About OMICS Group

OMICS Group International is an amalgamation of Open Access publications and worldwide international science conferences and events. Established in the year 2007 with the sole aim of making the information on Sciences and technology 'Open Access', OMICS Group publishes 500 online open access scholarly journals in all aspects of Science, Engineering, Management and Technology journals. OMICS Group has been instrumental in taking the knowledge on Science & technology to the doorsteps of ordinary men and women. Research Scholars, Students, Libraries, Educational Institutions, Research centers and the industry are main stakeholders that benefitted greatly from this knowledge dissemination. OMICS International also organizes 500 International conferences annually across the globe, where knowledge transfer takes place through debates, round table discussions, poster presentations, workshops, symposia and exhibitions.

About OMICS International Conferences

OMICS International is a pioneer and leading science event organizer, which publishes around 500 open access journals and conducts over 300 Medical, Clinical, Engineering, Life Sciences, Pharma scientific conferences all over the globe annually with the support of more than 1000 scientific associations and 30,000 editorial board members and 3.5 million followers to its credit.

OMICS International has organized 500 conferences, workshops and national symposiums across the major cities including San Francisco, Las Vegas, San Antonio, Omaha, Orlando, Raleigh, Santa Clara, Chicago, Philadelphia, Baltimore, United Kingdom, Valencia, Dubai, Beijing, Hyderabad, Bengaluru and Mumbai.

Use of electricity to direct microbial metabolite production

John M. Pisciotta

West Chester University

Department of Biology

4th International Conference and Exhibition on Metabolomics and Systems Biology

Philadelphia, PA,

April 28, 2015

- Talk Objective -

- Discuss recent discoveries detailing how electrical energy, alone or in combination with other factors, can be used to direct microbial metabolite formation.

- Touch on the potentials, possibilities and challenges for future research.

- Highlight the key role Metabolomics can play.

- Introduction -

- Organisms have evolved to respond to external stimuli ranging from radiation to chemicals to magnetic fields.

- Responses can often be measured *metabolically*.

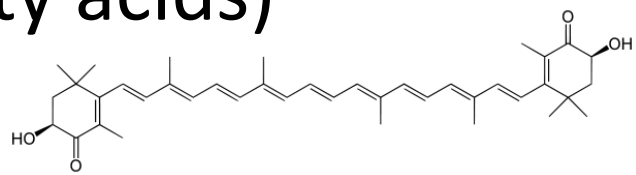
- Exposure to stresses like radiation or carcinogens may result in characteristic perturbation of the normal metabolite profile.

- In humans, induced metabolic changes can help us diagnosis illnesses – in *microbes* they can yield useful products.

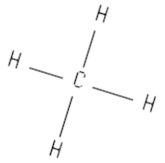
Why use Metabolomics?

In Biotechnology & Industrial Microbiology the product is *often* a Metabolite.

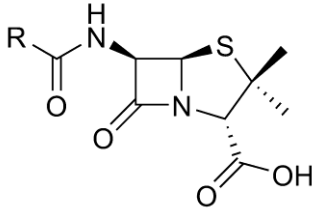
- Pigments (Carotenoids)
- Nutrients (Omega 3 fatty acids)
- Antioxidants (Astaxanthin)



- Biofuels (Ethanol / Methane)

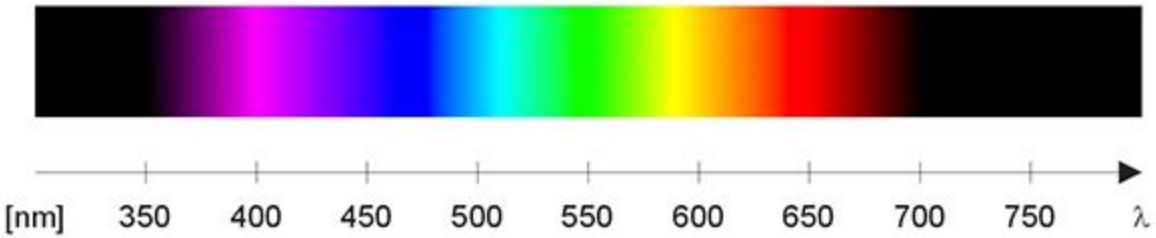


- Biosurfactants (Lipopeptides)
- Antibiotics (Penicillin)



Diverse Physicochemical parameters have successfully be used to time, tune & optimize metabolite output.

- Chemicals
- pH
- Light



- Temperature

*But what about **Electricity** as an inducer, and / or energy source?*

Bio-Electrochemical System (BES)

