Comparative metagenomic profiling of two pilot-scale microbial fuel cells treating industrial wastewaters

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Among proposed green energy technologies, microbial fuel cells (MFCs) hold promise as an efficient and cost-effective solution for global wastewater treatment. Within an MFC, anaerobically respiring microorganisms degrade organic compounds and donate electrons to an external circuit, thereby coupling removal of organics with electrical power production. These systems have proved efficient in laboratory-scale settings, and are now being scaled-up to be applied to the recovery of energy from industrial and municipal wastewaters. Several microbial species that are associated with anode surfaces of MFCs and capable of electron transfer have been identified, such as different species of *Geobacter*, but the structure of entire electrogenic communities is not well understood. To apply MFC technology to treat real municipal wastewaters such communities have not only to be capable of electricity generation, but are also expected to be capable of efficient biodegradation.

To investigate the structure of MFC communities we performed metagenomic analysis of microbial communities and corresponding anaerobic digester (AD) sludge inocula from two multi-electrode pilot MFC bioreactors of similar design, that successfully treated wastewater from local distilleries and generated electrical power; one in Edinburgh, Scotland (UK), the other in Okinawa, Japan (JP).

Proteobacteria, *Bacteroidetes* and *Firmicutes* were abundant in the inocula and constituted the dominant core of the MFC microbiomes. Functional analysis revealed genes involved in degradation of organic compounds common in food industry wastewaters. Finally, we found a range of species within the anode communities possessing the capacity

for extracellular electron transfer, both via direct contact and electron shuttles, and show differential distribution of bacterial groups on the carbon cloth and activated carbon granules of the anode surface. Overall, this study provides insights into structural shifts that occur in the transition from an AD sludge to an MFC microbial community and the metabolic potential of electrochemically active microbial populations with wastewater-treating MFCs.