Electroactive responses of bacteria for monitoring water quality

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Contents

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- Principles and operation of technology
- Applications for water quality monitoring
- Modelling of responses
- Modelling of the system

Background

Background

AGRICULTURE   **INDUSTRY**   **DOMESTIC**
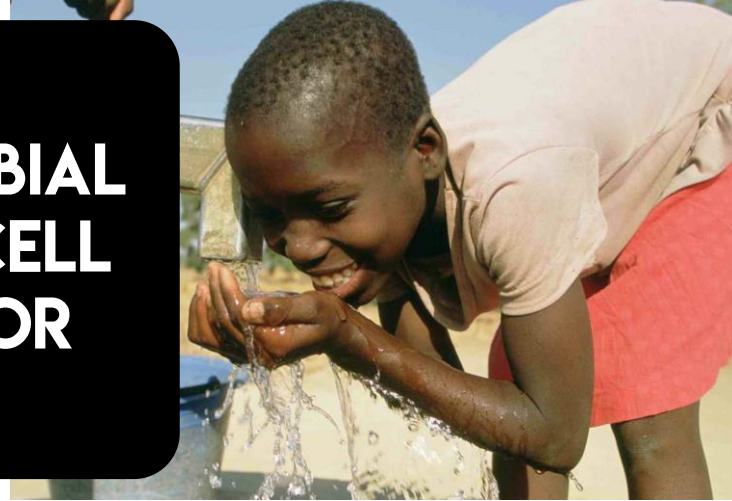

Change in nutrients
pH changes

<u>**Trace compounds:**</u>
Heavy metals, non-metallic toxicants,
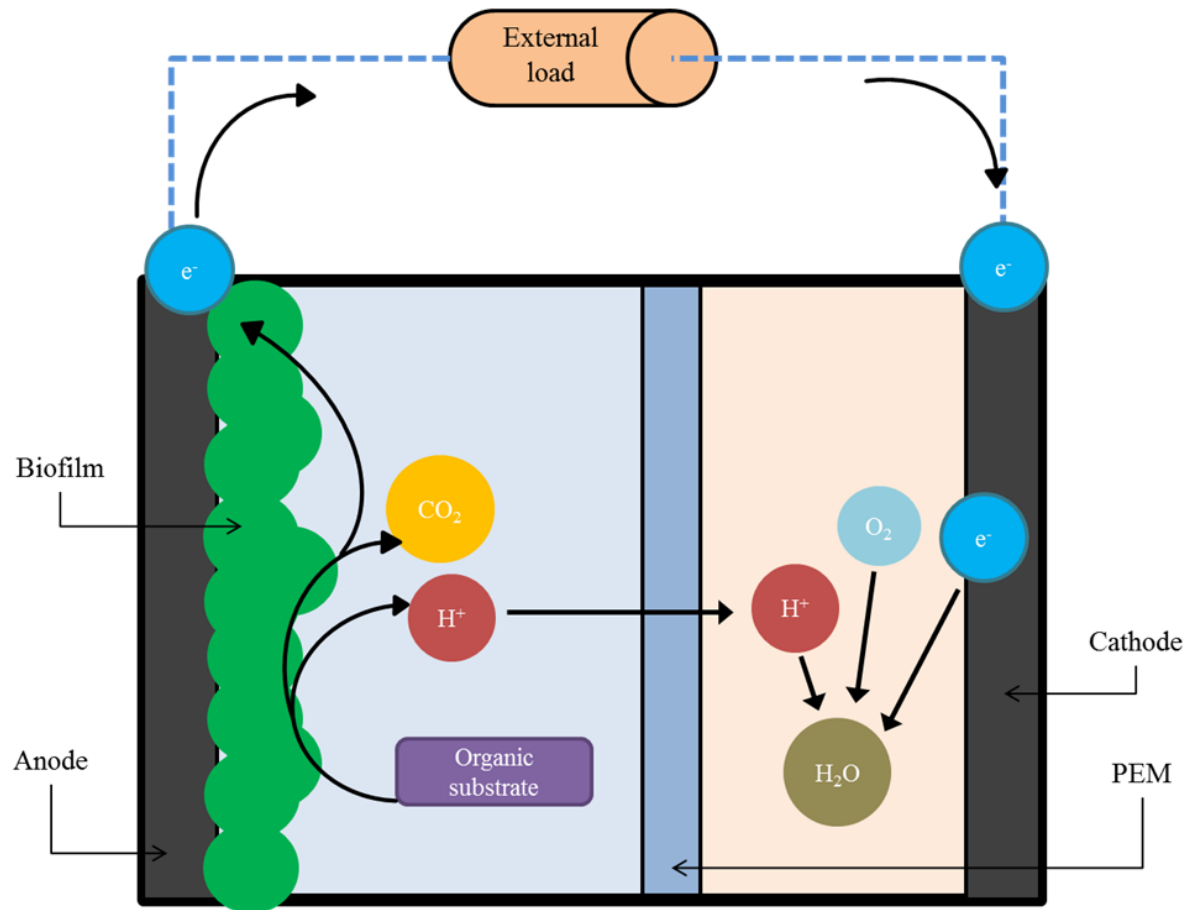**Organic molecules, Pesticides**

