RAINBOW$_{FLOW}$ CHIP$_{ONLINE}$: An impedance-based biosensor for water quality monitoring using permanent fish cell lines

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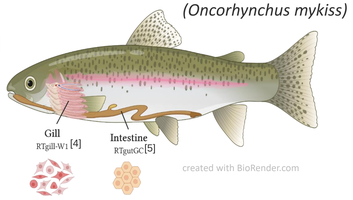
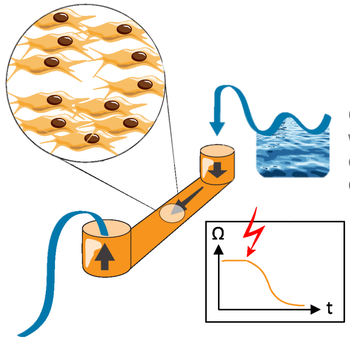
Aim

The aquatic environment is subject to contamination by a multitude of chemicals[1], which can be toxic to aquatic organisms. Thus, flexible biological monitoring solutions are required. Fish are important indicators for the health of their ecosystem. Using fish cell lines, which can predict toxic effects on whole fish[2][3], we are establishing a portable field biosensor for automated water quality testing in real time by impedance sensing.

Cell lines from the gill and intestine represent the first site of contact and major uptake routes for water- and food-borne chemicals, respectively

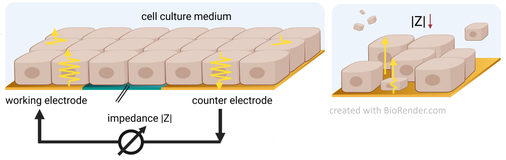




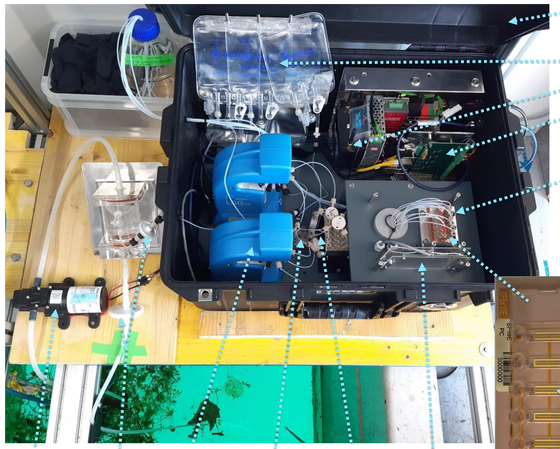
Cells are exposed to surface water in a **flow-through channel** where fresh water is continuously pumped through

Online access allows live monitoring of current water quality

Investigation of toxic effects by **impedance spectroscopy**: cells' resistance [Ω] to a non-invasive electric current reflects their health status[6]



Design of the biosensor



Protective case
1607 Air Case, Peli Products, S.L.U.

Salt and control solutions

LTE Router

Controller
Raspberry Pi, valve driver board, and thermoelectric temperature controller.

Temperature control unit
Peltier (ventilated) with aluminium holder plate for electrochip

Microfluidic electrochip
ECIS™ 6F10E PC, Applied BioPhysics / ibidi

External water pump

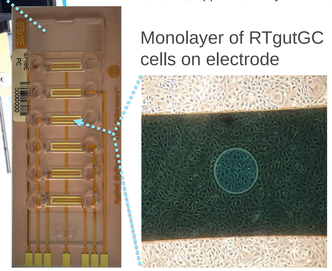
Syringe pumps
LSPone, Advanced MicroFluidics

PTFE tubing and PEEK tees

Filters
2 µm and 0.7 µm

Bubble trap

Impedance analyser



Monolayer of RTgutGC cells on electrode

RAINBOW$_{FLOW}$ CHIP$_{ONLINE}$ scientific background explained

click to play (3'15")

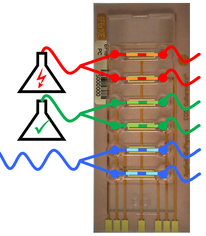
Field testing results discussed

click to play (5')

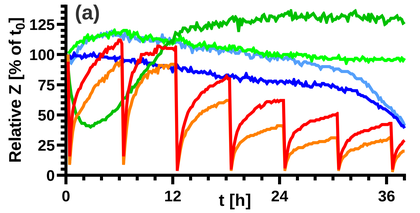
Field testing

LéXPLORE platform, Lake Geneva

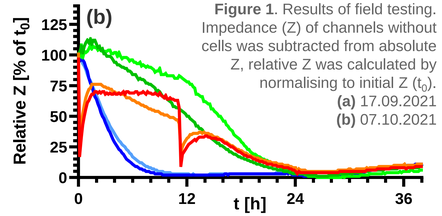
positive ctrl
negative ctrl
lake water



Duplicate channels each are exposed to a chemical stressor (positive control: EDTA in PBS, 200 mg/L, at regular intervals), deionised water (negative control), and water from lake Geneva.



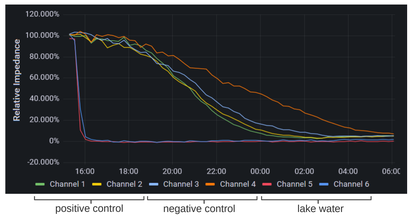
Absolute Z t_0 (4900 Hz): 3881 Ohm, 4275 Ohm, 3272 Ohm, 2456 Ohm, 3978 Ohm, 3437 Ohm.



Absolute Z t_0 (4900 Hz): 3680 Ohm, 2468 Ohm, 3039 Ohm, 3468 Ohm, 3068 Ohm, 2856 Ohm

Figure 1. Results of field testing. Impedance (Z) of channels without cells was subtracted from absolute Z, relative Z was calculated by normalising to initial Z (t_0).
(a) 17.09.2021
(b) 07.10.2021

Figure 2. Online data viewing. Impedance data are instantly uploaded to a database and plotted (Grafana), allowing for live monitoring. Displayed: Results of field testing on 12./13.11.2021.



References
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