Microbial Fuel Cells

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Waste Water a fuel?

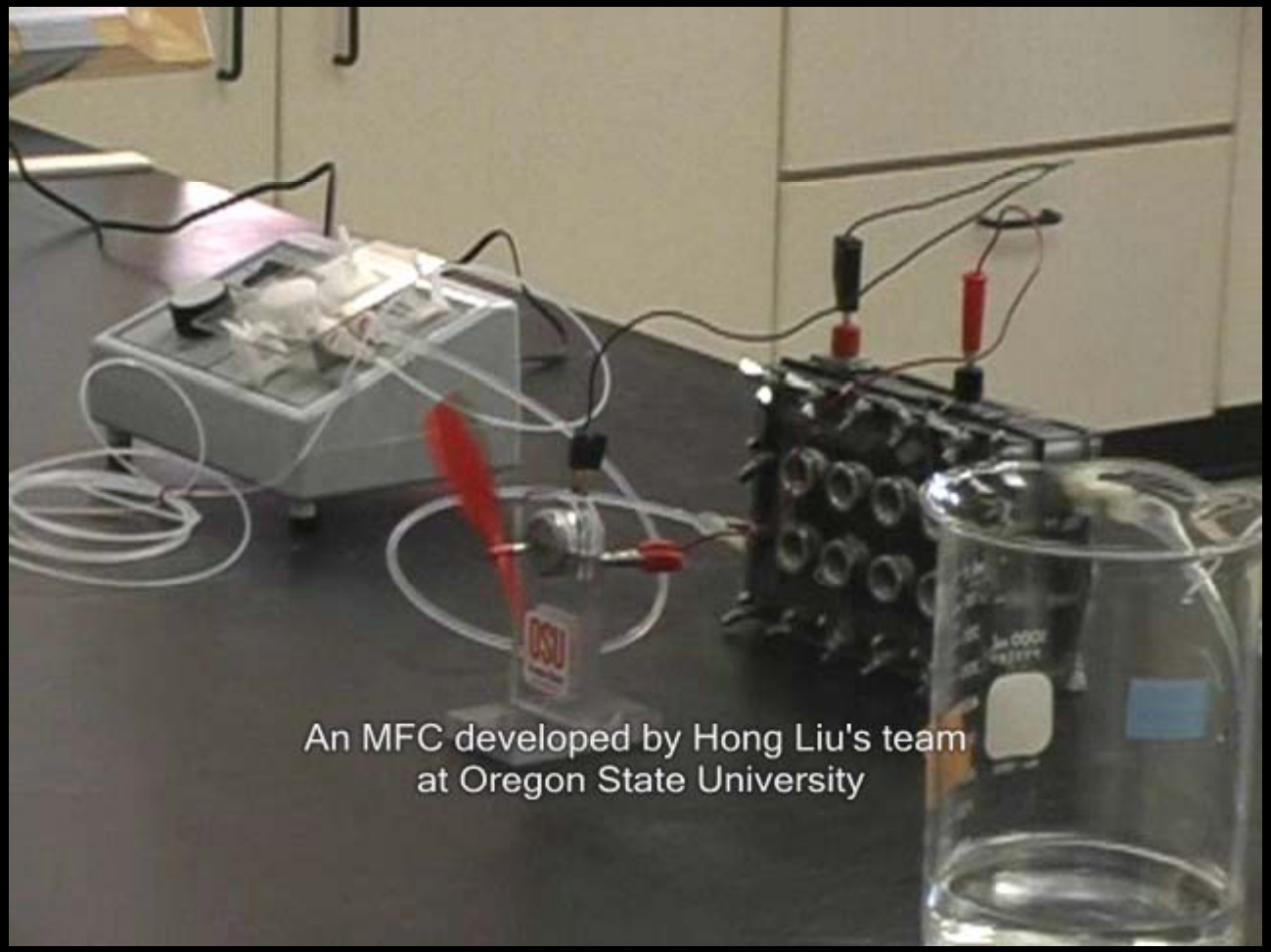
Economical Problems

- 33 billion gallons of domestic wastewater treated each day in U.S.
- $2 Trillion will be needed over next 20 years for wastewater and drinking water facilities

Imagine being able to create electricity that could power industrial factories and clean the waste water produced at these factories at the same time.