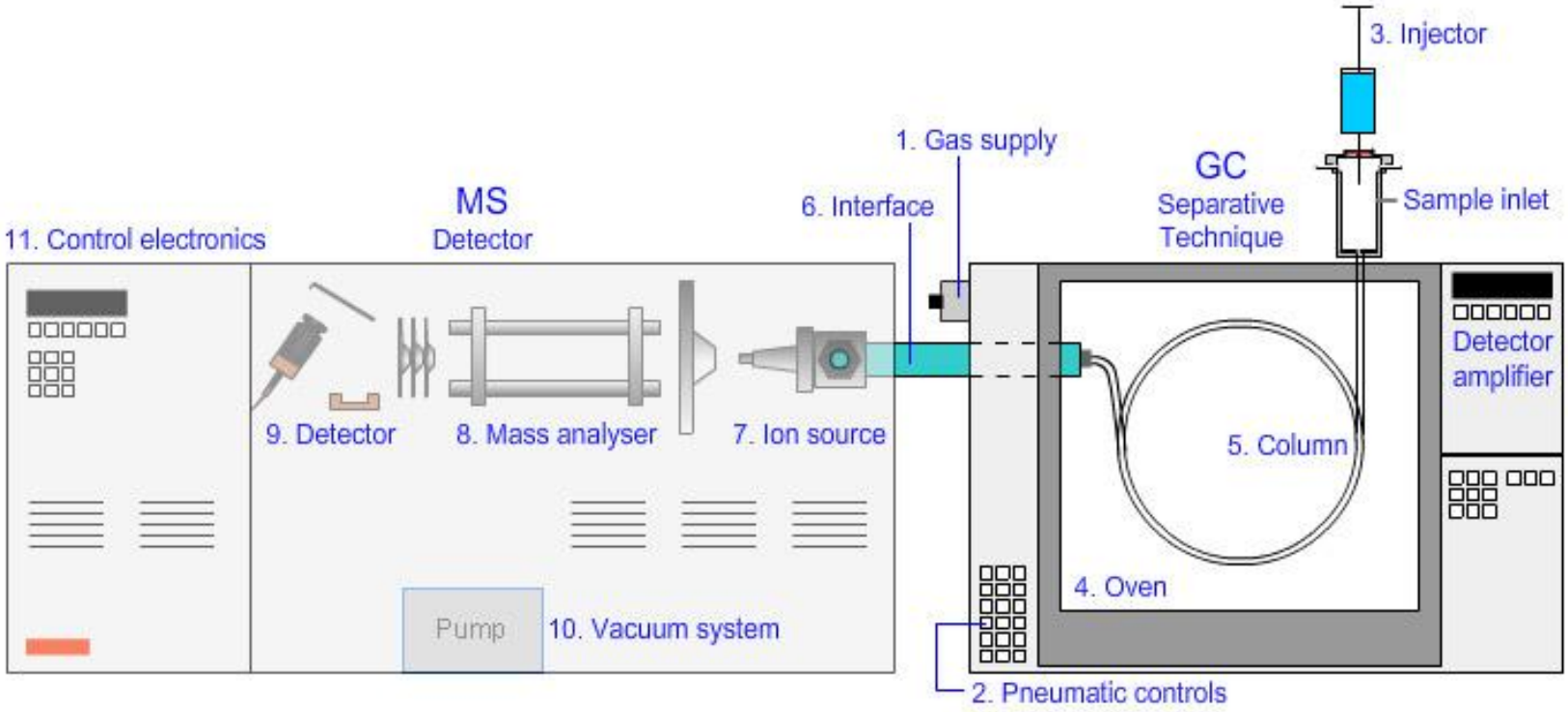
- **System that use microbes** (and/or cell products) **to convert chemical energy to electrical energy, or *vice versa,* and provide a useful service.**

- **BESs use electrode enzymes or cells (usually bacteria) as biocatalysts to drive oxidation & reduction reactions at 2 opposing electrodes.**

