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DEVELOPMENT OF A RENEWABLE NEXT-GENERATION BATTERY USING S. ONEIDENSIS

MOTIVATION

◆ The rapid increase in energy demand, together with the over reliance on non-renewable energy sources have caused an impending energy crisis.
◆ Alternative renewable source of energy, including microbial fuel cell (MFC), is one of the attractive solutions to the problem. The device uses microorganisms to convert chemical energy to electric current.
◆ In this project, I aim to explore the use of Shewanella oneidensis in MFCs and the method to enhance the power generation in order to overcome the existing disadvantage of a low power output.

METHODOLOGY

Lactate Permease (LDP) and Lactate Dehydrogenase (LDH) are the two essential enzymes involved in lactate metabolism in which S. oneidensis uses lactate as an energy source via the oxidation of lactate to pyruvate with electrons being generated. The electrons will be shuttled out to the external environment via the MTR pathway, after which they can then be utilized to power the MFCs. In order to enhance the power output, the mutants of the two enzymes which would facilitate lactate oxidation to be more efficient should be used.

Error-Prone PCR to generate mutants

Construct the plasmid containing mutant LDH and wild type LDP gene, using pHG101 as the backbone

Conjugate the plasmid into S. oneidensis cells

Measurement of cell growth rate and MFC voltage output

CONCLUSION

The growth curves (Fig.3) have shown that the Shewanella cells containing the mutant gene have a higher growth rate compared to the controls (SP-1 and SP-2). This indicated that mutations have led to a higher rate of lactate metabolism which is likely to cause a higher power output of the MFC. This deduction has been confirmed by measuring the voltage output of the MFC (Fig.4) using the cells containing the mutant gene, such as 7M6-8 (Fig.4(b)) has shown a significant increase in voltage output compared to the control (SP-1). Thus, mutations on the gene can potentially enhance the power output of the MFC.

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RESULTS

Figure 1. The plasmid construct

Figure 2. LDP and LDH genes from different bacteria were tested. (a) Growth curves and (b) lactate consumptions of S. oneidensis strains under anaerobic condition in Shewanella basal medium supplemented (SBM) with 18 mM lactate and 40 mM fumarate. (c) Voltage outputs of MFCs inoculated with S. oneidensis recombinants.

Figure 3. Random mutations were generated and tested. Growth curves of S. oneidensis recombinants (a) MSH7-pHG101, (b) MSH7-SH8-pHG101, under anaerobic condition in SBM with 18 mM lactate and 40 mM fumarate.

Figure 4. Voltage outputs of MFCs inoculated with S. oneidensis recombinants (a) MSH7-pHG101, (b) MSH7-SH8-pHG101. One particular set of mutations (7M6) was found to outperform the original wildtype gene.

Project Title: Development of a renewable next-generation battery using bacteria

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Co-Supervisor: Ms Zhang Lei

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