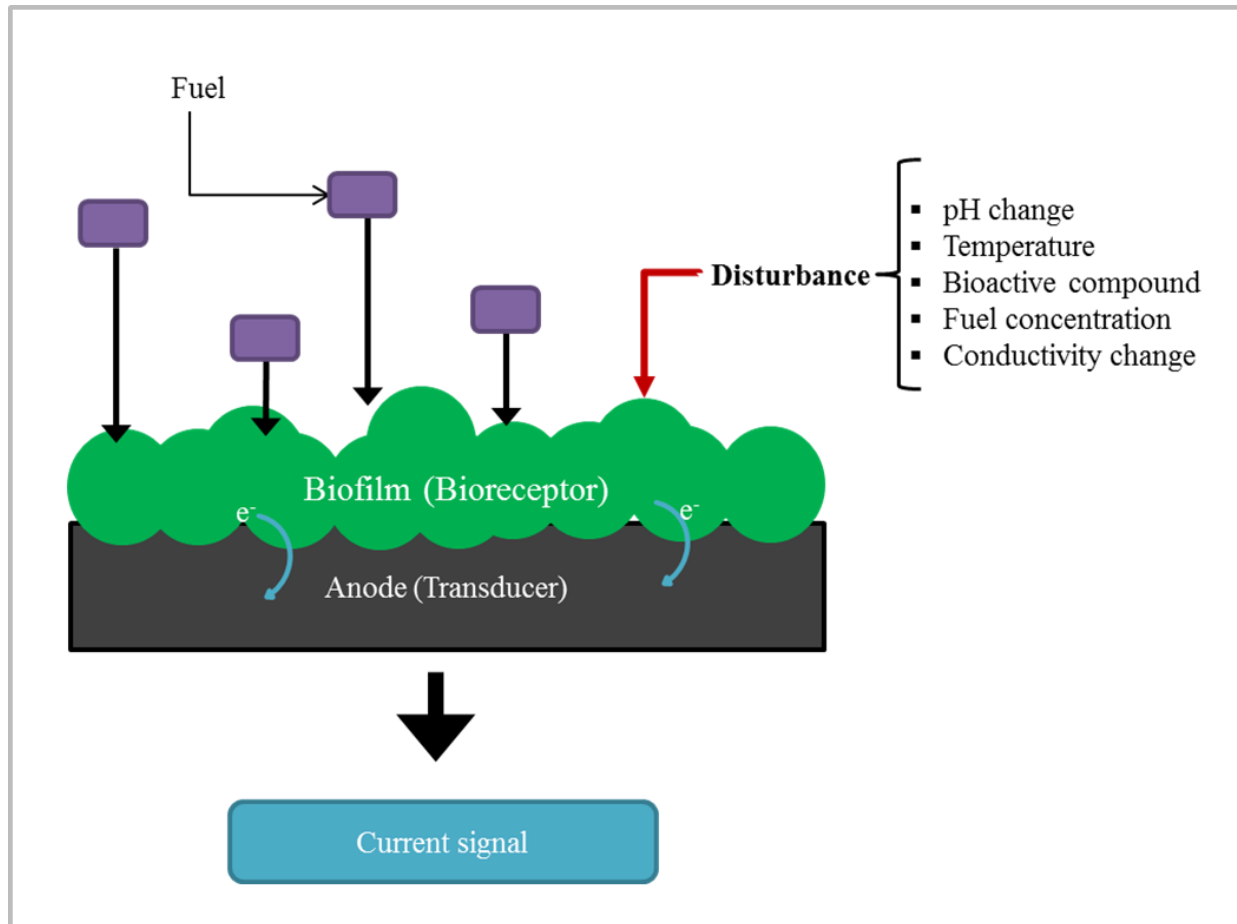# Background

MICROBIAL FUEL CELL SENSOR

SELF-POWERING BIOACTIVITY
SIMPLE
COST-EFFECTIVE
FAST RESPONSE
ONSITE

Water Aid, (2010)
EPA, (2015)

Principles and operation

Chouler and Di Lorenzo, Biosensors, 5(3), 450-470, (2015)