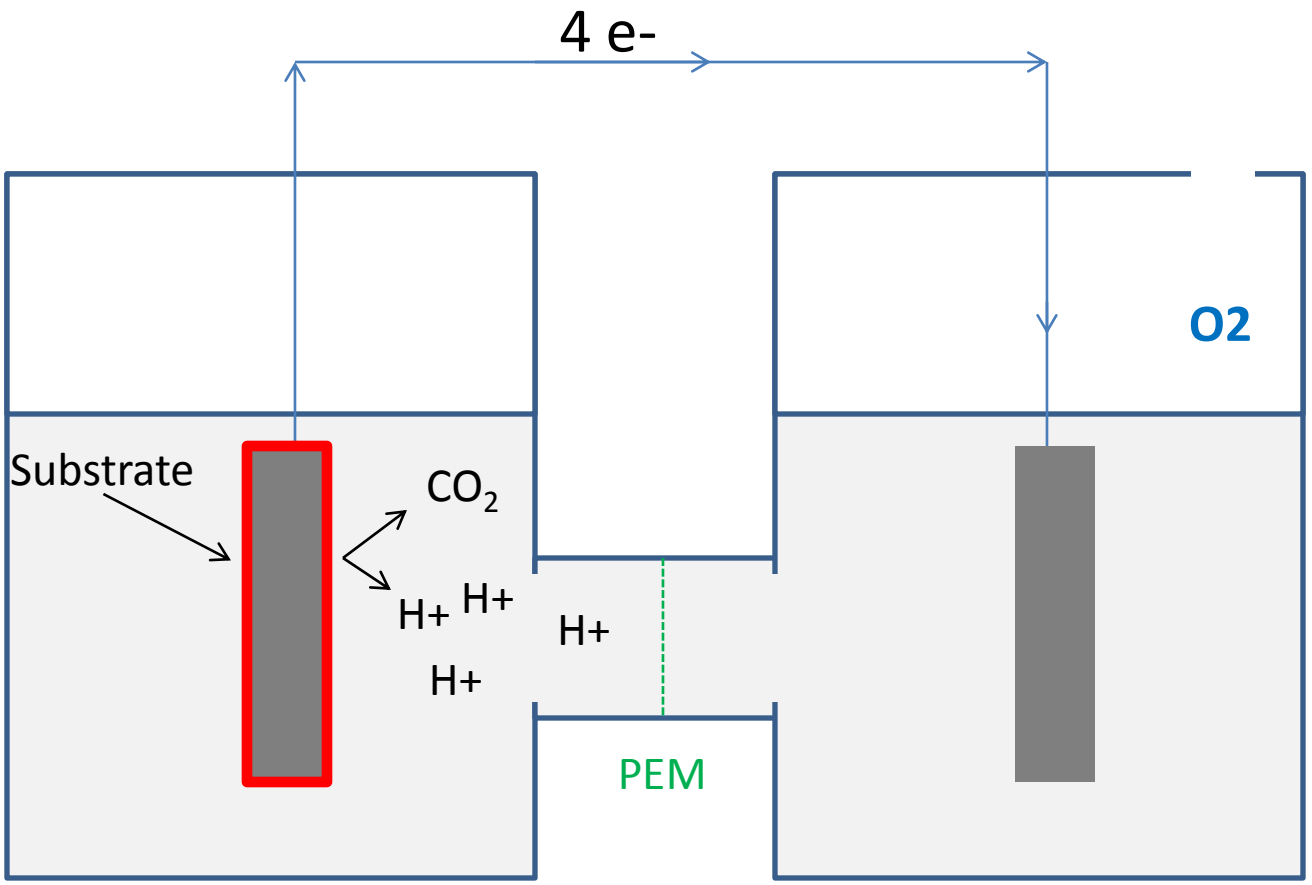
- **Bioanode and / or Biocathode**

Metabolomic Methods Used

- HPLC, GC, MS and *potentiostatic* techniques are used to study products of mixed or pure cultures or syntrophic associations.



