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Xenopus Laevis oocyte based Biosensors

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Introduction: *Envirobot*

Envirobot is a multidisciplinary project aiming to improve management of water pollutants in lakes and rivers. Biologist, chemist and engineers work together to develop a smart aquatic robot called Envirobot that will map water pollutants and find their source. The robot will provide scientists an analytical tool to manage more efficiently water pollutants, which are at the center of important social, environmental and economical concerns. Our specific work consists of a pollutant biosensor development to be implemented in the envirobot. This cell-based biosensor is based on a *Xenopus Laevis* oocyte

Aim: *Pollutant Sensor for Envirobot*

An oocyte based biosensors introduced by Shear et *al.* [4] will be developed for the specific detection of pollutant found in lake and rivers. Secondly, this biosensor will be implemented in the amphibious robot, previously developed by Crespi et *al.* [4].

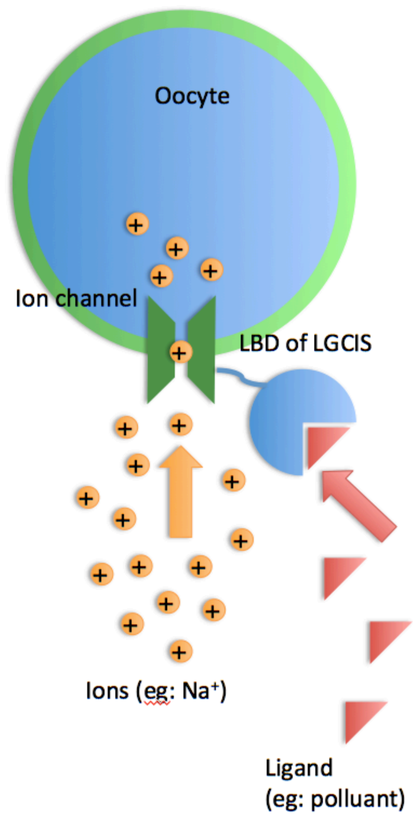
Specifications of pollutant sensors
- Robot integration
- Selectivity for a specific analyte (eg. Organic pollutant) [1]
- Response time <1s to allow the guidance of the robot
- Lifetime of at least 24h to cover the full robot mission

Context: *Pollutants in Lake Geneva*

Pollutants concentration in Lake Geneva has been monitored regularly by Ortelli et *al*. [1]. Since 2010 an increase of some specific organic pollutants have raised concerns. Metalaxyl, an organic fungicide [2] and Carisoprodol [3], a drug used as a muscle relaxant, increased in concentration by 2 to 3 folds from 2010 to 2012. The reason of those increase is not clear and further investigations are required to find their source. Current methodology involves time-consuming analytical techniques such as GC-MS not suitable for this type of investigation. Although average pollutant concentration in a waterbody is precisely measured with analytical techniques, finding its source location remains a problem. Thus, there is a need for smart tools that can sample, measure and accurately locate the source of pollutants in a waterbody.

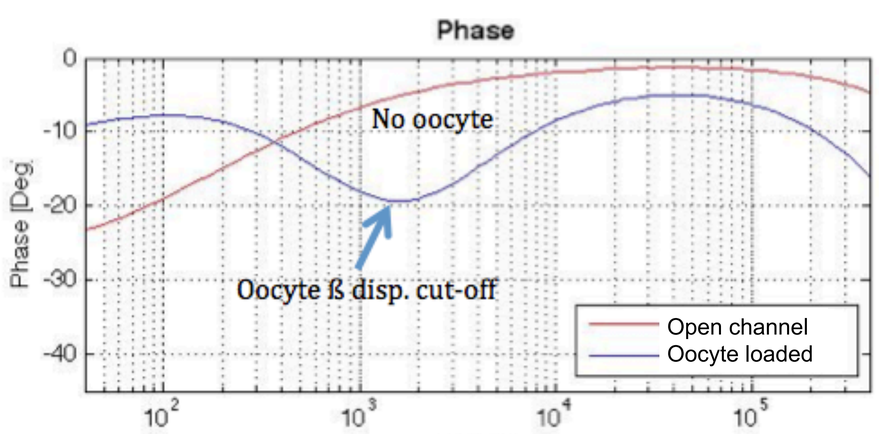
Principle: *Oocyte based biosensors*

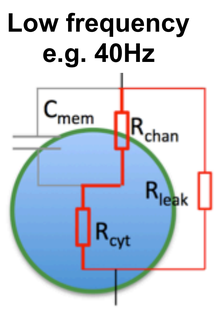
Xenopus Laevis Oocytes are microinjected with cRNA coding ligand-gated ion channels (LGCIS). LGICs are transmembrane proteins which open to allow ions such as Na^+, K^+, Ca^{2+}, or Cl^- to pass through the membrane in response to the binding of a ligand. This response can be monitored as a current or a voltage change (e.g. TEVC); here we aim to monitor it as a change in the resistance of the membrane (ATOVC).

