- Extract bulk viscoelastic properties and surface tension of cells

2. Membrane rupture characterization under mechanical stress:

- Subject cell membranes to compression and tension forces
- Quantify stress thresholds for membrane rupture and pore formation
- Investigate rate-dependent rupture behavior
- Examine the cytoskeleton's role in membrane mechanical resistance

Candidate Profile

Background in experimental physics/mechanics, bioengineering, or biophysics. Basic programming skills (Python/MATLAB/ImageJ). Experience with or willingness to learn cell culture. Interest in micromanipulation, microscopy, and familiarity with cell biology is a plus.

Practical Information

Duration: 5-6 months | **Start:** Flexible, 2026 | **Location:** LadHyX, Ecole polytechnique, Palaiseau

The internship provides hands-on experience with state-of-the-art single-cell manipulation, advanced microscopy, and quantitative analysis. Outstanding candidates may continue with a PhD on related topics.

Continuation opportunities: Outstanding candidates may have the possibility to continue with a PhD position on related topics.

Application

The LadHyX laboratory hosts a dynamic research environment with expertise in fluid mechanics, soft matter, and biophysics.

Application Procedure

Send CV, motivation letter, transcripts, and two references to julien.husson@polytechnique.edu

More information: <http://cellmechanics.jimdofree.com>

References

- [1] Hogan et al., Biophysical Journal 2015; doi: 10.1016/j.bpj.2015.06.015.
- [2] Markova et al., Biophysical Journal 2024; doi: 10.1016/j.bpj.2023.12.008
- [3] Husson, MIMB, vol. 2600; doi: 10.1007/978-1-0716-2851-5_1, 2023.
- [4] Gonzale-Rodriguez et al., Biophysical Journal 2016; doi: 10.1016/j.bpj.2016.11.001.