For our lab work we have taken bacteria samples from the Corvallis waste water treatment plant.

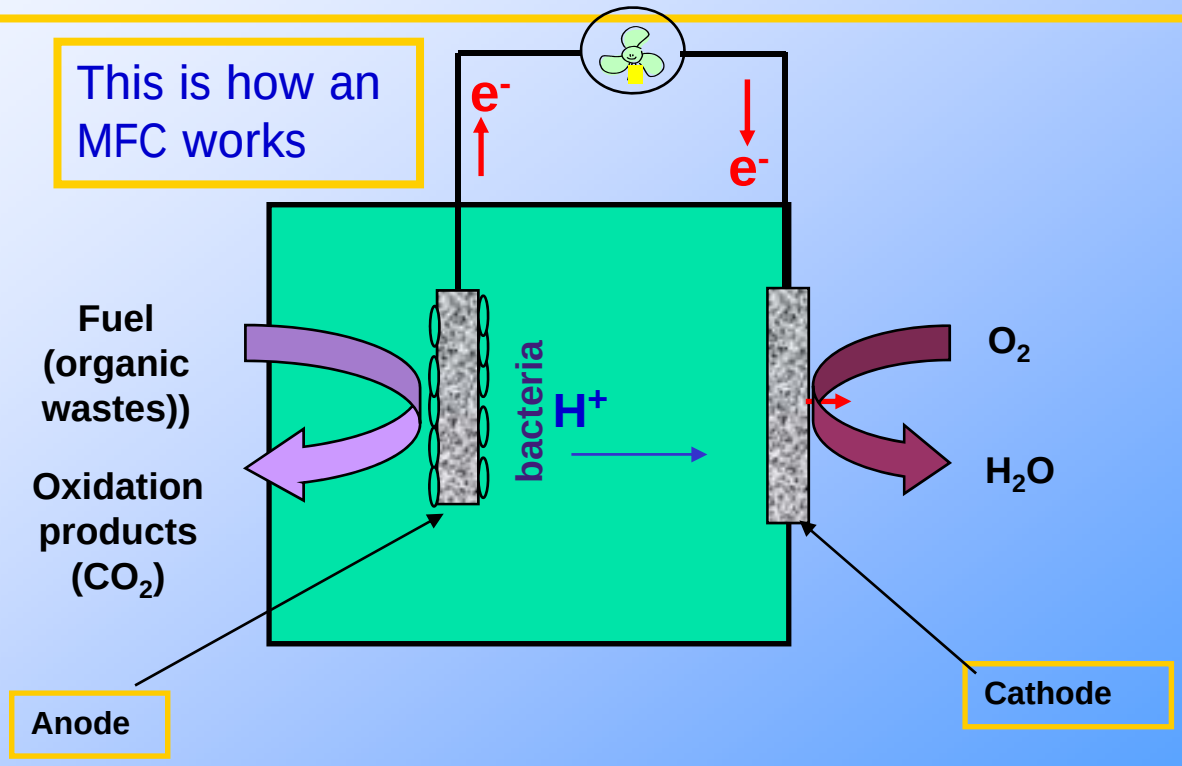
Waste Water into Usable Energy



Electricity Production in a Microbial Fuel Cell (MFC)

An MFC is a device that directly converts chemical energy into electricity through the catalytic activities of microorganisms.

