Master's Thesis Abstract

A Synthetic Biology Approach to Engineer an Extracellular Electron Transfer Pathway into *Escherichia coli*

Zahra Pourmand Tehrani
Supervisor: Prof. Ardemis Boghossian
Laboratory of Nanobiotechnology, École polytechnique fédérale de Lausanne (EPFL)

Extracellular electron transfer is a microbial metabolism enabling efficient electron transfer between living microorganisms and extracellular solid materials. However, the microbial inner membrane is generally not physically permeable to minerals. Engineering microbial cells with current production capability can create a platform with the potential to be used in different technologies, including microbial fuel cells [1].

The focus of this thesis is on using a synthetic biology approach to functionally express and further improve an electron transfer pathway introduced into *Escherichia coli* (*E. coli*). This pathway is based on the respiratory capacity of the dissimilatory metal-reducing bacterium *Shewanella oneidensis* MR-1. *Shewanella* uses a network of multiheme c-type cytochromes to transfer charge across the inner and outer membranes of the bacteria via the heme moiety in the cytochromes [2]. It is suggested that major components of this electron transfer pathway are the periplasmic decaheme cytochrome MtrA, the outer membrane decaheme cytochrome MtrC, and the outer membrane β-barrel protein MtrB. However, the expression of this pathway into *E.coli* has lower extracellular electron transport capacity compared to *Shewanella*. Thus, it is aimed to investigate possible improvements in the electron transfer pathway by enhancing the interaction between periplasmic protein MtrA and an endogenous *E. coli* membrane protein using directed evolution. By demonstrating the capacity of Mtr-expressing *E.coli* to extracellularly transfer electrons through both azo dye reduction and electrical current production, this work aims to establish Mtr-expressing *E.coli* as a platform to be used in various applications.

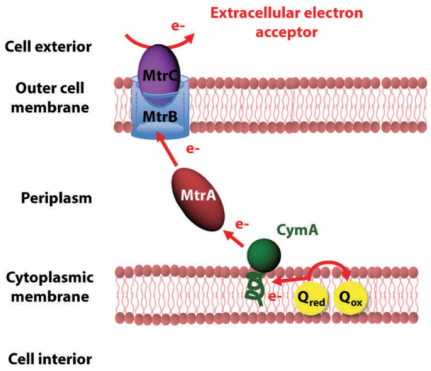

Figure 1: Extracellular electron transfer pathway in *Shewanella oneidensis* MR-1 [2]

References

[1] Shi, Liang et al. 2016. Extracellular Electron Transfer Mechanisms between Microorganisms and Minerals. Nature Reviews Microbiology 14(10):65162.

[2] Schuergers, N., C. Werlang, C. M. Ajo-Franklin, and A. A. Boghossian. 2017. A Synthetic Biology Approach to Engineering Living Photovoltaics. Energy Environ. Sci. 10(5):110215.