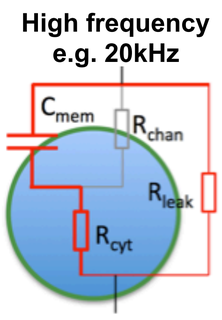


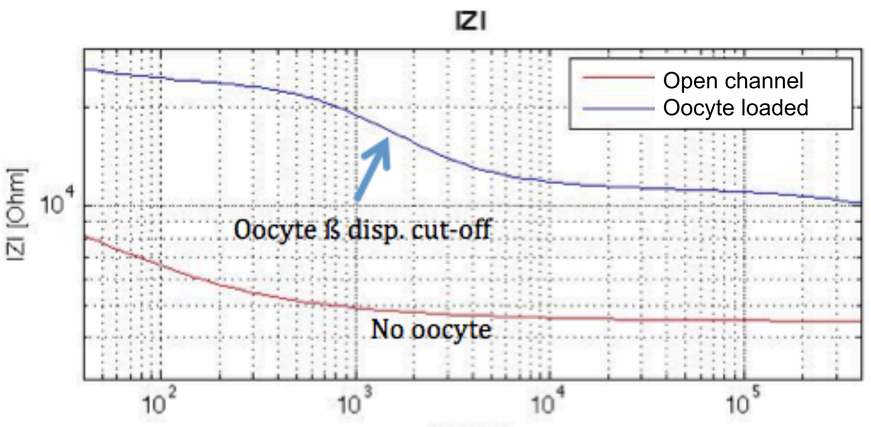
Preliminary results: *Oocyte based biosensors / ATOVC*

The development of the non-invasive electrophysiological measurement involve investigation of cytosolic resistance, membrane conductance and capacitance that are parameters affected by the binding of an analyte to the ligand binding domain of ion channels. Those three parameters can be measured by impedance spectroscopy on an oocyte.

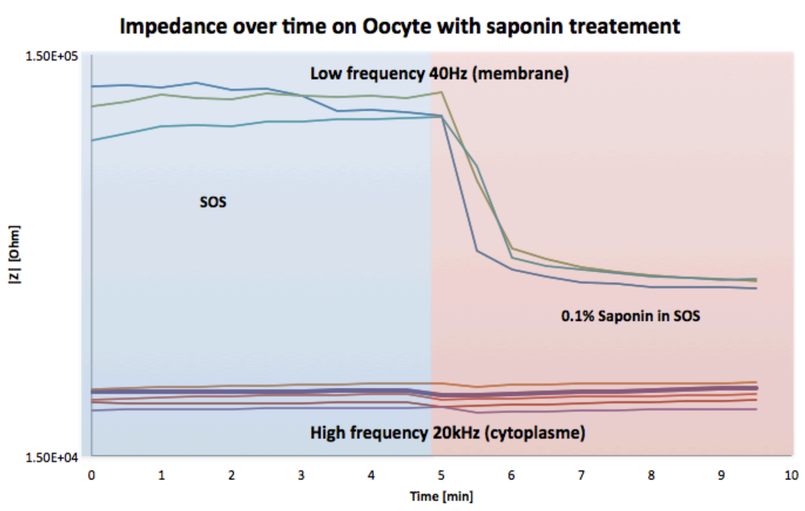








Preliminary tests consisted of measuring the membrane impedance (R_{chan}) changes related to a saponin treatment of the oocyte. Saponin is a detergent known to open the membrane bilayer and to reduce its impedance.



Perspectives

The current setup demonstrated sufficient sensitivity to detect pores artificially created in the membrane bilayer. Next steps consists of measuring impedance changes due to the opening of ion channels to answer sensitivity and response time requirements.

References

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