**Master 2 internship project**

**Year 2025-2026**

**Laboratory/Institute:** LPCV/IRIG CEA **Director:** Eric Maréchal

**Team:** Cytomorpholab **Head of the team:** Laurent Blanchoin

**Name and status of the scientist in charge of the project:** Laëtitia Kurzawa, Research engineer

**HDR: yes X no ☐**

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**Program of the Master’s degree in Biology:**

**☐** Microbiology, Infectious Diseases and Immunology **☐** Biochemistry & Structure

**X** Physiology, Epigenetics, Differentiation, Cancer **☐** Neurosciences and Neurobiology

**Title of the project: Scaling of cytoskeletal architectures and turnover in relation to cell size and function**

Objectives (up to 3 lines):

This project aims at understanding the mechanisms underlying cell size regulation and its relationship to cell function. In particular, we would like to address the following questions: 1/ how do cells adapt the turnover and organization of their numerous cytoskeletal structures assembled from a limiting pool of actin monomers with size? 2/ How do these adaptations endow cells with specific capabilities to respond environmental cues and how do they affect their function?

Abstract (up to 10 lines):

Cells are characterized by a narrow size distribution that can vary from as much as several orders of magnitude between smaller cells, such as red blood cells, and large muscle cells. This cell size scaling suggests that reaching and maintaining “the right size” for a given cell could play an important role in performing its function. However, the mechanisms underlying the regulation of this size and its relationship to cell function remain unclear.

In cells of increasing sizes, our preliminary data show that the overall actin content scales with the actual size and volume of cells and that the global turnover of actin networks varies with cell size. However, it is so far unknown how this translates between different cellular actin architectures displaying different turnover and how this relates to the function of cells. In this project, we thus propose investigating how interdependent cytoskeletal organizations and their associated dynamics adapt in different cell size contexts. To address this question, we are planning to characterize the presence, organization and dynamics of distinct actin networks in cells displaying significant differences in their area. In addition, we will assess how variations in cell size impact cell migration, a process that requires the activity of different cytoskeletal architectures. Finally, we plan to assess the feedback mechanisms between cytoskeletal architecture dynamics, cell size and function by perturbing the organization and dynamics of the actin cytoskeleton in cells of different sizes.

Methods (up to 3 lines):

An original pipeline of imaging and analysis will be set up to study actin organization and dynamics together with cell size and function. It will involve:

- Characterizing intracellular structures evolution with cell size (relative abundance, density and/or length of lamellipodium and of stress fibers). The structure’s identification will rely on advanced AI-assisted methods.

- Measuring the turnover of intracellular structures in cells of various size by the diffusion of photoactivated proteins.

- Characterizing cell migration in response to changes in cell size and cytoskeletal dynamics.

Up to 3 relevant publications of the team:

-Recycling of the actin monomer pool limits the lifetime of network turnover. Colin A et al., EMBO J., 2023.

-Balancing limited resources in actin networks competition. Guérin C. et al., Current Biology, 2024.

-Contractile forces direct the chiral swirling of minimal cell collectives. Badih G. et al., In revision at PNAS

-Stress fibres are embedded in a contractile cortical network. Vignaud T. et al., Nat Materials, 2021

Requested domains of expertise (up to 5 keywords):

Cell biology, Cytoskeleton, Fluorescence Microscopy, Image analysis