Principles and operation
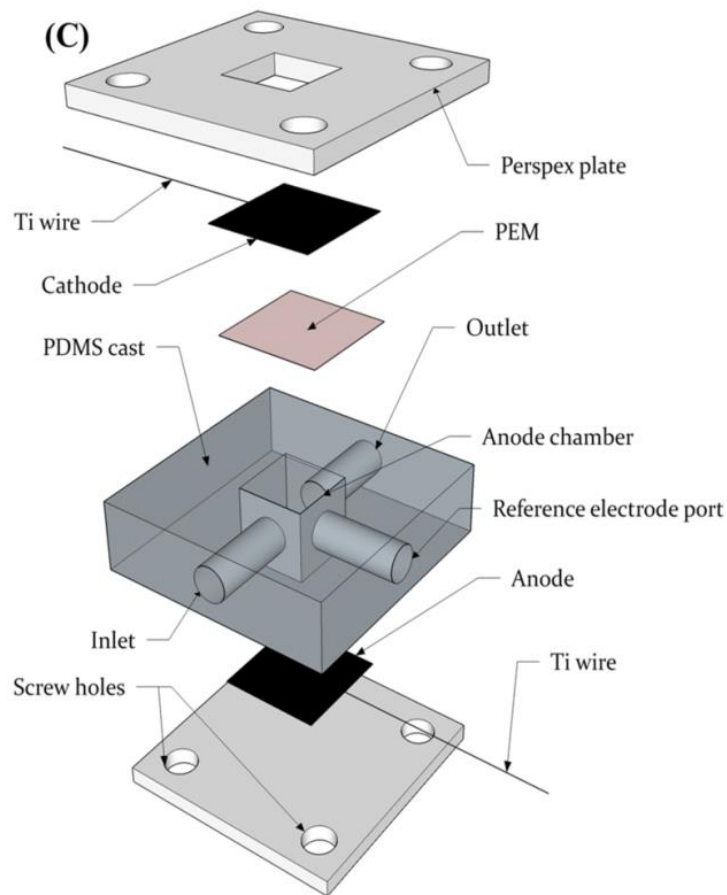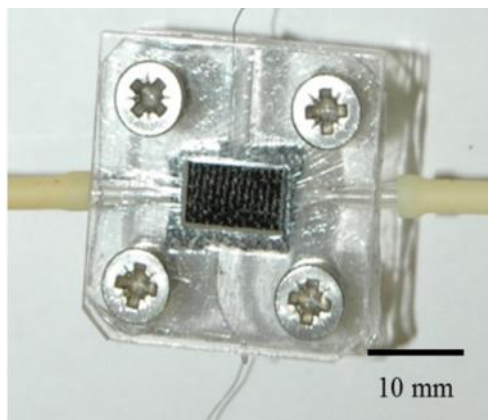

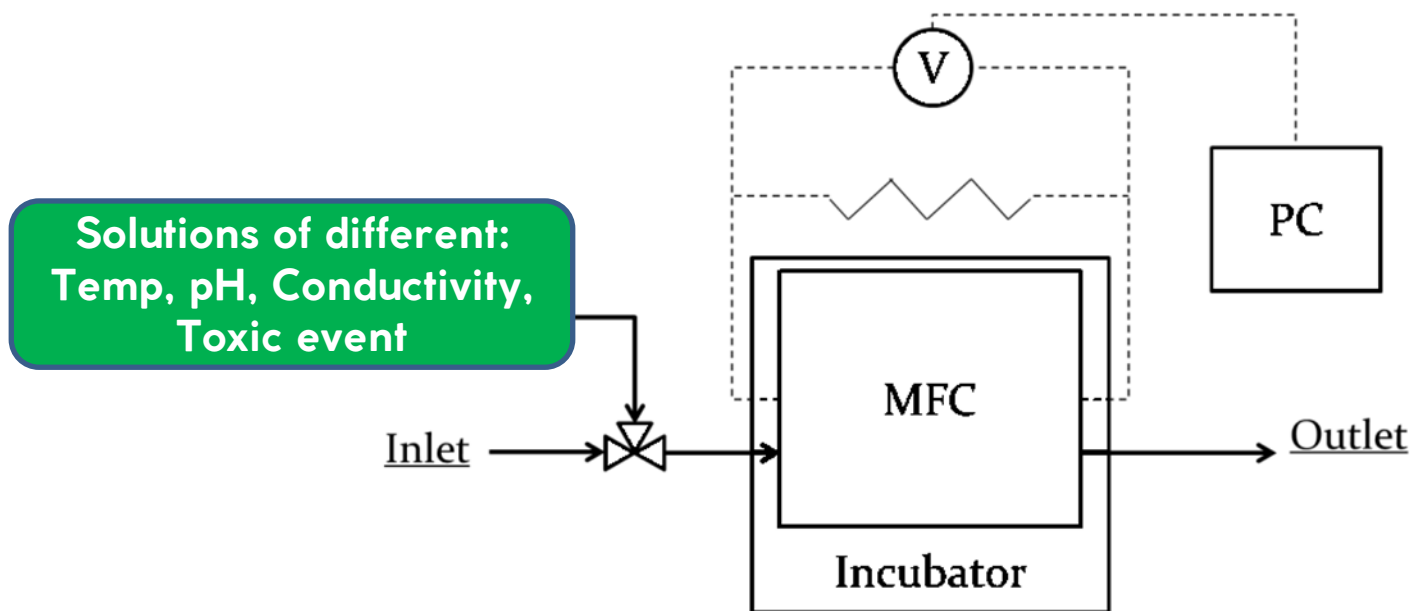
Chouler and Di Lorenzo, Biosensors, 5(3), 450-470, (2015)

