

# Sperm cell crawling in the nematode *Caenorhabditis elegans*

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## Laboratory

Physical chemistry of living systems (Physicochimie Curie)  
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## Subjects / Tools-Methodologies

- 1 : cytoskeleton / *C. elegans*
- 2 : cell motility / biophysics
- 3 : biomimetic systems / biochemistry

## Summary of lab's interests

We develop dual in vitro/in vivo approaches to probe the physical and biochemical mechanisms of cell motility. Using an in vitro bead system, we reproduce cell movements powered by the polymerization of actin, a major component of the eukaryotic cell scaffolding. In parallel, we study actin-based movements in the *Caenorhabditis elegans* embryo. We are enlarging our studies to include another biopolymer system that induces movement: the Major Sperm Protein-based motility of *C. elegans* sperm cells. By comparing these two very different cytoskeletal systems that have identical roles in cell movement, we hope to define the universal biochemical and physical properties governing cell polarization and cytoskeletal reorganization for motility.

## Summary of project

The crawling behavior of eukaryotic cells is due, in part, to actin assembly. We mimic this process using in vitro systems composed of beads coated with actin polymerization activators, incubated in cell extracts. Under controlled conditions, beads thus treated generate comet tails that propel the beads forward, reproducing the forward movement of the plasma membrane of a moving cell. This system lend itself to quantitative measurements as the size and properties of the beads can be varied, as well as the nature of the cell extracts and the density and nature of the polymerization activators. This set-up thus allows for a complete physical and biochemical description of actin-based movement. Now we are applying this technology to the MSP (Major Sperm Protein) cytoskeleton which drives sperm cell movement in the nematode *Caenorhabditis elegans*. MSP plays the role of actin in other crawling cell types although the two proteins have no structural or biochemical homology. The goal of the project is to understand how MSP polymerization produces movement, to define the physical and biochemical mechanisms of sperm cell motility and to compare MSP-based motility to actin-based movement. Ultimately we hope to define the universal physical and biochemical characteristics of a movement based on biopolymer assembly. This PhD project will start with the identification of the activators responsible for catalyzing MSP polymerization in the cell. We will then find conditions for absorption of this protein(s) to beads and MSP comet formation in sperm cell extracts. By analyzing the composition of the comets, we will identify other ingredients of the MSP motility system, and establish a minimal mix of protein ingredients that support bead movement. By playing with the composition of the mix and the physical properties of the bead, we will test how biochemical and physical factors affect force generation and MSP dynamics for bead movement. We will then perform RNAi and transgenesis in the worm, targeting proteins identified in the previous study, in order to observe the effect of these proteins for sperm cell movement and MSP turnover in vivo. In particular, we will observe sperm cell movement in collagen gels in order to better understand the universal molecular basis of invasion, a crucial process for cancer

metastasis. With this study, we hope to understand how biochemistry affects force generation and how individual filament dynamics are integrated in the cell to produce forces, movements and invasion.