Cell Dynamics and Fragmentation Laboratory Master's Projects 2026

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The Cell Dynamics and Fragmentation Laboratory is a newly established research group at EPFL lead by Juan Manuel Garcia-Arcos, founded as part of the Ambizione project "Molecular and Physical Basis of Cell Fragmentation" and hosted at the unit of Pierre Gönczy. Our research aims to uncover how cells break into distinct, biologically active fragments outside of classical cell division. This phenomenon occurs in cancer progression, immune cell behavior, and developmental processes, yet the underlying mechanical and molecular principles remain largely unexplored.

Cell fragmentation represents a unique intersection between biophysics, cell biology, and engineering. By combining advanced live-cell imaging, microfluidic technologies, molecular perturbations, and quantitative modeling, we investigate how forces, membrane tension, cytoskeletal activity, and lipid composition determine when and how cells fragment. Understanding these principles will allow us not only to explain unexplored biological behaviors, but also to engineer new experimental systems for studying cell mechanics and communication.

In this exciting context, the laboratory offers a series of Master's projects for motivated students interested in multidisciplinary research that blends modern biophysical tools with molecular and cellular biology. Each project is designed to give students ownership of a scientifically meaningful question while providing training in cutting-edge methods and conceptual frameworks.

Apply with your transcripts, CV, and a motivation letter.

1. Identifying cell types prone to fragmentation and building a primary-cell panel

Keywords: cell biology, primary cells, cancer, differentiation, fragmentation
Objective: establish and characterize a panel of primary cells and cell lines that are likely to fragment in vivo. Evaluate their behavior under mechanical confinement and shear stress in vitro and create a reference dataset of fragmentation propensity across cell types.
Approaches: culture and differentiation of primary cells (e.g., megakaryocytes, immune progenitors), maintenance of cancer and epithelial cell lines, standardized confinement and flow assays, live imaging, quantitative screening, construction of a cell fragmentation database.
Ideal for students in: Life Sciences, Medicine, Bioengineering.
This this a paid internship offer. Duration: 4-12 months

2. Dynamics of membrane tension and cell deformation under oscillatory osmotic stress

Keywords: quantitative biology, Python, membrane tension, Kuramoto models, image analysis

Objective: analyze an extensive dataset of cells exposed to oscillatory osmotic shocks with varying frequencies, amplitudes, and waveforms (square, triangular, gradient). Determine how plasma membrane tension (Flipper lifetime) and cellular strain evolve in time, and quantify phase relationships or delays between these signals.

Approaches: image processing in Python, FLIM lifetime extraction, signal analysis, cross-correlation and phase-locking metrics, comparison with theoretical models such as Kuramoto oscillator frameworks, mechanotransduction interpretation.

Ideal for students in: Physics, Bioengineering, Computational Biology, Life Sciences.

This this a paid internship offer. Duration: 4-12 months

3. Advanced live-cell imaging of membrane and cytoskeletal dynamics

Keywords: FLIM, confocal, TIRF, live-cell imaging, image analysis

Objective: use advanced microscopy techniques to measure membrane tension, cytoskeletal dynamics, and organelle behavior in living cells during fragmentation.This will be done mainly using fluorescence lifetime probes such as Flipper-TR. Students will be trained on fluorescence lifetime imaging (FLIM) and confocal microscopy and will extract quantitative measurements from microscopy image datasets. This internship is in collaboration with BIOP, the bioimaging platform.

Approaches: live-cell imaging on multiple platforms, optimization of acquisition parameters, preparation of fluorescent probes and markers, quantitative analysis using ImageJ/FIJI and Python, measurement of membrane tension, actin dynamics, and morphological changes.

Ideal for students in: Life Sciences, Bioengineering, Biophysics.

This this a paid internship offer. Duration: 4-12 months

4. Contact guidance in blebbing cancer cells using nanostructured substrates

Keywords: contact guidance, blebs, nanostructures, cancer cell migration, microfabrication

Objective: investigate how nanoscale topographical cues guide the migration of cancer cells that rely on bleb-driven motility. Preliminary unpublished results indicate that nanofabricated ridges and grooves can steer blebby cancer cells in opposite directions depending on their migration mode and cytoskeletal organization. The aim of this project is to complete this study for publication, by expanding the dataset, refining the substrates, and quantitatively analyzing how nanotopographies modulate bleb formation, polarity, and guidance.

Approaches: fabrication of nanostructured substrates using accessible and low-cost microfabrication approaches; culture and imaging of cancer cells exhibiting bleb-based motility; live-cell imaging (phase contrast, confocal, and TIRF as needed); quantitative trajectory and morphology analysis using ImageJ/FIJI and Python; perturbation experiments to test cytoskeletal or membrane-tension mechanisms underlying guidance responses.

Ideal for students in: Life Sciences, Bioengineering, Microengineering, Biophysics.

This this a paid internship offer. Duration: 4-12 months