Principles and operation

- Device schematic

Anode chamber:
128 μL
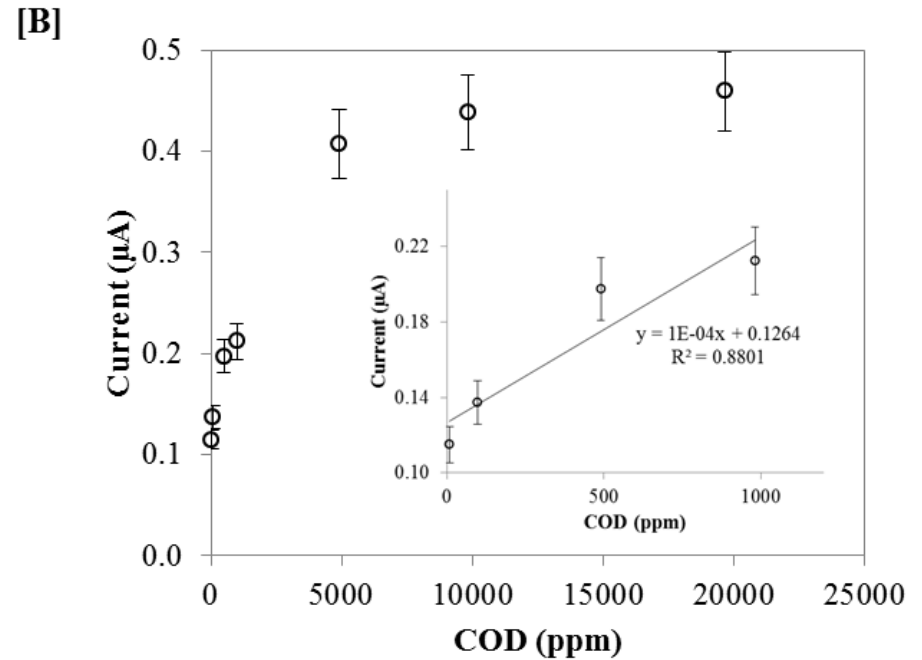**Electrode surface area:**
0.32 mm^2
Fed with artificial wastewater

10 mm

(C)

Perspex plate
Ti wire
PEM
Cathode
PDMS cast
Outlet
Anode chamber
Reference electrode port
Anode
Inlet
Ti wire
Screw holes

