

# Self-powered microbial fuel cell biosensor for monitoring organic freshwater pollution

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## Stand-Alone Microbial Fuel Cell Biosensor for Monitoring Organic Pollution

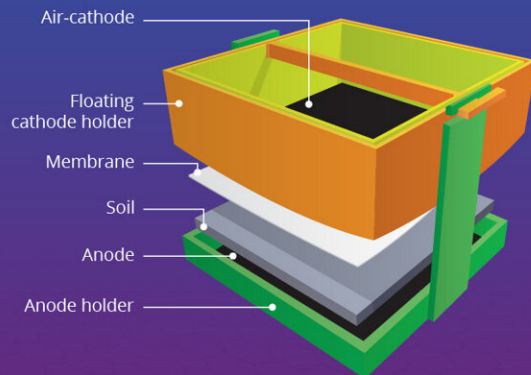
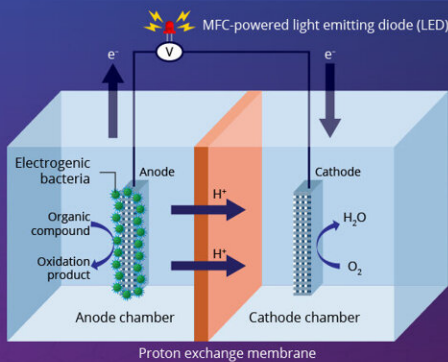
The release of organic effluents into freshwater bodies raises environmental concerns



A simple and inexpensive method for monitoring water quality is essential to address these concerns



### A self-powered biosensor based on a floating microbial fuel cell (MFC)



Linear relationship between chemical oxygen demand (COD) of water and MFC output voltage

COD  $\geq$  60 mg/L  $\rightarrow$  LED flashes

$\uparrow$  COD  $\geq$  60 mg/L  $\rightarrow$   $\uparrow$  LED flashing pace

- ✓ 3D-printed floating device
- ✓ Low-cost carbon-based material
- ✓ Early detection of effluents
- ✓ Powers low-power sensors/devices

**This inexpensive floating biosensor can monitor water quality using inputs from freshwater bodies**

Stand-alone floating microbial fuel cell-based biosensor for tracking organic pollution influx

Nakamoto et al. (2023) | *Biochemical Engineering Journal* | DOI: 10.1016/j.bej.2023.109087

The 3D-printed, low-cost, and floating biosensor monitors water quality at the input of freshwater lakes and rivers. Credit: Kozo Taguchi from Ritsumeikan University, Japan

The discharge of organic effluents—biodegradable waste materials from plants and animals—into freshwater bodies is a significant environmental concern, affecting the health and sustainability of these aquatic ecosystems. However, the methods currently available for inspecting water quality are complex and costly.

Researchers from Ritsumeikan University, Japan, have recently developed a self-powered, inexpensive, and floating biosensor for monitoring [water quality](#) at the input of freshwater lakes and rivers. The study was [published](#) in the *Biochemical Engineering Journal* on November 1, 2023.

"We developed a self-powered, stand-alone, floating biosensor based on a microbial fuel cell (MFC) for early organic wastewater detection. The MFC case was fabricated by a 3D printer and the electrodes were fabricated from low-cost carbon-based materials," states Professor Kozo Taguchi from the College of Science and Engineering, Department of Electrical and Electronic Engineering, Ritsumeikan University, who led the study.

MFCs generate electricity with the help of electrogenic bacteria. These microorganisms produce an [electric current](#) as a result of their biological metabolism. The amount of electricity generated by the MFC is proportional to the concentration of the organic waste that is being consumed by the electrogenic microorganisms. This characteristic feature is therefore used to design organic waste biosensors powered by MFCs.

Using inexpensive carbon-based materials, the Japanese research team developed a self-powered biosensor based on a floating MFC (FMFC) to continually track the level of organic contamination in lakes and rivers. To achieve this, they filled the anode (the electrode where oxidation occurs and electrons are given off) of the FMFC with soil containing electrogenic bacteria. The anodic bacteria subsequently decomposed the organic matter present in the water and converted the stored chemical energy into electricity. The [electrical output](#) was then used as a measure of the organic waste present in the contaminated water.

Although the researchers did not characterize the bacterial communities present in the soil sample, they rationally hypothesized that microorganisms from the genera *Geobacter*, *Shewanella*, and *Pseudomonas* contributed to the [electrical activity](#). Prior studies indicate that paddy soils naturally contain electrogenic bacteria belonging to these genera.

Next, the team added a [light-emitting diode](#) (LED) to the floatable biosensor assembly. The LED was able to harness the electricity produced by the electrogenic bacteria and visually indicate the level of organic contamination in the water samples under investigation. It started flashing when the chemical oxygen demand (COD)—a parameter used to measure the level of organic contaminants in water—exceeded the [threshold value](#) of 60 mg/L. In addition, the LED flashed at an increased pace when the COD significantly exceeded the threshold value.

Prof. Taguchi adds, "Because the FMFC biosensor produces its own electricity, it requires no external power supply. Moreover, it can be used in early detection systems that monitor influxes of organic wastewater in freshwater bodies."

**More information:** Trang Nakamoto et al, Stand-alone floating microbial fuel cell-based biosensor for tracking organic pollution influx,

*Biochemical Engineering Journal* (2023). [DOI: 10.1016/j.bej.2023.109087](https://doi.org/10.1016/j.bej.2023.109087)

Provided by Ritsumeikan University

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