Lab : Adhesion et Inflammation, Inserm U1067 / CNRS UMR733
Adress : Aix Marseille Université, Campus de Luminy, Marseille
Head of the lab : Olivier Théodoly, DR2 CNRS

PhD adviser : Pierre-Henri Puech, CR1 Inserm, in collaboration with D. Gonzalez-Rodriguez, U. Metz.
Email : pierre.henri.puech@inserm.fr
Web : https://phpuech.wordpress.com/
Web Lab : https://labadhesioninflammation.org/

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Expected starting date : position open since sept. 2024, starting date to be discussed

Tittle : Phase transitions and criticality in T cell early mechano-activation

Scientific context

Responses of living system to external inputs are surprisingly fast and robust. Such responsiveness has recently been attributed to living systems being poised at criticality, ready to transition from a meta-stable state to another. Although the idea is extremely enticing from the physics point of view, there is a lack of specific biological examples where well-defined observables of criticality have been identified and quantified. Here we propose to study a fundamental biological system that shows critical behavior which is moreover sensitive to mechanical cues, is relevant for cell biology and immunology and is at the core of our immune response: the activation of a T lymphocyte (a crucial type of immune cell) by a so called antigen presenting cell. This system involves communication (chemical and mechanical) between two isolated cells. We hypothesize that both cells are poised at criticality, i.e., near a phase transition, and that their mutual control interlocks them at a self-organised critical point.

Objectives of this project

We will construct the phase diagram underlying T cell antigen recognition and activation by using surrogate substrates whose decoration (nature and density of presented molecules) and rigidities (their Young's modulus) will be varied systematically over a large range of conditions exhibited by real antigen presenting cells . On these substrates, we will determine the levels of activation of T cells using fluorescent reporters such as Calcium indicators cell shape changes such as spreading (which is a good indicator of their activation state) or mechanical parameters (classical moduli, membrane or cortical tension, exerted forces) using traction force microscopy[18] and atomic force microscopy (AFM).

All techniques are already available in the LAI. Modelling of the data will be done in collaboration with D. Gonzalez-Rodriguez, who is a theoretical (bio)physicist.

Profile

Physicist or biologist, with an interest in quantitative biology and biophysical experiments. Programming knowledge (Python) would be a plus. Curiosity, independence are tenacity are some of the “must have” for such an intersciplicary project.