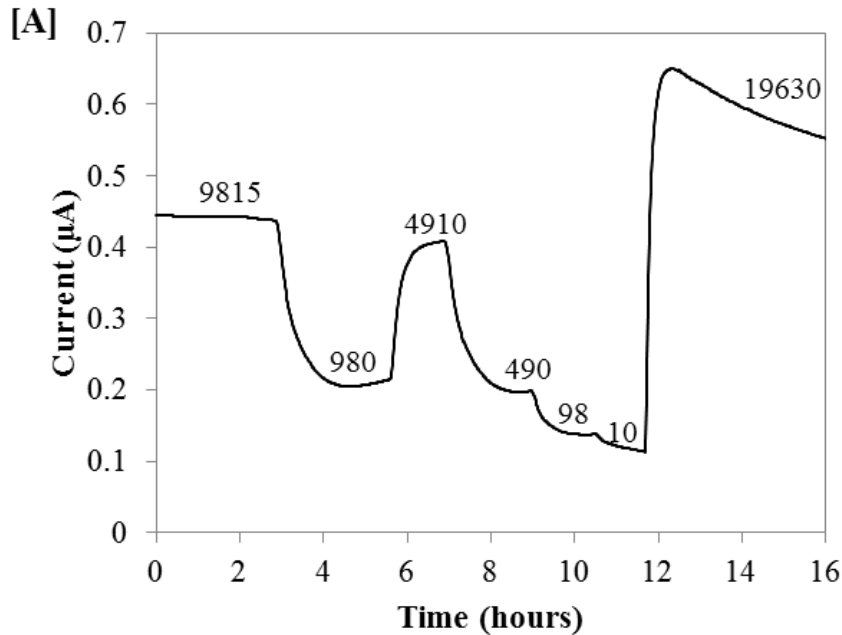Chouler et al., Electrochemica Acta, 192, 89-98, (2016)
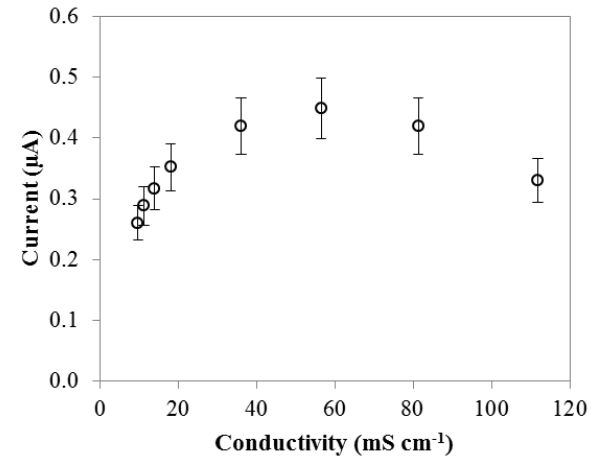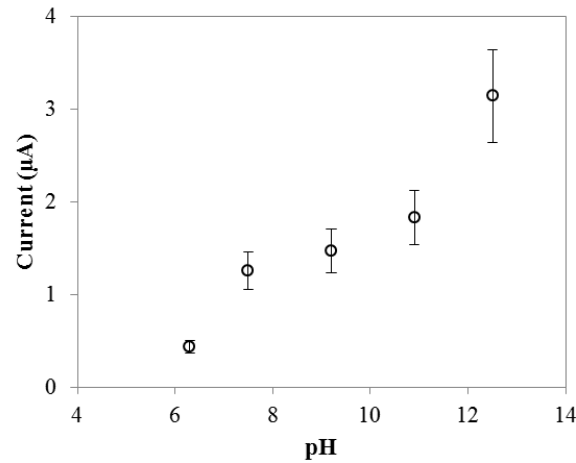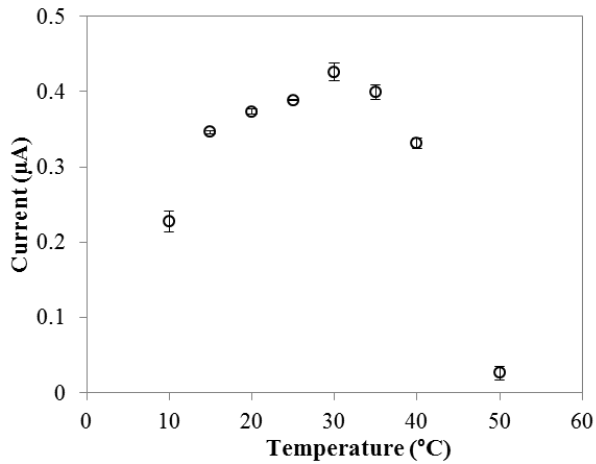
Principles and operation

Applications for water quality monitoring
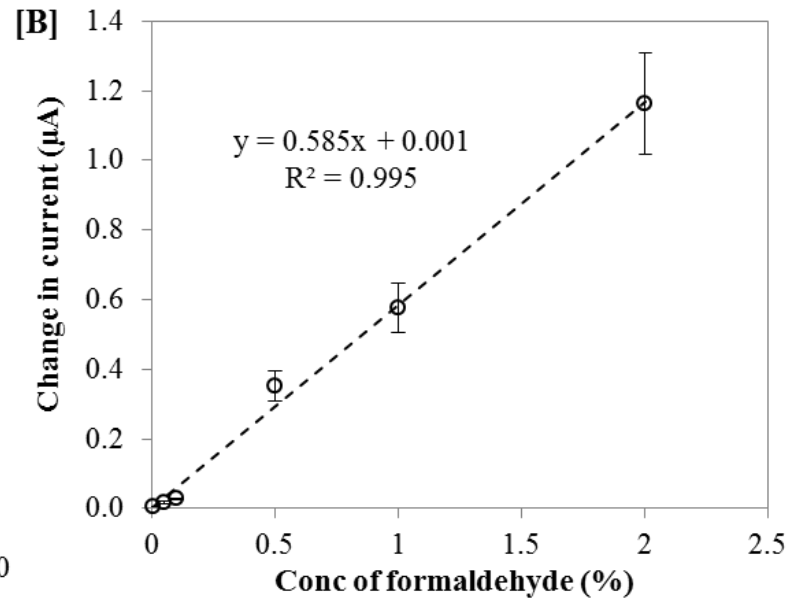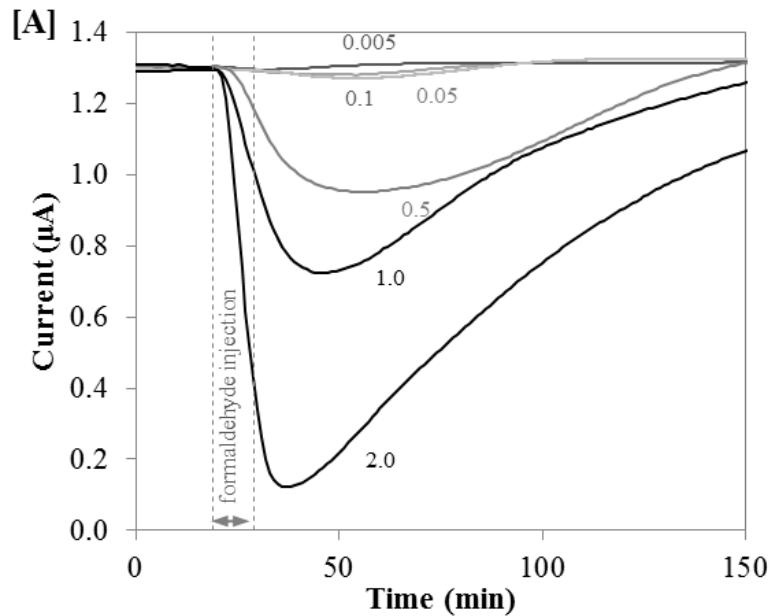
- Detecting organic content in water

