Funded PhD project in Integrated Structural & Cell Biology in Grenoble, France (2024-2027)

Title of the PhD project: Reconstitution of competitive dynamic actin architectures

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Host team: Cytomorpholab
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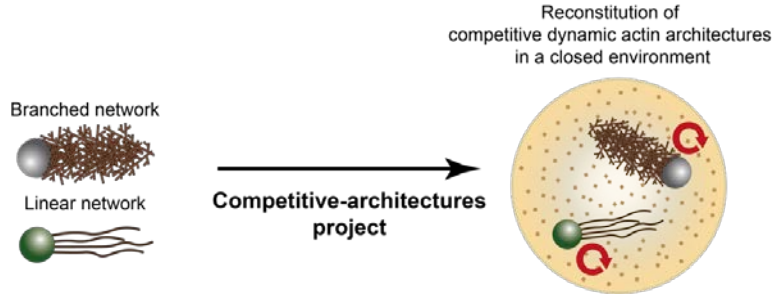
Project summary:
In cells, multiple actin architectures coexist and, in principle, compete for the same building blocks. These structures have different biochemical identities and dynamics, enabling them to respond to different cellular needs. However, the mechanisms by which these different architectures coexist coherently to ensure cellular integrity are not known. Given the complexity of the cell, a complete understanding of the molecular mechanisms underlying the self-organization and dynamics of these architectures is still lacking. We therefore propose to use a **bottom-up approach to reconstitute competing dynamic actin architectures in a cell-sized environment**. We will vary the biochemical composition, size and shape of the microenvironment, and the number of competing architectures to determine the key parameters controlling this complex living system. This experimental work will be carried out in parallel with theoretical work that will help us to narrow down the number of conditions to be tested, and to refute attractive but false hypotheses. This work should enable us to establish general principles on how the diversity of actin architecture is orchestrated in space and time to ensure a coordinated cellular response.



Preferred skills: Basic knowledge in biochemistry, in fluorescence microscopy and image analysis. Basic knowledge in microfabrication would be a plus. Interest for interdisciplinary projects

Student role: The first 3-6 months will be dedicated to learn the experiments and to start data acquisition on the first part of the project. The PhD student will first learn separately the biochemical experiments (to have the two kinds of beads working in an unlimited environment) and the microfabrication part (to build microwells). Then, the student will use the two at the same time to start the first part of the project. The analysis tools will be set-up in parallel, once the experiments will be running on the day-to-day basis. At the beginning of the second year, the first part of the project should be mostly done and could give the opportunity to the PhD student to draft a first paper. During the second year, we will set-up a method to apply various perturbations on the system. We already have preliminary data to perturb the system but further development is needed to run those perturbations on a day-to-day basis and this will be in the tasks of the PhD student (with the help of the engineers in the team). Once, the perturbation method will be set-up, the data acquisition of the second part of the project will be done.

Keywords: cytoskeleton, biomimetic systems, self-organization, biochemistry, fluorescence microscopy, image analysis

Relevant publications of the team:

1. Colin A., Kotila T., Guérin C., Orhant-Prioux M., Vianey B., Lappalainen P., Mogilner A., Théry M., Blanchoin L. Recycling limits the lifetime of actin turnover. EMBO Journal, 2023
2. Colin A.*, Orhant-Prioux M.*, Guérin C.*, Savinov M.*, Scarfone I., Roux A., De La Cruz E., Mogilner A., Théry M., Blanchoin L. Friction patterns guide actin network contraction. PNAS, 2023
3. Yamamoto et al. Actin network architecture can ensure robust centering or sensitive decentering of the centrosome. EMBO Journal, 2022
4. Kučera et al., Actin–Microtubule Dynamic Composite Forms Responsive Active Matter with Memory. PNAS 2022
5. Kollimada et al., The Biochemical Composition of the Actomyosin Network Sets the Magnitude of Cellular Traction Forces. MBoC 2021

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