Microbial Fuel Cell



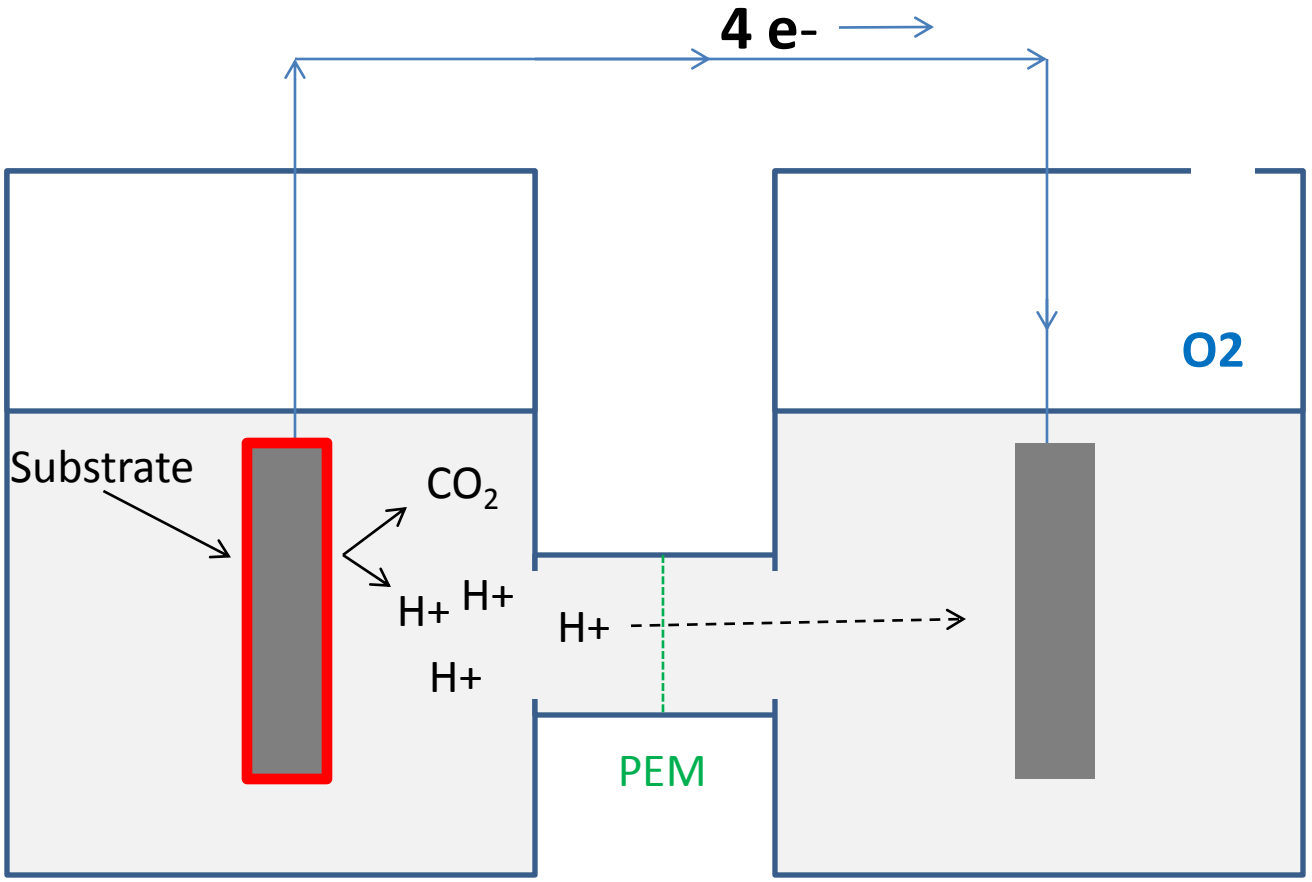
Anode (e- enter circuit)
Anaerobic

Air Cathode (e- exit circuit)
Aerobic

Microbial Fuel Cell

Metal reducing bacteria

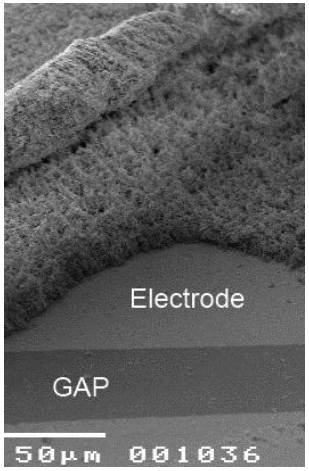
Geobacter TEM
Cologgi, 2011



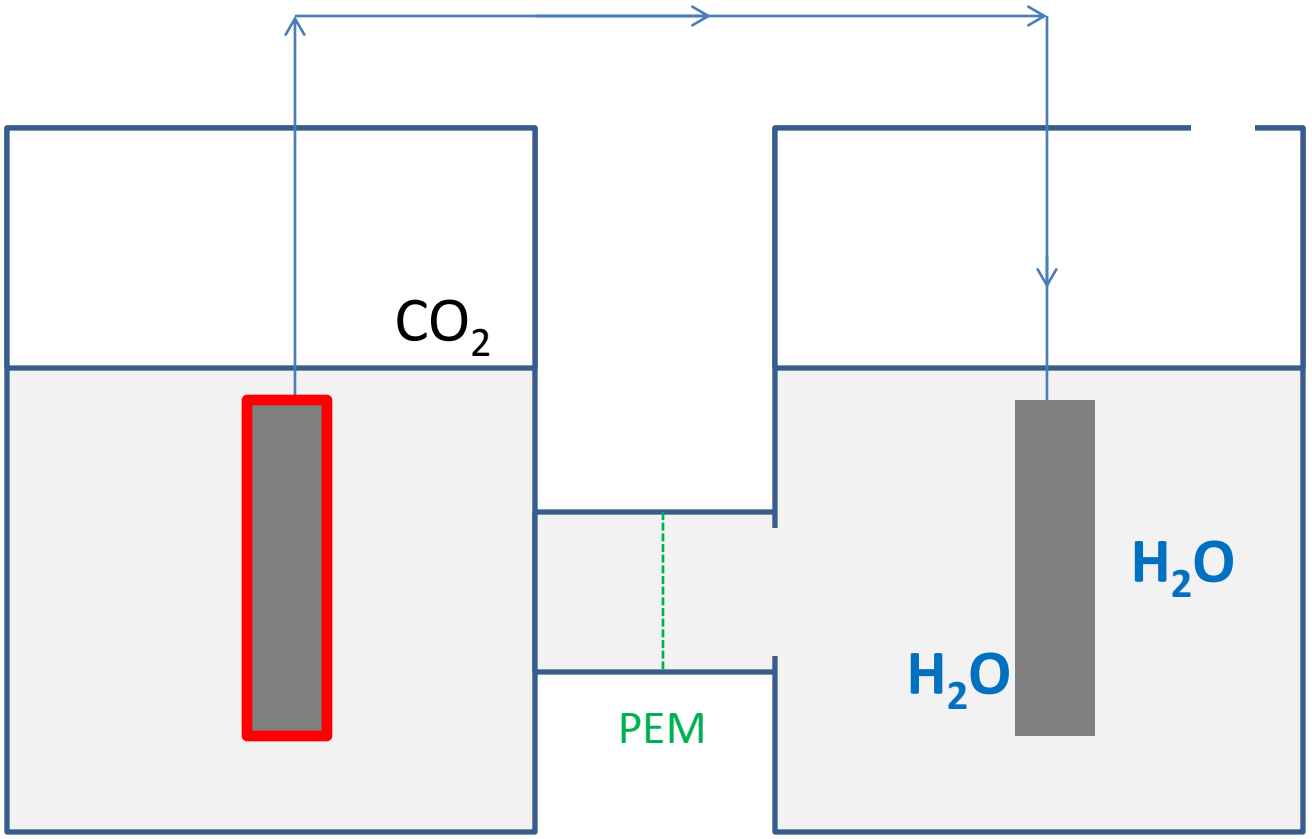
Anode (e- enter circuit)
Anaerobic

Air Cathode (e- exit circuit)
Aerobic

Microbial Fuel Cell



Malvankar,et al. 2011



Anode (e- enter circuit)
Anaerobic

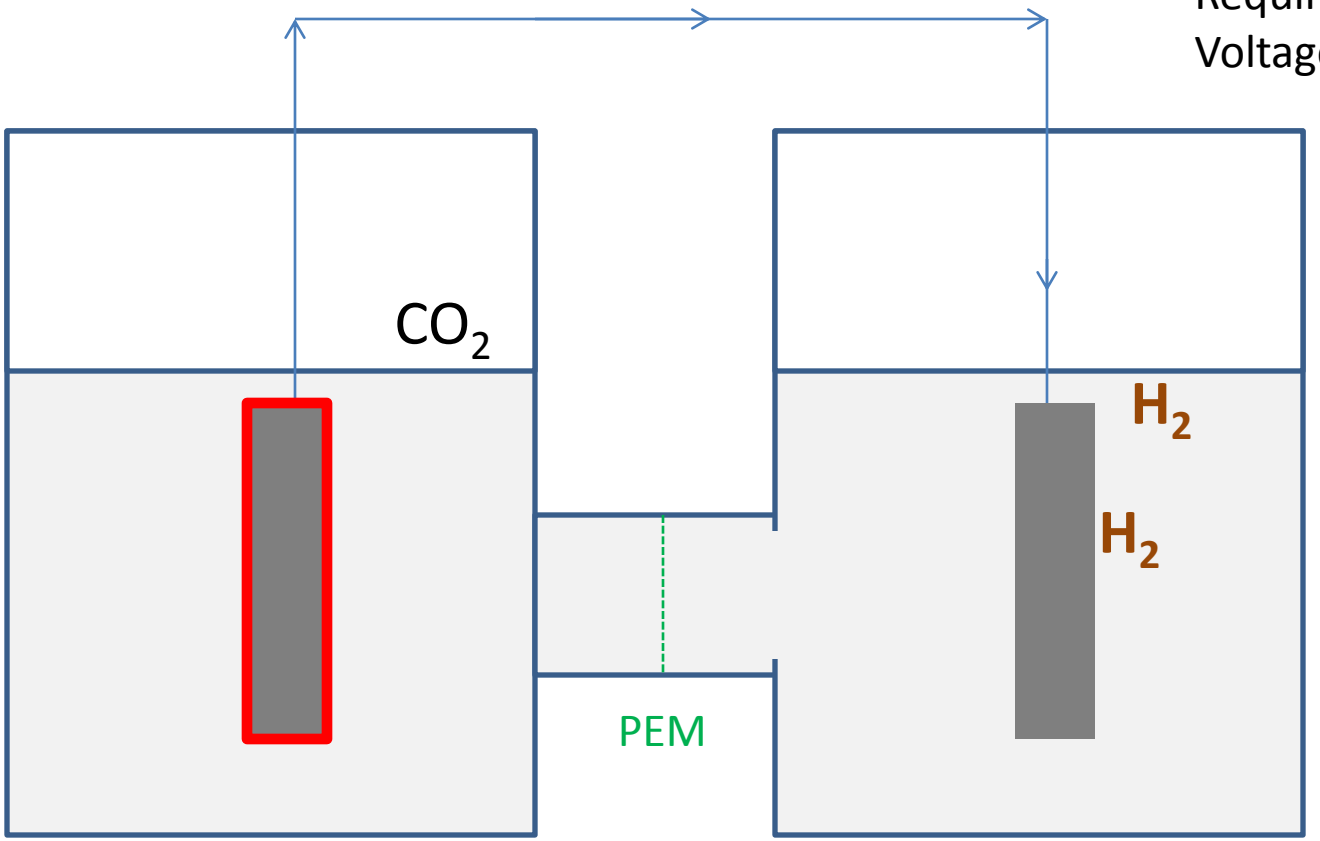
Air Cathode (e- exit circuit)
Aerobic : O2 is e- acceptor > H2O

Microbial Electrolysis Cell = H_2

Cheng & Logan, 2007, PNAS

MEC's convert organic wastes (ex. acetate) to usable hydrogen, producing 140%+ more *usable* energy than electrical energy consumed.

Requires applied Voltage



Anode (e- enter circuit)
Anaerobic

Cathode (e- exit circuit)
Anaerobic : H+ is e- acceptor

Electro-methanogenesis

Direct Biological Conversion of Electrical Current into Methane by Electro-methanogenesis

Cheng et al. 2009. *Environ. Sci. Technol.*

- Conversion efficiencies of up to 96% at 1 Volt.
- Major Advance: **Use of BIOCATHODE** **(archaea).**

- ***Implication:*** Electrically-guided Microbial CO2 fixation

Microbial Electrosynthesis

Microbial Electrosynthesis: Feeding Microbes Electricity To Convert Carbon Dioxide and Water to Multicarbon Extracellular Organic Compounds