Applications for water quality monitoring

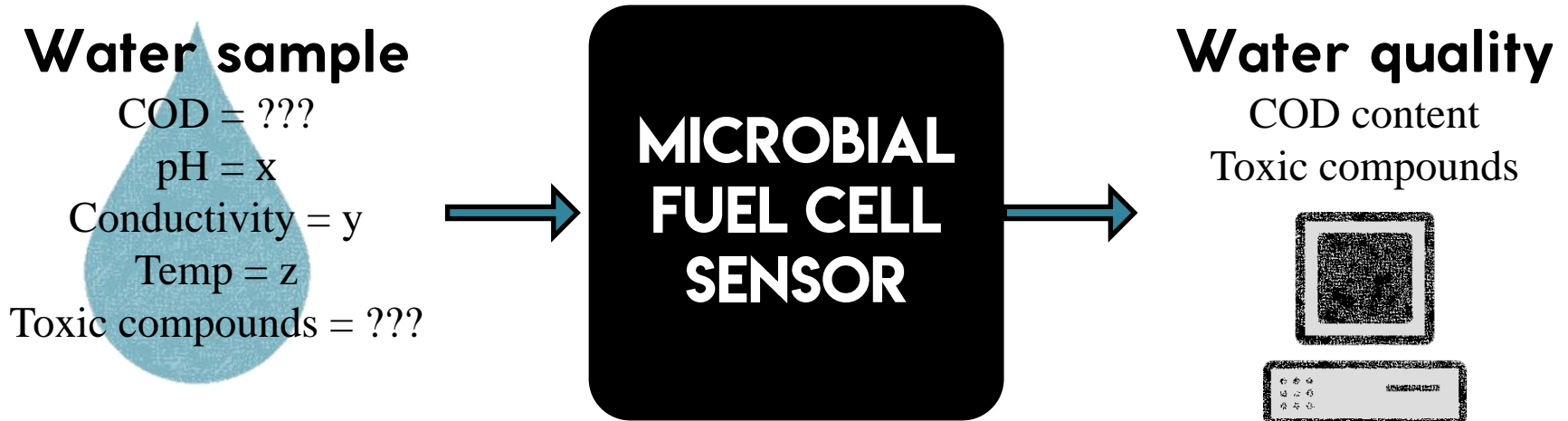- Responses to temperature, conductivity, pH

Applications for water quality monitoring

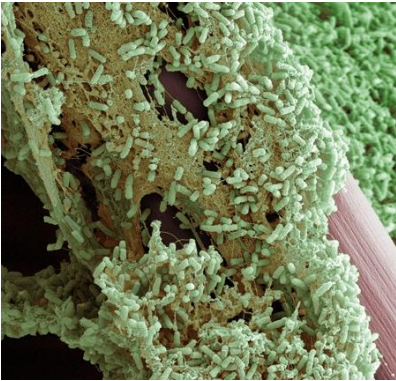- Responses to toxic compounds- i.e. formaldehyde

Modelling responses

- Is there a way we can model responses to indicate what *one change* in the input is?

- Is there a way we can model responses when *two or more events* are happening at once?

Water sample
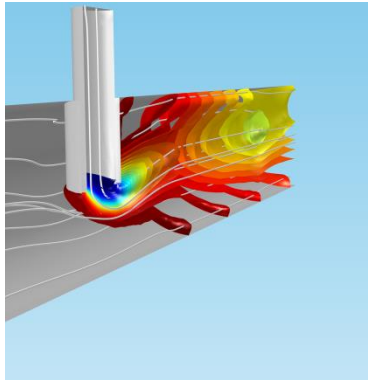
COD = ???
pH = x
Conductivity = y
Temp = z
Toxic compounds = ???

