2016-10

IC-**3i** International PhD Program

PhD thesis project

2017 Call for application

Asymmetric Cell Division and the Acto-Myosin Cytoskeleton

General information

Call	2017
Reference	2016-10-PLASTINO
Keyword(s)	actin cytoskeleton; acto-myosin cortex; cortical flows; rheology of embryo cytoplasm; symmetry breaking in development; nematodes

Director(s) and team

Thesis director(s)	Julie Plastino
Research team	Biomimetism of Cellular Movement
Research department	UMR 168 - Physical Chemistry

Description of the PhD thesis project

The first division of the Caenorhabditis elegans embryo is a classic example of asymmetric cell division, and much has been learned from this model concerning the role of the acto-myosin cortex in symmetry breaking and polarity establishment, and the role of astral microtubules in spindle positioning. Although they undergo similar asymmetric divisions, nematode embryos from other genera appear to be lacking many of the key characteristics observed for Caenorhabditis, including stereotypical spindle movements and cortex behavior. Additionally in parthenogenetic species, which develop without fertilization, the initial cue for symmetry breaking is unknown.

The PhD project aims at determining how asymmetric division is achieved in three nematode species evolutionarily distant from C. elegans, including a parthenogenetic species.

We will characterize the actin cytoskeleton in these embryos, evaluate cortical flows and properties, measure rheological properties of the cytoplasm and perturb cytoskeleton dynamics via laser ablations and drug treatments. We will further perform comparative biochemistry of actin-binding proteins and gene replacement experiments in C. elegans in order to understand how different protein activities are related to phenotypes. Results of this study will reveal conserved mechanical and molecular principles of the cytoskeleton for achieving asymmetric cell division, revealing the richness of solutions provided by evolution to solve a cell biology problem.

International, interdisciplinary & intersectoral aspects of the project

The PhD project will involve cell biology and biochemistry with strong elements of evolutionary biology, soft matter physics and chemical biology. The different manipulations and observations of the acto-myosin cytoskeleton in embryos will be complemented by *in vitro* analysis of purified actin-binding proteins and gene replacement experiments to discover how mechanisms to achieve

asymmetric cell division evolved in different genera of nematodes. Physical properties of both the acto-myosin cortex and the cytoplasm will be measured using laser ablations and optical tweezer/rheology techniques (collaborations in Germany and the USA). With the company CytoSwitch (Germany), novel small molecules will be tested in the development of photo-switchable inhibitors for cytoskeleton control *in vivo*.

Recent publications

1. Sens, P., **Plastino, J**.
Membrane tension and cytoskeleton organization in cell motility.
J Phys Condens Matter. 2015 Jul 15;27(27):273103. doi: 10.1088/0953-8984/27/27/273103.

2. Havrylenko, S., Noguera, P., Abou-Ghali, M., Manzi, J., Faqir, F. Lamora, A., Guérin, C., Blanchoin, L., **Plastino, J**.
WAVE binds Ena/VASP for enhanced Arp2/3 complex-based actin assembly.
Mol Biol Cell. 2015 Jan 1;26(1):55-65. doi: 10.1091/mbc.E14-07-1200.

3. Havrylenko, S., Mezanges, X., Batchelder, E., **Plastino, J**.
Extending the molecular clutch beyond actin-based cell motility.
New J Phys. 2014 Oct;16(10). pii: 105012.

4. Blanchoin, L., Boujemaa-Paterski, R., Sykes, C., **Plastino, J**.
Actin dynamics, architecture and mechanics in cell motility.
Physiol Rev. 2014 Jan;94(1):235-63. doi: 10.1152/physrev.00018.2013

5. Batchelder, E., Hollopeter, G., Campillo, C., Mézanges, X., Jorgensen, E., Nassoy, P., Sens, P., **Plastino, J**.
Membrane tension regulates motility by controlling lamellipodium organization
Proc Natl Acad Sci U S A. 2011 Jul 12;108(28):11429-34. doi: 10.1073/pnas.1010481108.

Expected profile of the candidate

Applicants should be interested in quantitative and physical approaches to cell and evolutionary biology. Applicants can be physicists with cell biology experience or developmental/cell biologists with a strong interest in biophysics. The project will rely heavily on imaging, molecular biology and biochemistry techniques, as well as nematode manipulation. Knowledge of nematode culture would be appreciated but is not required.