BIOMEDICAL SCIENCES PhD PROGRAM

Dr. Mill W. Miller, Director, 114 BS I, 775-2504

DISSERTATION DEFENSE

JOSEPH SANTIN

PhD Candidate

"CONTEXT-DEPENDENCE OF PHYSIOLOGICAL SYSTEMS: ENVIRONMENT PHYSIOLOGY INTERACTIONS IN THE RESPIRATORY CONTROL SYSTEM"

Friday, March 10th, 2017

11:30 a.m.

120 White Hall

Advisor: Lynn Hartzler, PhD
Department of Biological Sciences

WRIGHT STATE UNIVERSITY

Biomedical Sciences Ph.D. Program

Santin, Joseph, Biomedical Sciences PhD Program, Wright State University, 2017

We intuitively know that animals are tuned to survive different environmental conditions or else life would not exist. Unfortunately, this is often forgotten or ignored when designing experiments. As Marsh Tenney articulated, "The physiologist keeps the whole always in mind. He accepts the tactical necessity of reductionism to understand parts, but, once done, for him it is only the beginning, never the end." In an era when it is all too common to take environmental complexity out of the organism to understand physiology, my work puts some of that complexity back in the organism. I take advantage of the plasticity and robustness of the bullfrog, *Lithobates catesbeianus,* as my model system to determine environment-physiology interactions in the regulatory systems that control breathing. Given that breathing is a critical process for sustaining life, under most circumstances, I determine how the respiratory control circuit operates on background of changing environmental conditions, specifically temperature and seasonal fluctuations. My major findings include 1. CO_2 chemosensory neurons that regulate breathing frequency in bullfrogs do not act as chemosensors at cold temperatures (Santin et al., 2013), 2. CO_2 chemosensory neurons have firing frequencies inversely proportional to temperature (*i.e.,* they are cold-activated) (Santin et al., 2013), 3) activation of a hyperpolarization-activated cation current (I_h), paradoxically, leads to reversal of neuronal cold-activation (Santin and Hartzler, 2015a), 4) lung ventilation *can* be measured in bullfrogs (Santin and Hartzler, 2016c), 5.) breathing motor processes operate normally after months without use, but lose CO_2 chemosensitivity (Santin and Hartzler, 2016a), and 6) after overwintering, the chemosensory system within the brainstem of adult bullfrogs resembles that of predominately water-breathing tadpoles (Santin and Hartzler, 2016b). Overall, these findings have major implications for interpreting well-studied physiological problems. First, CO_2 sensing in ventilatory control may be more or less important depending on the environmental context of the animal. Second, factors that regulate neuronal excitability exert different effects depending on whether environmental factors are stable or changing. Third, bullfrogs may have unique physiological adaptations that allow normal motor function after months of respiratory inactivity. Finally, phenotypes described as developmental may, in fact, be a plastic response to changing environmental conditions that overlap with a developmental time course. Although it is common to take environmental complexity (internal and external) out of experiments when studying biological problems, all animals live in environments that alter the function and need for specific physiological processes. My work highlights that only when physiological systems are tested across a range of environmental situations can organismal function be ascribed to specific mechanisms.