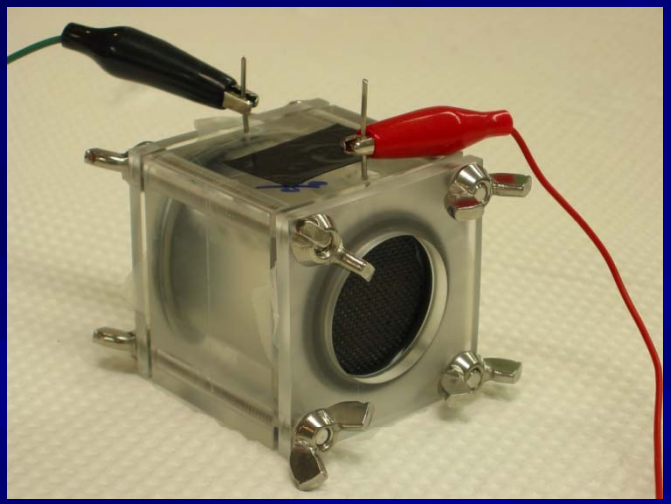
This is how an MFC works



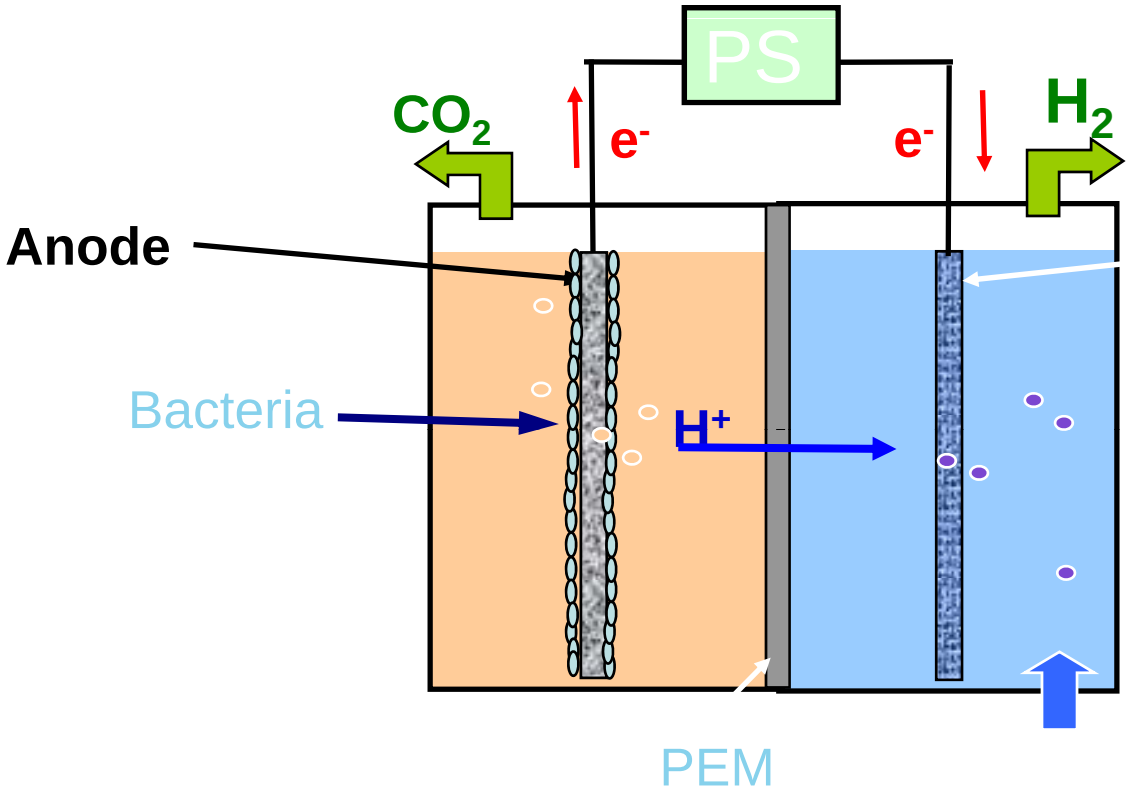
Anode: $C_xH_yO_z + H_2O \rightarrow CO_2 + e^- + H^+$