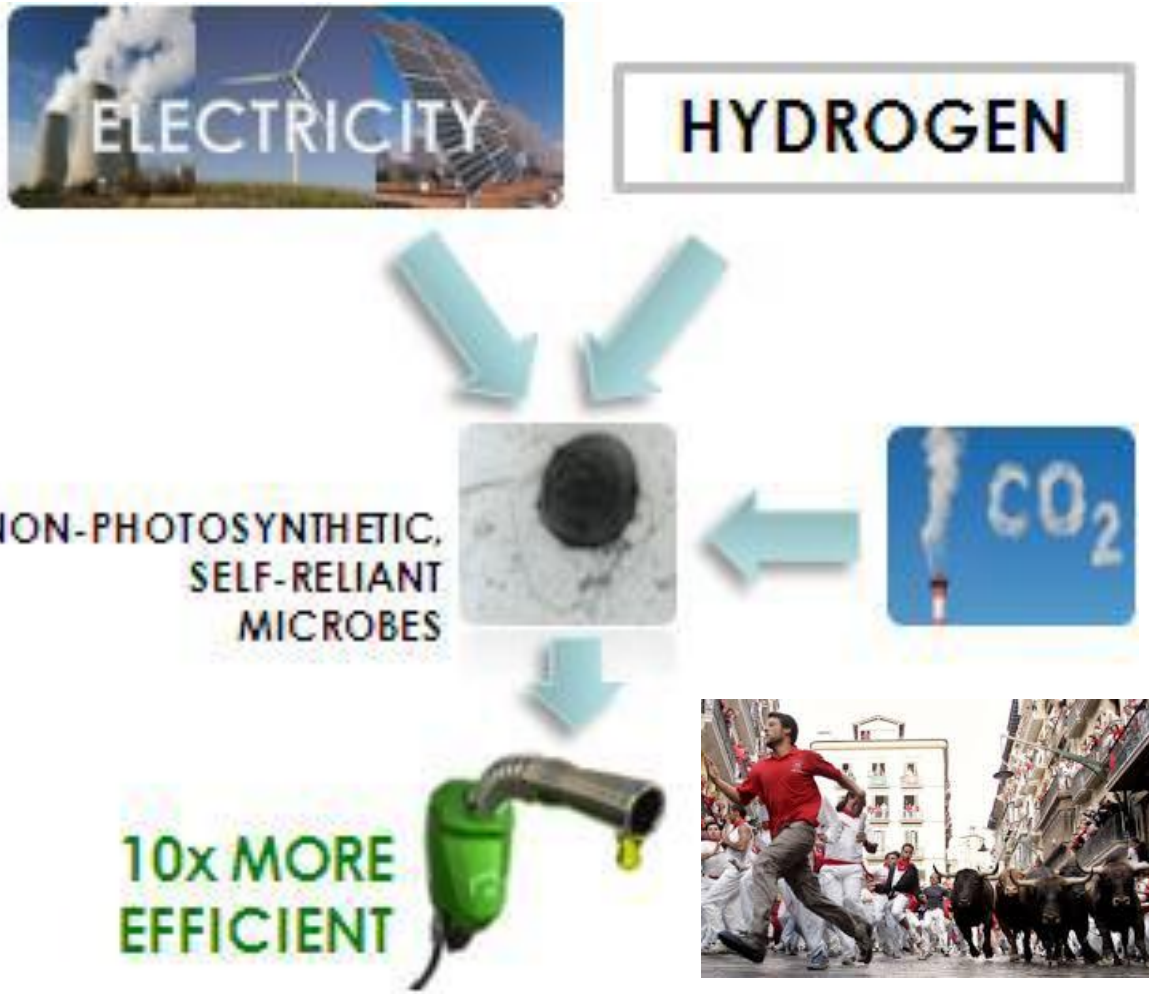
Nevin et al., 2010. mBio.

- Acetogenic bacteria can use electricity to fix CO_2 into organic molecules.

- Efficiencies of around 80% using Wood Ljungdahl pathway.

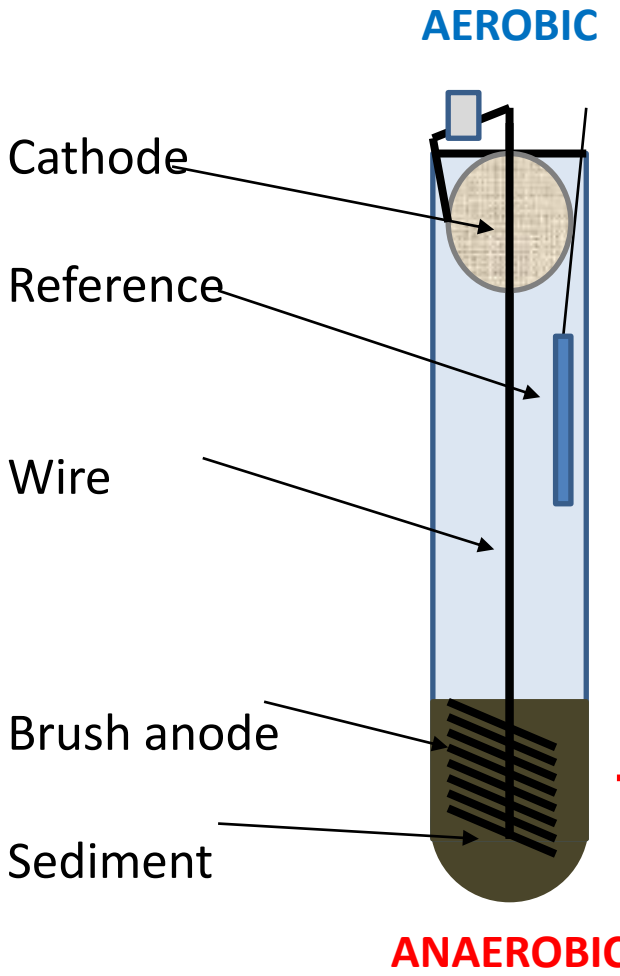
Electrosynthesis:

The DOE ARPA-E Electrofuels initiative 2010-2013



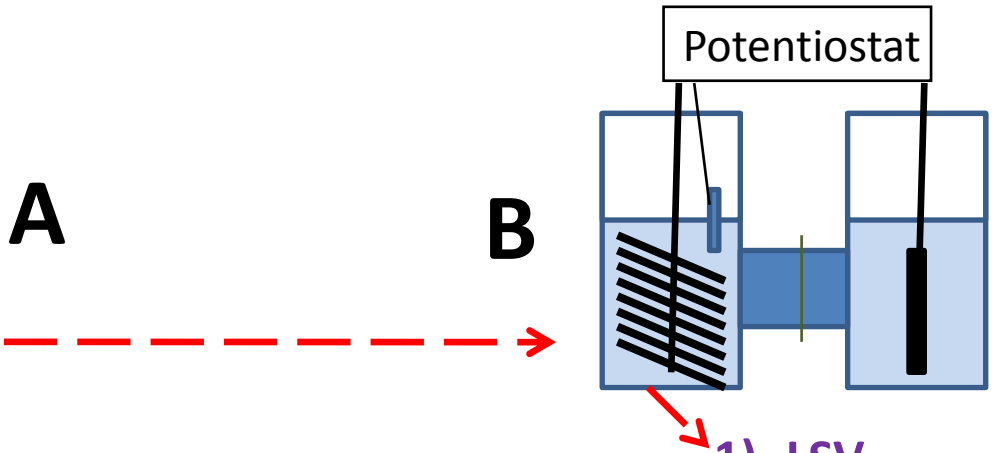
Enrichment of microbial electrolysis cell (MEC) biocathodes from sediment microbial fuel cell (sMFC) bioanodes.

