Thesis proposal CSF Brazil 2014

Title:

Computational analysis of complex migratory patterns in lymphocyte populations

Thesis supervisor:

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PhD School name:

Biology, Health and Biotechnologies (BSB)

Research Laboratory:

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Laboratory website:

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CsF Scientific domain:

Biology, biomedical and health sciences

Type of proposal:

Full PhD in France

Short subject description:

The PhD project is at the heart of an interdisciplinary collaboration between the laboratories of Loïc Dupré, immunologist at the Centre de Physiopathologie de Toulouse Purpan (CPTP) and
Guy Theraulaz, quantitative ethologist at the Centre de Recherches sur la Cognition Animale (CRCA), both located in Toulouse, France. Thanks to a funding from the French Agency for Research (ANR), we have recently set up a working group composed of cell biologists, quantitative ethologists, bioinformaticians and biophysicists to unravel new facets of lymphocyte motility.

We are seeking to recruit a highly motivated student with either a background in cell biology with specific training in quantitative biology or a physicist since most of the project will consist in quantitative analysis and modeling. The candidate should have knowledge of tools such as R, Fortran, C++ as well as previous experience in statistical physics for the analysis of complex data sets and model simulation.

**Subject description:**

Collective motility, defined as the coordination of biological entities (cells or organisms) to operate displacements as groups, has been reported at all scales of living organisms, from bacteria colonies to human crowds (1). Despite the diversity of mechanisms regulating collective motility in different biological systems, fundamental rules appear to be shared. Although lymphocytes are usually described to migrate individually through the organism in search for foreign antigens, our recent in vitro data demonstrate that both normal and malignant lymphocytes can migrate as collective entities in chemokine gradients, thereby increasing their chemotactic sensitivity (2). We postulate that lymphocytes may adopt collective migration strategies, at least under certain physiological or pathological conditions. In this PhD project, we will explore the principles and mechanisms of collective motility in lymphocytes by bringing expertise from well-established models of collective motility.

The project will benefit from a collaboration between a cellular immunologist, expert of lymphocyte interaction and motility (3-7) and a quantitative ethologist, expert of collective motion in fish schools (8, 9), insect swarms (10, 11) and human crowds (12, 13). The candidate will combine an original set of approaches including high-resolution time-lapse microscopy and automated tracking to elaborate a computational model. This will allow to define the key motility rules, the interactions among lymphocytes, the consequences of these interactions on lymphocytes behaviors and the parameters setting the pulse to the coordinated motility of lymphocytes.

This transversal project will provide novel insight into fundamental aspects of collective motility and into the biology of lymphocytes. It will contribute to the training of a PhD student in a truly interdisciplinary manner by covering the fields of data processing, computational modeling and biological sciences.

**References**

regulating adhesion to intercellular adhesion molecule-1. Immunology. 2012;137:183-96.

2 major publications in the domain of PhD:

Gautrais J., Ginelli, F., Fournier R., Blanco S., Soria M., Chaté H. and Theraulaz G. Deciphering interactions in moving animal groups. Plos Computational Biology (2012) 8: e1002678


Expected collaboration in Brazil:

We have established contacts and ongoing collaboration with Brazilian partners:

Leonardo G. Brunnet, Instituto de Física, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil
expertise: theoretical and numerical modelling, in particular in the field of cellular behavior.

Vinicius Cotta-de-Almeida, Oswaldo Cruz Institute, Fiocruz, Rio de Janeiro, Brazil
expertise: cellular immunology, focus on T lymphocyte biology (including motility aspects).