Cathode: $O_2 + 4\ H^+ + 4\ e^- = 2\ H_2O$

Laboratory MFCs



H2 Production by MEC



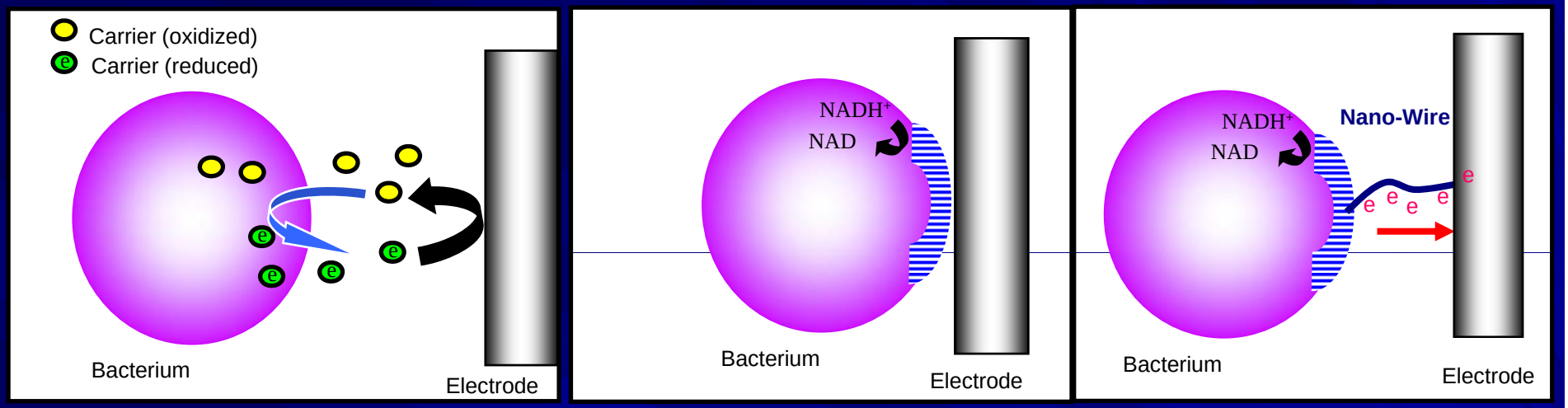
No oxygen: Cathode chamber is kept anaerobic

Anode: $C_2H_4O_2 + 2\ H_2O \rightarrow 2\ CO_2 + 8\ e^- + 8\ H^+$

Cathode: $8\ H^+ + 8\ e^- \rightarrow 4\ H_2$

Laboratory Microbial Electroysis Cell (MECs)

How do electrons reach the electrode?



