



جامعة نيويورك أبوظبي  
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**Sustainable bioelectricity production during wastewater treatment by  
origami-inspired fabrication of Microbial fuel cells using E. Coli with  
Dynamic Sensor-Regulator Systems .**



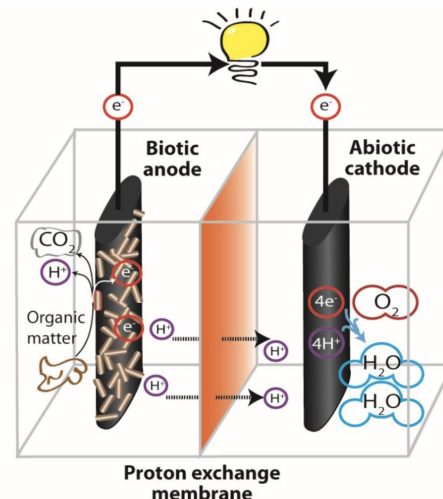
**Word Count: 500 words**

## Problem Description

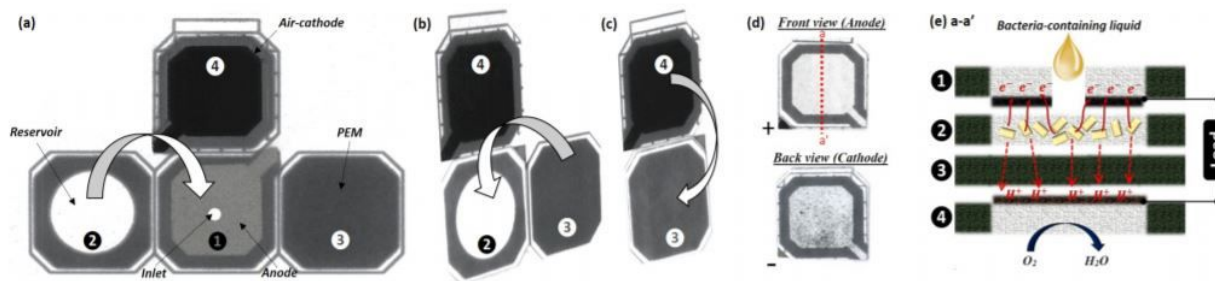
In recent years, global consumption has increased in non-renewable energy [1] as prospects of controlling climate change become ever dimmer. However, the UAE has stuck to the vision of an environmentally sustainable future. Yet, difficulties include the high cost of wastewater treatment [2] and water pollution [3]. The use of MFCs, microbial fuel cells, in treating wastewater and generating energy have been acknowledged in the UAE, but due to cost and efficiency, none are currently operational in the UAE [4]. The improvements we intend to make to MFCs from past designs are with the materials and structure of the electrodes, and the microbes themselves, as will be discussed.

## Solution Concept

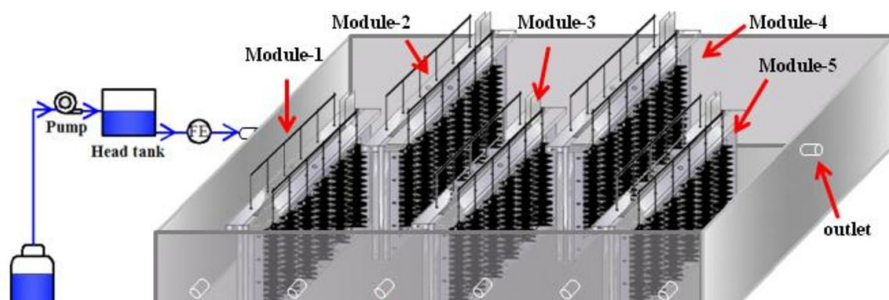
MFCs function by using organic-matter-consuming microbes on an anode in wastewater, cleaning it, and releasing carbon dioxide, electrons, and protons [5]. The electrons, via a circuit, and protons, via a semipermeable membrane, complete a circuit; generating electricity. It therefore uses the metabolism of certain strains of microbes to clean water and generate energy.



We would experiment with 3 improvements from the most popular present models. (1) To lower the cost of MFC production, individual parts of MFCs should not be constructed as parts, but rather as a whole that can be mass-produced. The diagram below elaborates on how the PEM, proton exchange membrane, and the electrodes can be created as a single unit, and can be fold into an effective fuel cell origami-style.



The design is also scalable as a multi-chambered implementation in the real world.

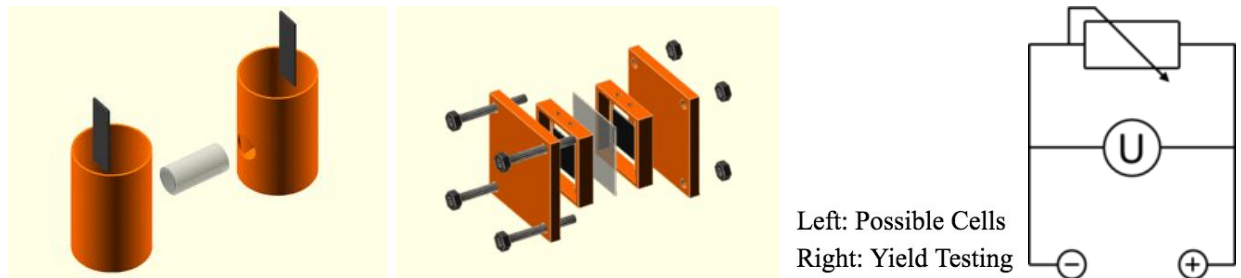


(2) Due to the structure of our design, a combination of carbon paper and carbon felt will be used instead of graphite rods, which are the most

common anode material; moreover, recent research has shown that carbon paper/felt combinations generate up to 140% more power than graphite rods [6]. (3) Microbes used on the anode will be strains of *Escherichia coli* modified with a dynamic sensor-regulator system, which yields more efficient metabolism in the bacteria and thereby increases production to a maximum of three folds compared to conventional microbes used, and to 28% of the theoretical maximum [7]. Additional reasons to use only *E. Coli* is its ability to reproduce without oxygen, easier manipulation and monitoring, and lessened risk of contamination; advantages over most MFCs which uses a mix of microbes [8].

### Reduction to Practice

The yield of the design and materials chosen will be tested first in a film canister for potential improvements. Improved models from experiments will be prototyped with 3D printed cases, and final models out of laser cut components. The final models can then be stacked and tested against large volumes of wastewater. Our diagrams below are for reference.



### Benefits and Pathways of Implementation

Although MFCs cannot replace other forms of energy in the UAE for the near future, the added value from continued improvements still makes a huge difference. Wastewater treatment usually takes 10% of municipal electricity consumption [9], and making it so that no energy is needed to treat wastewater would be hugely beneficial to not only the UAE, but all countries. Thus the reason to strive in reducing the cost of MFCs and increasing its efficiency.

In the far future, when all oil wells have depleted, it may be possible that MFCs be a reliable and significant source of renewable energy like wind or solar, but that is a consideration for another generation.

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