Project area: Biochemistry

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Lab/Institution: Inorganic Biochemistry and NMR Laboratory / ITQB-UNL

Duration: 12 months

Number of students: 1 or 2

Title: Engineering the "super bug" towards bioenergy production

Project Summary/abstract:

Extracellular electron transfer (EET) pathways allow bacteria to transfer electrons from the cell metabolism to extracellular substrates, such as insoluble compounds and metal oxides. This ability makes these organisms a target of biotechnological research for the development of novel bioremediation processes or generation of energy in microbial fuel cells (MFC). Among the exoelectrogenic organisms, *Shewanella oneidensis* MR-1 is one of the most studied organisms, where its extracellular electron transfer pathway relies on several multiheme *c*-type cytochromes. They form a network of interacting redox proteins that extends from the inner membrane, across the periplasm to the cell surface, being responsible for electron transfer to insoluble electron acceptors or to electrodes in MFCs.

Despite their technological importance, MFCs are still restricted to lab-research projects, with only a few devices being implemented in the real world. This is mainly due to the low efficiency of the electron transfer from microbes to the electrodes. This can be assessed by the fact that the conditions used in these devices are distinct from those encountered in their natural environment, which may lead to the use of an extracellular electron transfer pathway that was not evolutionarily designed to power up MFCs. In this work, genetic engineering tools will be used to tailor *S. oneidensis* MR-1 to enhance extracellular electron transfer processes in MFCs. This innovative approach will allow to improve the properties of this electroactive bacterium towards energy production in these promising systems, contributing for their practical application in the real world.

This project will rely on genetic engineering tools to modify the proteins involved in extracellular electron transfer processes, and microbiology and biochemical studies will be used to study the ability of the mutant strains to perform extracellular electron transfer. Taking into consideration that the outer-membrane cytochromes MtrC and OmcA are the main responsible for the extracellular electron transfer pathway in *S. oneidensis* MR-1, these will be the proteins that will be modified. For these two proteins a genetic expression system is already available in the laboratory. It is expected that with this project several *Shewanella* strains with enhanced capabilities in performing extracellular electron transfer processes to an electrode will be constructed, which will provide significant knowledge on the molecular factors that enhance electron transfer to electrodes.