Institut Microbiologie, Bioénergies et Biotechnologie
Aix*Marseille Université

PhD position

Deciphering the photosynthetic pathway of *Halorhodospira halophila*

Keywords

Bacteria; sulfur; arsenic; anoxygenic photosynthesis; flash induced optical absorption spectroscopy

Summary of the project

Halorhodospira halophila, an obligate phototroph and strict anaerobe, is a "purple sulfur bacterium" which means that it uses sulfur compounds oxidation as electron donors to supply its anoxygenic photosynthesis. Very little information on the photosynthetic pathway of this member of the *Halorhodospiracea* family is currently available and the PhD project aims to decipher its precise mechanism. Only three investigations on this γ-proteobacterial family [1-3] have been carried out, sketching the current draft model: a cyclic electron transfer takes place between a cytochrome bc1 complex and a photosynthetic Reaction Centre (RC), with the intermediate electron transporters as both soluble or membrane-bound protein carriers and a membrane diffusible menaquinone (MK) pool. The protein carriers do not directly reduce the bacteriochlorophyll special pair (P) of the RC but a tetrahemic subunit of the RC, that in turn reduces P. Cyclic electrons are presumably coming from membranous enzymes reducing the MK pool. They are completed by periplasmic enzymes, enabling a linear reduction of the protein carriers and then the RC. Taken together the three previous works propose a metabolic network with a high degree of "redundancy", with multiple soluble electron carriers, multiple soluble and membranous enzymes. One of the questions is therefore the respective role of the different electron carriers and enzymes. The previous works also suggest unusual properties, in *H. halophila*, for three enzymes: the RC, the Sulfur OXidation system SOX and the alternative arsenite oxidase Arx [1-3]. The very low redox potential of the first one raises the question of its function, the possible role of the second one in oxidation of thioarsenate would make it unique while the inability of the third one to sustain photosynthetic growth under arsenite is questioning. The three enzymes will therefore be further characterized.

To address these questions the PhD student will combine several technical approaches. The first one is the construction of deletion mutants developing a protocol inspired by the one published for a closely related strain [4] thus deleting the different proteins and enzymes proposed to be involved in the photosynthetic network. The second one is the use of light induced spectroscopy (set up by Pierre Joliot [5]), on whole cells of Wild Type and deletants grown under various compounds oxidation conditions. This will allow the detailed kinetic analyse of deletions' impact on the photosynthetic process. *In vitro* characterization (redox potential evaluation by UV-Visible spectroscopy, complementation studies by light induced spectroscopy and EPR spectroscopy) of heterologously produced proteins (as described in [1]) will give additional information to reconstruct the photosynthetic metabolism.

[1] D'Ermo, G. et al. (submitted) Quantitative proteomics pointed out the possible role of the sox system in the interplay between sulphur and arsenic metabolism in the phototroph *Halorhodospira halophila*.
[2] Lieutaud, C. et al. (2005) doi: 10.1073/pnas.0407768102.
[3] Schoepp-Cothenet, B. et al. (2009) doi:10.1073/pnas.0813173106.
[4] Hernandez-Maldonado, J. et al. (2017) doi:10.1111/1462-2920.13509. [5] Joliot, P. et al. (1980) doi: 10.1051/jcp/1980770209.

The co-supervisors

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Location

BIP, Campus Joseph Aiguier, Marseille, France
BIAM, CEA-Cadarache, Saint-Paul-lez-Durance, France

Doctoral school

Life and Health Sciences (ED 62), Aix-Marseille Université (https://ecole-doctorale-62.univ-amu.fr/)

Expected profile of the candidate

Biophysics (flash induced optical absorption spectroscopy and EPR); Biochemistry (chromatography for protein purification, subcellular fractions preparation); Molecular Biology (cloning and deletion mutants' construction).

How to apply?

Send us a CV (specifying the English level), a cover letter, transcripts and ranking of Master degree (Master 1 and first semester of Master 2), and the contact information for at least two references by April 15th 2024.

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The candidate selected by the co-supervisors will be interviewed on June 4th 2024 by the Institute of Microbiology, Bioenergies and Biotechnology (IM2B) jury. Defense modalities will be given later.