Innovative electrochemical genosensors for detecting pathogenic protists and their toxins in resident shellfish in Narragansett Bay

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Abstract
Narragansett Bay and its associated rivers provide spawning ground, nursery, and habitat for more than 60 species of fish and shellfish. An interdisciplinary team of faculty will mentor undergraduate students in the design of electrical genosensors for the detection of shellfish parasitic protists and their toxins in Narragansett Bay. This 'immersive research experience' shall prepare SURF scholars for careers in RI's coastal and mariitme sectors while developing novel efficient genosensors to detect diseased shellfishand toxin-polluted waterways. Mollusk disease-causing proitsts such as *Perkinsus marinus*, *Haplosporidium nelson*, *H. costale*, *Bonamia ostreae*, and *Mucochytrium quahogii* (QPX) affect the ecology and economy of marine communities and their habitats. *Alexandrium catenella* Group 1, and *Gymnodinium* spp. are the leading agents of paralytic shellfish poisoning (PSP) in North and South America, Europe, Africa, Australia, and Asia. Detection of these pathogenic protists informs aquaculturists about disease distribution and abundance. Current detection and identification methodsinclude histopathology, molecular (e.g., protein-based, PCR variants), or biosensing (bio-transducer) methods. Electrochemical biosensing of pathogenic bacteria and viruses is in progress, while the technology for detection of marine pathogenic protists is incipient. Collaborating faculty-student teams aim at generating practical genosensors for the detection of shellfish protistan parasites and convey the process and outcomes to diverse audiences.

Project Objectives

1. Develop electrochemical genosensors for mollusk disease-causing protists *Perkinsus marinus*, *Haplosporidium nelson*, and *H. costale*.

2. Develop electrochemical genosensors for *Alexandrium catenella* Group 1, and *Gymnodinium* spp., the leading agents of paralytic shellfish poisoning (PSP) in North-, South America, Europe, Africa, Australia, and Asia.

3. Test the efficacy of electrochemical genosensors from objectives 1 & 2 *in vitro*, *in vivo*, with parasite cells, genomic samples or environmental water samples.

4. Communicate the practical application of this Blue Economy multidisciplinary molecular biology, physics, and engineering research to diverse audiences.

The economic impact of mollusk disease-causing protists and PSP toxins in RI and the US is underestimated according to Woods Hole Oceanographic Institute (WHOI) outdated reports. Although shellfish diseases and PSP toxins are currently monitored in the Northeastern US, we propose to develop a cost-effective field device that will improve the detection and distribution of these protists in shellfish populations and in PSP-polluted waterways in RI. A collaborative interdisciplinary team led by Avelina Espinosa (molecular biology, parasitology), Allison Marn (electrosensing, engineering), and Jennifer Pearce (physics, DNA-based microfluidic devices) has the expertise to combine transducers (planar, polymers, wires/fibers, nanostructures, arrays), electrochemical signals (impedance sensing), and platforms (paper-, flow-, and droplet-based) to develop electrochemical genosensor devices. The purpose is to design genosensors that are portable, disposable, easy to use for specimen collection, environmentally friendly, affordable, sensitive, specific, rapid, and equipment-free for the detection of shellfish protistan parasites. A practical, low-cost genosensor would also increase accessibility of this technology for research and education practices.