



Microbial electrosynthesis – A shocking method of creating renewable energy

Currently most of our energy is supplied through petroleum, coal, and natural gas deposits. These sources of energy, however, are both finite and non-renewable. Recently, efforts have been made to

generate sustainable energy via the production of biofuels from commercially available products such as corn and sugar cane. However, these sources of energy require food to be used as fuel rather than for human sustenance. To resolve these aforementioned issues, current bioenergy research is focusing on the use of microorganisms in the generation of multicarbon organic compounds that can be used as precursors for fuels and other desirable organic chemicals¹.

Presently, there are several mechanisms in which microorganisms are employed for the generation of bioenergy. In one approach, microbial communities are applied in the conversion of plant, animal, and industrial biomass into usable energies such as ethanol and methane. In a second approach, photosynthetic microorganisms such as algae are used in the conversion of sunlight to biodiesel². In recent years, microbial electrosynthesis has been analyzed as a third option for microbial bioenergy production. In this approach, electricity is used to drive biosynthetic pathways that reduce chemical structures into industrially relevant compounds^{1,3}.

For microbial electrosynthesis to be successful, microorganisms must be capable of linking complex oxidation/reduction reactions to electrodes. For example, in the facultative anaerobe, *Shewanella oneidensis*, the Mtr respiratory pathway can catalyze the flow of electrons from cytoplasmic oxidative reactions to electrodes. Thus, through the reversal of this pathway, it may be possible to drive reductive metabolism to synthesize biofuels and other valuable compounds. In a recent study, Ross et al. examined the *S. oneidensis* Mtr respiratory pathway to determine its potential use in microbial electrosynthesis⁴. Using an electrochemical approach combined with the development of relevant genomic deletion mutants, the group was able to successfully demonstrate that this pathway has the ability to power reductive reactions. Overall, the results from this study suggest a role for the Mtr respiratory pathway in engineered microbial electrosynthesis.

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References

1. Centi G., and Perathoner S. Opportunities and prospects in the chemical recycling of carbon dioxide to fuels. *Catal. Today* 148: 191-205, 2009.
2. Rittmann BE. Opportunities for renewable bioenergy using microorganisms. *Biotechnol. Bioeng.* 100(2): 203-212, 2008.
3. Nevin KP, et al. Microbial Electrosynthesis: Feeding Microbes Electricity to Convert Carbon Dioxide and water to Multicarbon Extracellular Organic Compounds. *mBio* 1(2): 1-4, 2010.
4. Ross DE, et al. Towards Electrosynthesis in *Shewanella*: Energetics of Reversing the Mtr Pathway for Reductive Metabolism. *PLoS One* 6(2): 1-9, 2011.



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Thursday, November 14

1:00 PM (EST)

Jeffrey A. Gralnick, Ph.D.

University of Minnesota

Some bacteria have the ability to live by breathing certain oxide minerals. In this presentation, Dr. Gralnick will talk about one of the best understood model organisms for this process, *Shewanella oneidensis*, and how a detailed understanding of this microbe could lead to breakthroughs in the areas of energy and bioremediation.

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