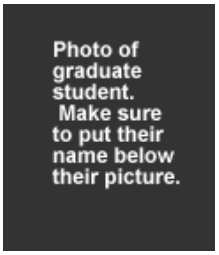
From Genomics to Physiomics: Development of Tools for Environmental Assessment and Real-Time Sensing of Contaminants

Maria S. Sepúlveda, D.V.M., Ph.D., Principal Investigator

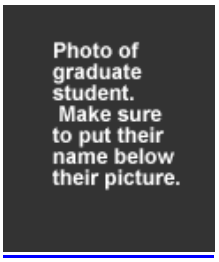
Cooperators:
Adamec, J., Ph.D., Bindley BioScience Center, Discovery Park (BBC)
Kane, M., Ph.D., BBC, C&IT,
Ochoa-Acuña, H.G., D.V.M., Ph.D., VM, CE
Porterfield, M., Ph.D., BBC, ABE

Graduate Students:
K. Ralston-Hooper, M.S., FNR
B. Sanchez, M.S., FNR

Funding Source:
Center for the Environment (C4E)



Kimberly Ralston-Hooper



Brian Sanchez

Goals:

1. Identify unique gene and protein expression profiles and correlate them to specific whole-animal physiological responses elicited by common contaminants.
2. Identify unique metabolome responses and correlate them to specific whole-animal physiological responses elicited by common contaminants.
3. Contrast and compare molecular biomarkers and real-time physiome responses to determine differences in sensitivity and specificity after exposure to common contaminants.

Statement of Problem:
An organism's ability to adapt to its environment is the result of responses regulated within various operational "subsystems". The genome codes the production of specific proteins (enzymes, structural proteins, etc.) which in turn comprise what is known as the proteome. The genome and the proteome then give rise to the metabolome or the complete set of low molecular weight compounds produced by an organism. The overall adaptive capacity of an organism to a contaminant is the result of responses operating at all these levels. Based on this holistic approach, we are now defining the total integration of these systems, from cells to organisms, as the ***physiome***. Understanding how an environmental contaminant affects an organism's physiome will provide valuable information on the mechanism of toxicity and will also identify biomarkers of exposure as well as effects. Real-time sensing of contaminants is a method that continuously measures biological endpoints such as O_2, Cl^-, Na^{+2} (just to name of few) production or reduction due to exposure of environmental stressors. Traditionally, environmental assessment has relied on the use of bioassays where test organisms are chronically exposed to contaminants and physiological effects on survival, growth, and reproduction are measured. These bioassays can be quite expensive, time consuming, and provide limited information on the contaminant of interest. However, real-time sensing may result in tools that are broadly applicable, offer robust and biologically relevant results, and can be developed into highly marketable products with a wide range of potential uses. Finally, this innovative technique could provide information regarding biological changes due to contaminant exposure prior to physical manifestations of toxicity. Overall, this project aspires to develop new environmental assessment and real-time sensing approaches.

Current Activities:
- Development of metabolomic protocol for vertebrate and invertebrate species exposed to various environmental stressors using GC-GC/MS-TOF (Ralston-Hooper).
- Development of real-time oxygen flux measurements in fathead minnow eggs exposed to contaminants (Sanchez).
- Proteome comparison of vertebrate and invertebrate species exposed to various environmental contaminants using 2-dimensional electrophoresis (2-DE) (Ralston-Hooper and Sanchez).