PhD PROJECT

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Bacterial adaptation by OXPHOS dynamics: from single cell biology to gut microbiota

Host teams
Axel Magalon / LCB / magalon@imm.cnrs.fr
Didier Marguet / CIML / marguet@ciml.univ-mrs.fr

The project stands at the crossroads between optics, physics, modelisation, metabolism and bacterial cell biology thus providing a unique opportunity for interdisciplinary research. It will be conducted between the groups of Axel Magalon, a biologist, and Didier Marguet, a biophysicist and will benefit from multiple collaborations established by the host laboratories thus providing a stimulating and high quality scientific environment.

Scientific background - Oxidative phosphorylation (OXPHOS), an essential process for most organisms and controlled by a wide variety of membrane-associated enzymes acting both as sources and sinks of proton flux, has to optimally respond to environmental and cellular cues. We have recently evidenced that dynamic spatio-temporal organization of OXPHOS complexes is the utmost driving force for an efficient utilization of a given substrate. The overarching goal of this project is to understand how bacterial OXPHOS adapts to rapidly changing environments.

PhD Objectives - The objectives are (i) to provide a comprehensive picture of the distribution and dynamics of OXPHOS complexes in bacterial cells using spatially and temporally resolutive high end fluorescence microscopy approaches, (ii) to develop computational modeling of the recorded signals at the single molecule and cell levels and (iii) to employ mathematical models to predict how dynamic spatial organization impacts OXPHOS outcome.

Proposed approach - SMLM will be conducted on a versatile setup built by Marguet's group which, in conjunction with specific algorithms, will provide detailed information about the distribution of OXPHOS complexes with spatial resolution up to 20 nm. In-depth dynamic view of their distribution will be provided with diffusion measurements by FCS-related methods. Computational modeling of the recorded signals will be supervised by N. Bertaux. Overall, these approaches will allow us to record biologically relevant parameters over multiple decades in time and to resolve dynamic biomolecular heterogeneity on different spatial scales of observations. Mathematical modeling fueled by those parameters will be conducted in collaboration with V. Fromion (MiAGE). Microbial genetic and biochemical approaches will be conducted in Magalon's group.

PhD student's expected profile - The project being highly multi-disciplinary, we are seeking for an excellent, highly motivated candidate willing to explore, learn and master new technologies. The candidate will have to work with different people of different backgrounds; thus, very good communication skills in English are required. Candidates could have a Msc degree in physics or mathematics and be highly interested in biology or vice-versa. Good background or previous experiences in one of the following fields would be desirable: optics, cell imaging, data processing and microbiology. Interest and skills to perform additional theoretical is most welcome.