**Project Title**

Integrated Biosensing Platform for Waterborne Pathogen Detection: Improving Public Health

**Lead Supervisor Name**

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**Lead Supervisor Location/Student Home Institution**

Institution: Bath

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**Full Project Description**

Waterborne diseases are caused by pathogenic micro-organisms that most commonly are transmitted in contaminated fresh water. This is a problem in many developing countries due to poor sanitation and water/wastewater infrastructure or lack of suitable monitoring systems. The development of systems that provide a health warning to environmental agencies, NGOs or local communities requires the development of simple to use, inexpensive biosensing platforms. We envisage a portable integrated sensing platform for rapid, on site, simultaneous detection of several contaminants associated wth waterborne diseases. One possible route is the development of lab-on-a-chip devices that measure the presence of DNA associated with key pathogens of concern (e.g. E. Coli, Salmonella and Pseudomonas Aeruginosas). Within this project we will focus on the design of arrays of DNA probes that capture different sections of the DNA characteristic of the pathogens of concern and measuring the hybridization events via amperometry, electrochemical impedance and with the use of filed-effect transistors. Redox-active sensitisers that bind with the hybrid duplex resulting from capture of target DNA will provide on-chip impedance signal amplification and enable detection capability. This approach will provide valuable information towards the design of a full lab-on-a-chip device with microfluidics, filtration, lysis and PCR. The project student will assess the use of off-the-shelve components for modular lysis and PCR chambers that couple to the sensors. This novel approach offers a very timely and transformative solution to a complex problem requiring technology integration across a number of disciplines. The project involves aspects of DNA detection and biosensor development (Dr Pedro Estrela – Bath), design and use of redox-active intercalator compounds (Dr Niklaas Buurma and Prof Simon Pope – Cardiff), microfluidics (Dr Mirella Di Lorenzo – Bath) and microbial biochemistry (Prof Nigel Silman – Public Health England). The student will be trained on these multidisciplinary techniques at the different collaborative laboratories, which have all the required facilities and equipment. The overall aim of the project is to develop generic biosensors for the detection of a variety of pathogens in fresh water such as reservoirs, rivers, wells. By changing the design of the DNA probes and PCR primers, the sensing platform can be adapted to the detection of a wide range of pathogens.

**Real Life challenges this project will address**

The project will enable generic sensing platforms that can be used for portable integrated devices for rapid and on site simultaneous detection of several waterborne pathogens that affect public health. Waterborne diseases are caused by pathogenic micro-organisms that are most commonly transmitted in contaminated fresh water. This is a problem in many developing countries due to poor sanitation and water/wastewater infrastructure or lack of suitable monitoring systems. As an example, seasonal high levels of pathogens such as E coli, Salmonella and Pseudomonas are present in the Billings reservoir in Brazil, which provides water to half of the population of Sao Paulo city, putting at risk millions of people. The devices to be developed will enable early warning of high pathogen levels so that local authorities can take preventive actions. The platform can be adapted for on-site monitoring of different pathogens in most fresh water reservoirs.

**What you should know about this project**

The project deals with the detection of waterborne pathogens in fresh water reservoirs for public health warning systems. Pathogens will be detected by their DNA, through their unique genetic code. The student will develop novel DNA hybridization electrochemical sensors compatible with portable devices for the detection of DNA amplification products extracted from pathogens. The supervisory team has vast experience in the development of DNA sensors as well as microfluidics, sensor integration and synthesis of redox-active DNA intercalators. The team has collaborative experience on the use of such intercalators for sensing applications. The involvement of Public Health England as a stakeholder ensures a co-design approach for the development of fit-for-purpose devices.

**What expertise you will develop**

Water sampling techniques, on-chip Polymerase Chain Reaction, electrochemical DNA sensing, synthesis of redox DNA intercalator compounds

**Why this project is novel**

The project will establish the underlying sensing technology for the first portable integrated sensing platform for rapid and on-site detection of several contaminants associated to waterborne diseases.

**Rest of Supervisory Team:**

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