A: Electron transfer by mediators

Pseudomonas aeruginosa

B: Direct electron transfer through bacteria outer-membrane enzymes

Geobacter sulfurreducens
Shewanella putrefacians

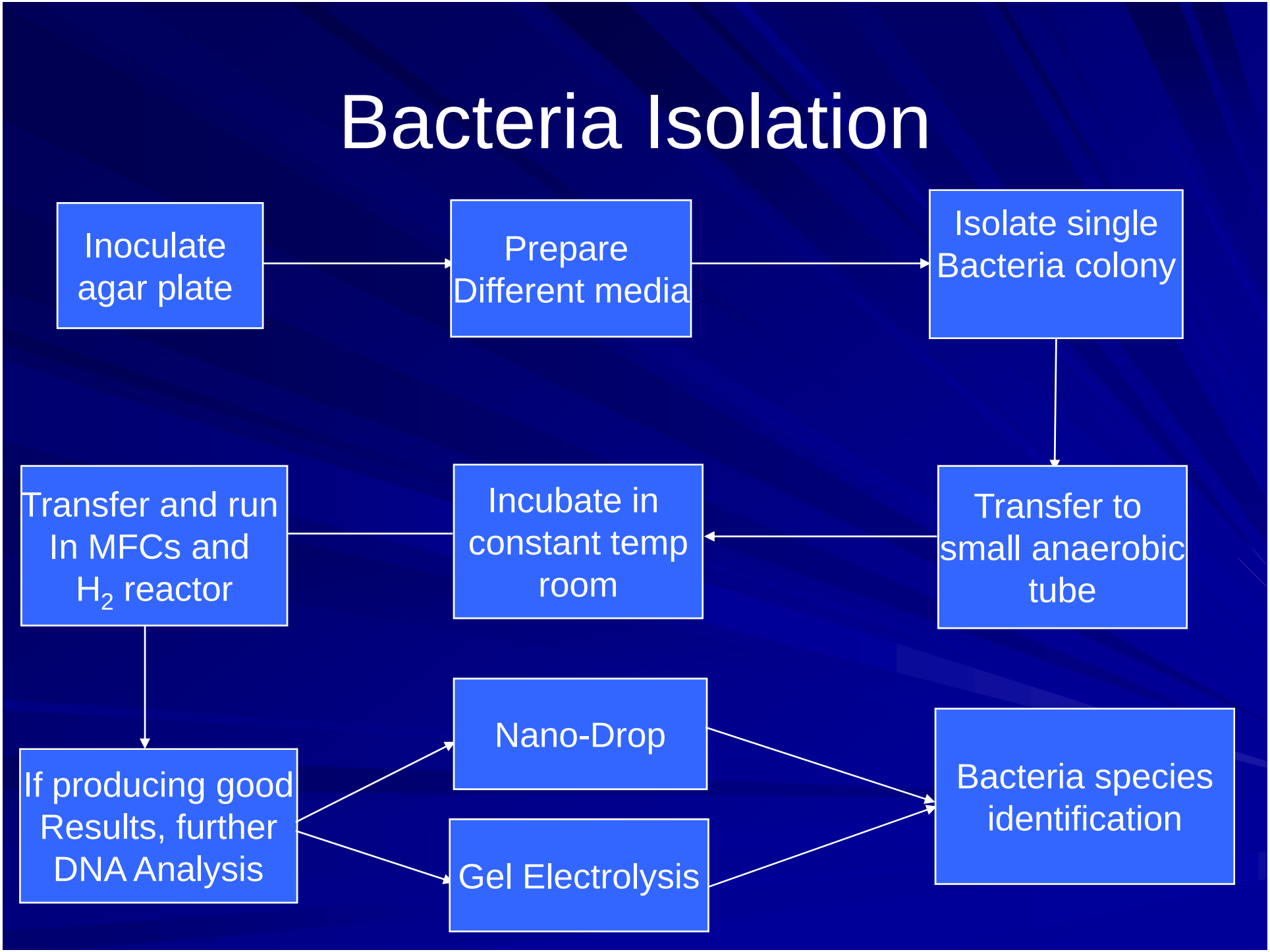
C: Electron transfer via pilus-like nanowires

Shewanella oneidensis

Typical numbers for MFCs

- Open circuit potential: 0.7-0.8V
- Current density: 0.1-4mA/cm^2
- Power density: 1-7 W/m^2 (0.01- 1.5kW/m^3)
- Energy recovery: 10-65%
- Coulombic (electrons) recovery: 20-95%
- COD removal (domestic wastewater): over 80%

Bacteria Isolation



PURE CULTURE

- Produce lower levels of electricity
- Produce less hydrogen
- Grow slower

VS

MIXED CULTURE

- Produce higher levels of electricity
- Produce more hydrogen
- Grow much quicker
- Works as a community

Disadvantages

- Unable to determine electron transfer mechanism
- For H_2 production, can not avoid CH_4 production, reducing amount of H_2 produced