Pisciotta et al., 2012. AEM



A) MFC anodes in anaerobic sediment **establish electrogenic biofilm.**

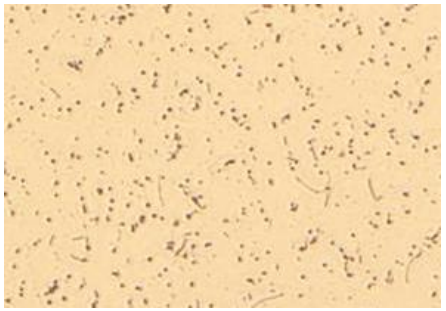
B) Electrode inverted to form functional MEC biocathode.

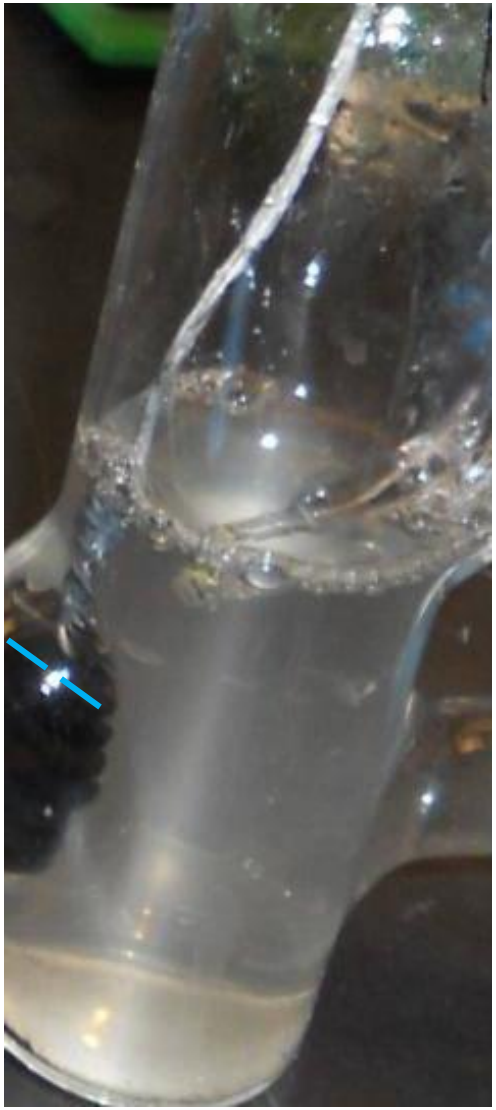


1) LSV
2) CV
3) Current Uptake
4) Chemical Analysis

Electrotroph Cultivation on CO_2

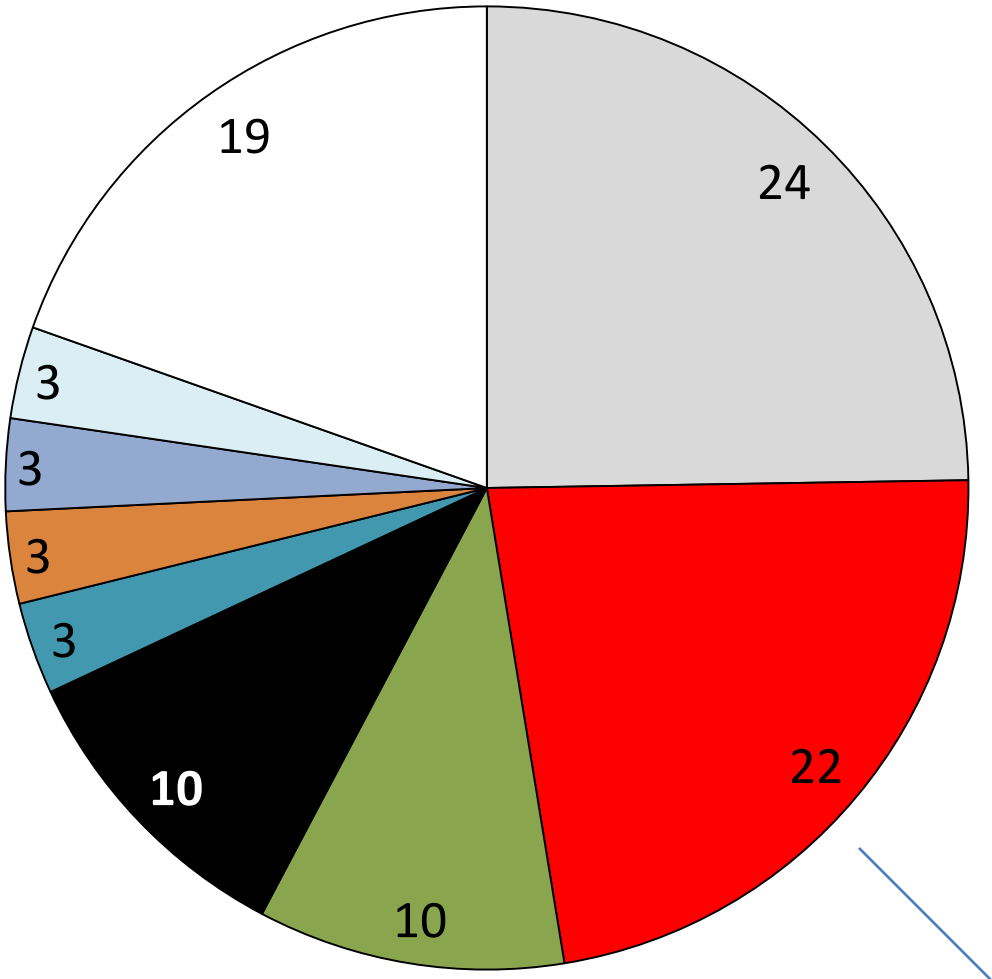
1) Demonstrated Transferability





Pisciotta et al., 2012. AEM

16s DNA Clone Library:
Chesapeake Bay



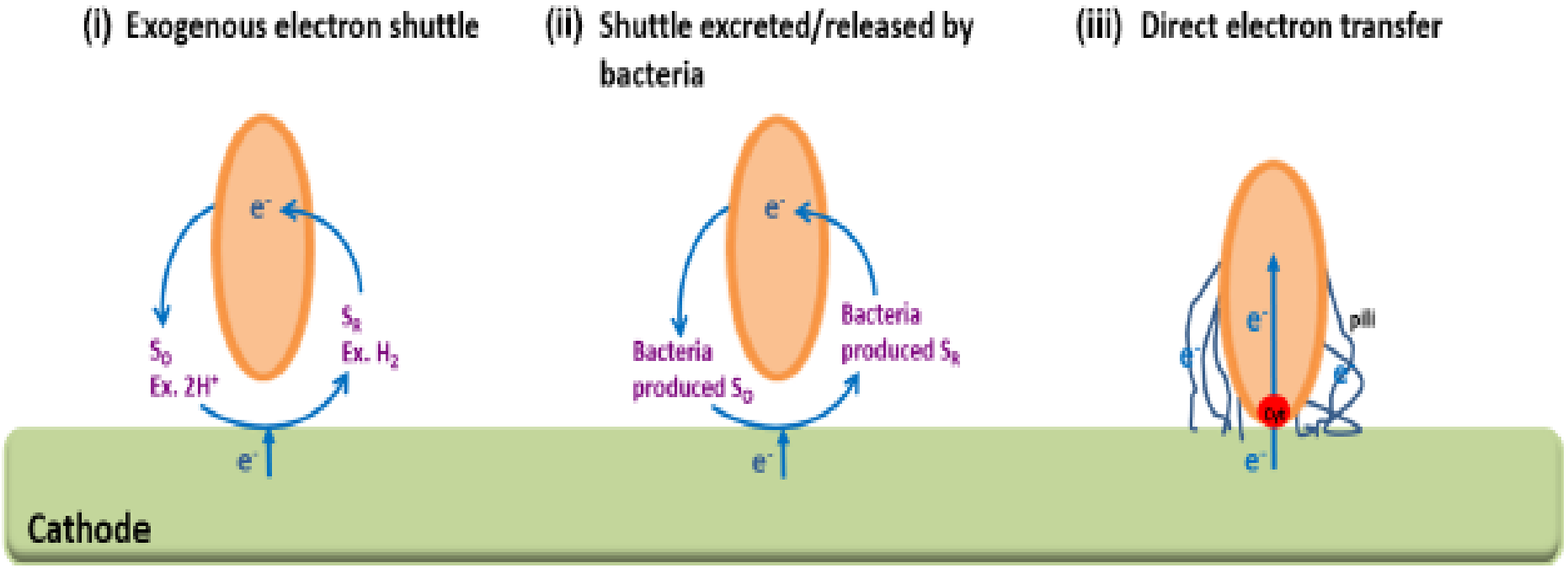
(n = 97)

- *Mesorhizobium*
- *Rhodococcus*
- *Azospirillum*
- *Gemmata obscuriglobus*
- *Sphingopyxis alaskensis*
- *Labrenzia aggregata*
- *Endosymbiont of Tevnia*
- *Marine actinobacterium*
- *Remainder*

Pure Culture Testing

Major Question for Metabolomics

The Mechanistic Basis of Electron Uptake?



Possible extracellular electron transfer mechanisms from the cathode to the microbial catalyst. Indirect electron transfer via (i)

Tremblay & Zhang. 2015.
Frontiers in Microbiology

- Summary -

- Electricity *can* be used for autotrophic conversion of CO_2 to useful metabolites.
- Selective enrichment of "*electrotrophs*" from diverse environments is possible.
- Coupling current with other stimuli (ex. light) may accelerate, expand types of metabolites formed.
- *Metabolomics* can help screen for novel electrotroph products, explore voltage effects and determine the electron exchange pathways involved.

Acknowledgments

- **JHU Sullivan Lab**: Metabolomic GC-MS/MS training.
- **UMD Baskakov Lab**: Metabolomic analysis of pMFC using HPLC w/ PDA detector.
- **PSU Logan Lab**: Electrochemical Analysis
- West Chester University: Hybrid Designs (MEC-PBR)
- Many thanks to the Meeting Organizers.

Let Us Meet Again

We welcome you all to our future conferences of OMICS International

Please Visit:

www.metabolomicsconference.com
www.conferenceseries.com
http://www.conferenceseries.com/clinical-research-conferences.php