MICROBIAL FUEL CELL SENSOR

Water quality
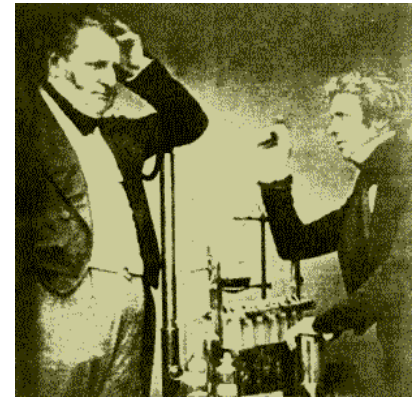
COD content
Toxic compounds

Modelling the system

Biological
Processes

Physiological
Processes

Electro
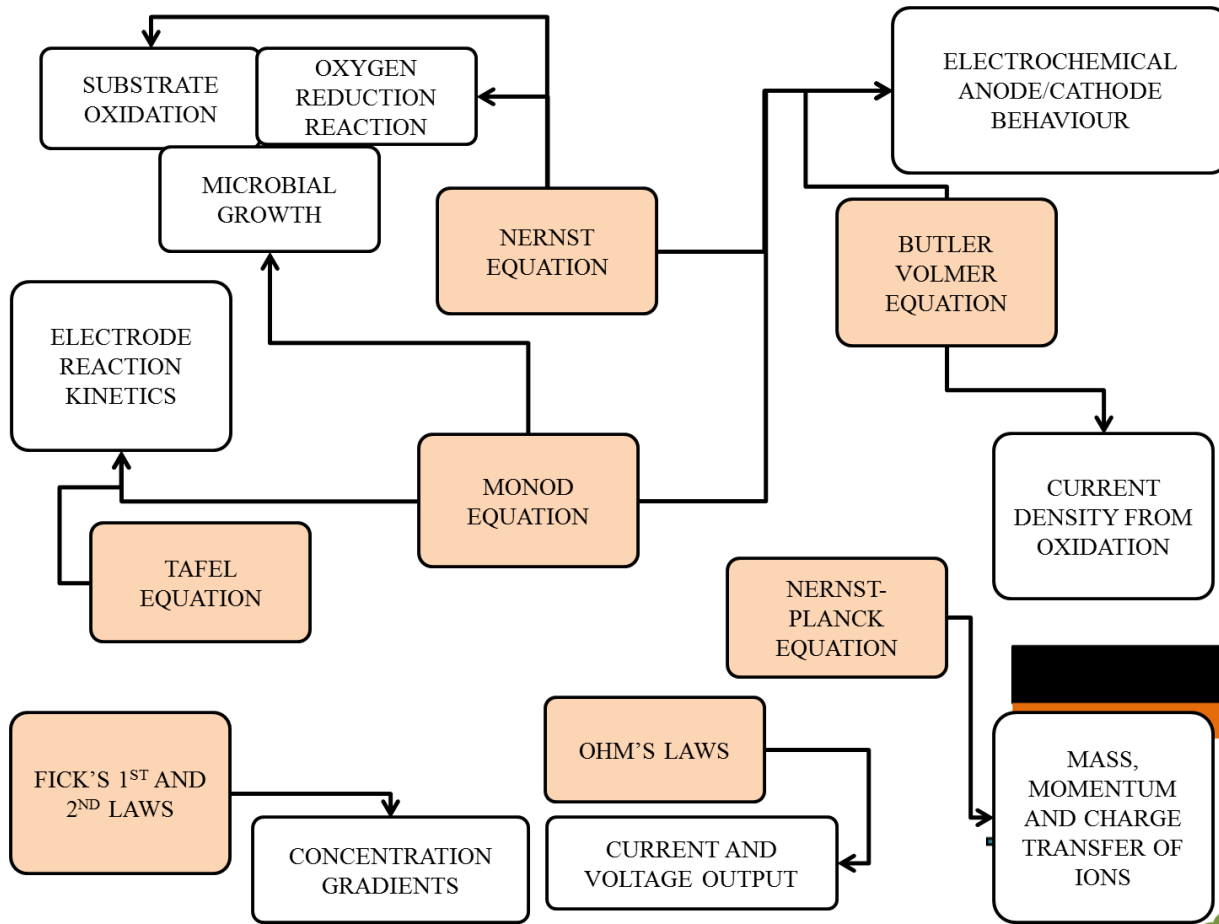Chemical
Processes

Modelling the system

O₂

Reaction kinetics
Mass transfer

C A T H O D E

M E M B R A N E

Geometry effects
(1, 2, 3 dimensional)

