Doctoral school of chemical sciences

PhD fellowships 2019

PhD thesis title : Electrochemical studies of an electron-bifurcating hydrogenase

Laboratory : Laboratoire de Bioénergétique et Ingénierie des Protéines, Marseille, France

Team : Hydrogen metabolism

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PhD project description:

Hydrogenases are enzymes that catalyze protons to dihydrogen conversion :

$$2H^+ + 2e^- \rightleftarrows H_2$$

This PhD project focuses on Hnd hydrogenase. We have recently purified and characterized this hydrogenase and shown that it can perform electron-bifurcation reaction [1]. Flavin-based electron bifurcation is a mechanism that couple an exergonic redox reaction with an endergonic reaction [2]. This mechanism was discovered only 10 years ago and is not well studied yet. We showed that Hnd catalyzes the simultaneous reduction of a ferredoxin (small iron-sulfur cluster protein) and NAD^+ with dihydrogen oxidation. Furthermore, Hnd hydrogenase can catalytically exchange electrons with an artificial partner (methyl-viologen) or an electrode.

The aim of the project is to study, using mainly electrochemical methods, the enzymatic behavior of this enzyme, in particular the electron-bifurcation mechanism. Because the enzyme catalyzes the simultaneous oxidation or the reduction of 2 species (ferredoxin and NAD^+, redox partners of the enzyme), a ring-disk rotating electrode will be used to analyze independently these 2 species. Methods for electrode modifications will be developed during the thesis: hydrogenase immobilization (covalent grafting, carbon nanotube porous network) [3] and electrode modification by polymers for NADH / NAD^+ conversion [4].

The analysis of electrochemical data (ratio ferredoxin/ NADH produced during catalysis, is catalysis possible with only one of the redox partnersé) with electrode modification will provide us insight on electron bifurcation mechanism by hydrogenases. The energetic benefit of this reaction will be later exploited to make a biofuel cell that recycles NADH, which is a highly valuable molecule for enzymatic synthesis.

Candidate profile:

The applicant must have a Master of Science in Chemistry or Physical Chemistry and basic knowledge of electrochemistry. An interest in biology is welcome. Highly motivated, independent and dynamic, he/she should be able to work in a multidisciplinary team.

Please send your applications including (i) a detailed CV, (ii) official transcripts of master and undergraduate studies, (iii) an application and motivation letter, and (iv) a copy of official transcript by e-mail at: carole.baffert@univ-amu.fr

Application deadline : 6th May 2019 ; Interview by the doctoral school : 21th May 2019

References :

[1] A. Kpebe et al. Biochim. Biophys. Acta, 859(12) (2018)1302-1312.
[2] W. Buckel, R.K. Thauer, Chem Rev. 118(7) (2018) 3862-3886.
[3] I. Mazurenko, et al. Energy Environ. Sci. 10 (2017) 1966ï 1982.
[4] C.W. Narváez et al. ACS Appl. Mater. Interfaces. 3 (2011) 2402ï 9.