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Experimental and quantitative study of the coupling between Min oscillations in the cytoplasm and periplasmic dynamics of the adhesin Ag43 in *E. coli*.

Outer membrane proteins (OMP) mediate the interactions between bacteria and their environment. Their localization is relevant for many physiological processes such as cell infection or biofilm formation. Recent development on the dynamics OMP insertion have shown that OMP are mainly inserted at midcell and then passively advected to the poles. This scenario, where the source of OMP insertion on the outer membrane is located at midcell likely predicts a gradient from the center to the poles. However, a number of OMP have been reported to follow an inverted gradient from poles to cell center. In Gram-negative bacteria, OMPs are first translocated from cytoplasm to periplasm before being inserted in the outer membrane. We recently reported how the periplasmic dynamics of Ag43 in E. coli, an OMP involved in cell-cell adhesion, drives its polar insertion. We demonstrated that the dynamics of periplasmic Ag43 is sustained by anisotropic diffusion and an advective drift patterned along the cell axis, which can be captured by a Fokker-Plank equation. Unexpectedly, we further showed that the dynamics in the periplasm is coupled to the Min system, whose cytoplasmic components are known to oscillate from pole to pole during cell cycle. Our results suggest that different pathways co-exist for OMP positioning and that the Min system not only organize cytoplasmic components but also contributes to the organization of OMP on the cell envelope.
The proposed internship, that can open on a thesis, aims at :

1. Understanding from a « system » point of view how the Min oscillations from poles to poles in the cytoplasm could generate a net drift for protein dynamics in the periplasm. We propose therefore to modulate the period of Min oscillations and combine experiments and modelling to propose a physical mechanism for the coupling.
2. Understanding from a molecular point of view how the Min systems conveys its positional information from the cytoplasm to the periplasm. We suspect surface charges to play a prominent role in the coupling. We will therefore conduct FLIM experiments to measure simultaneously the local electric transmembrane electric field et the spatial distribution of Min proteins.

Technics :

- quantitative biology (modeling)
- fluorescence microscopy (TIRF/FLIM)
- image analysis (python/MatLab)
- Molecular biology