Fluid flow
properties

Ion mass
transfer

substrate

Substrate consumption
Mass transfer

H⁺

Biofilm growth
Metabolic rates

B A C T E R I A
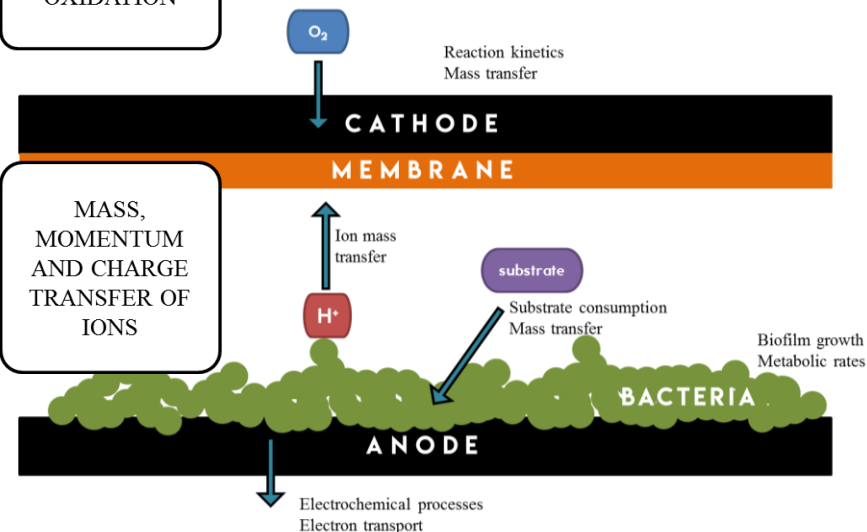
A N O D E

Electrochemical processes
Electron transport
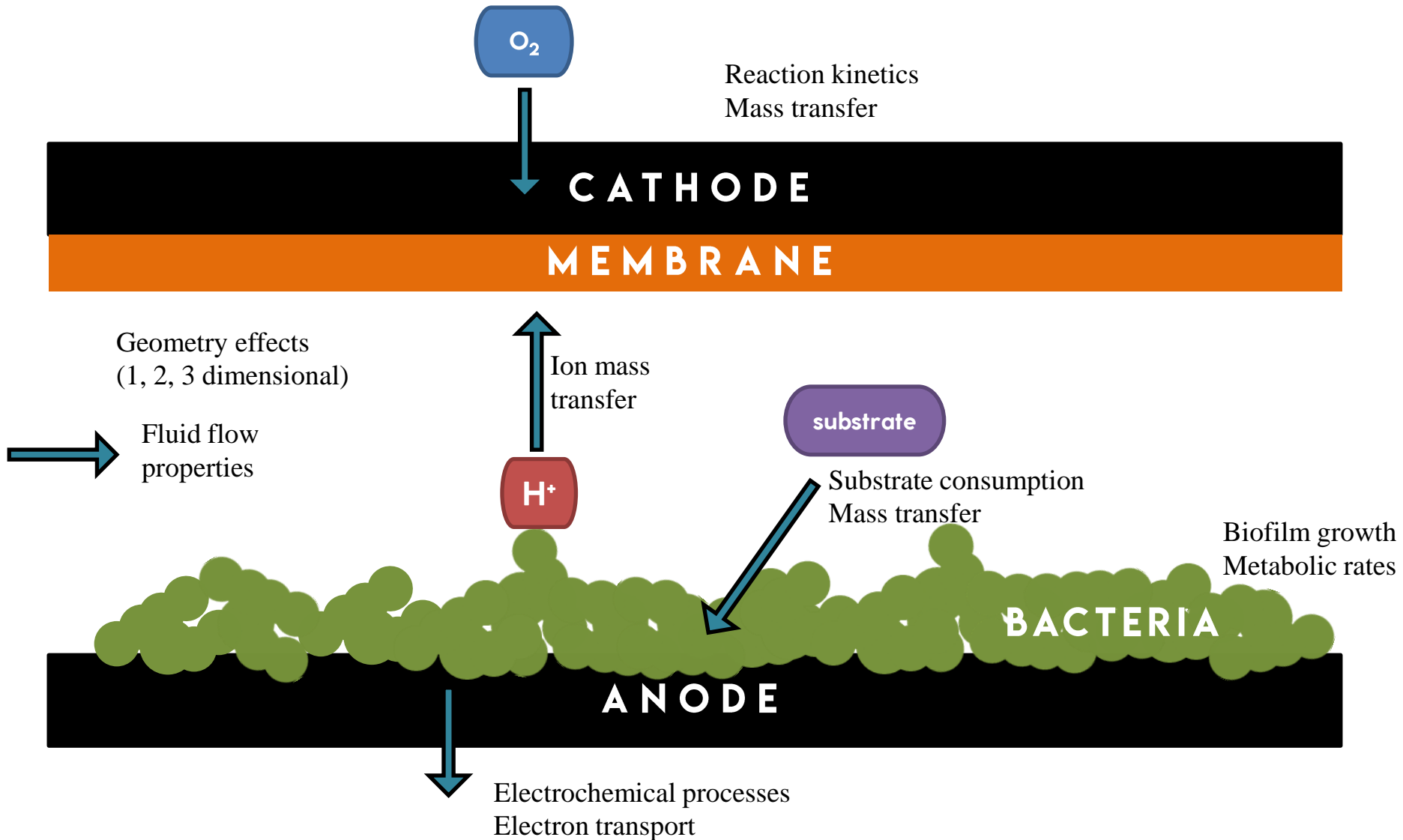
Modelling the system

Can we *simulate a response* to an event using known equations and phenomena?

Conclusions

- Microbial fuel cells can give an indication of *water quality*
- Challenges ahead:
  - Corroborating the output response to input parameters for *complex mixtures*
  - Coupling the output response to *system processes* and *properties*.

Questions?