IU BLOOMINGTON

EMERGING AREAS OF RESEARCH

Abstract Template -- Due June 30, 2017

Title of initiative to be proposed:

The Center for Advanced Chemical Safety, Toxicology, and Risk Prediction

Name of lead PI, with title, department/school:

Joseph R. Shaw, PI, Associate professor, School of Public and Environmental Affairs

Key team member names and departments/schools (up to 10 names):

Joseph Shaw, PI, School of Public and Environmental Affairs (SPEA); James E. Klaunig, co-PI, Environmental Health, School of Public Health (EH-SPH); Stephen Jacobson, Chemistry; Maria Bondesson, Intelligent Systems Engineering, School of Informatics and Computing(ISE-SOIC); John Graham, SPEA; Zemin Wang, EH-SPH.

Other potential key participants include James Glazier, ISE-SOIC.

Description of area to be proposed. What constitutes this area of research or creative activity as emerging? (Word limit=500)

Worldwide, we are increasingly exposed to chemicals through our indoor and outdoor environments, producing a "chemosphere" in which we live. Many of these chemicals are potentially harmful to human health; the WHO finds that 8.3% of all deaths are directly attributable to just 14 chemicals, with pollution estimated to kill 1.7 million children per year. This issue is particularly relevant to Indiana, which the EPA identifies as the second largest contributor of toxic chemicals per square mile of the 50 states. These health crises are only the tip of the iceberg. Attempts to regulate chemicals in our environment have been difficult (costing 3% of GDP), because we lack basic scientific information needed for industry to comply with legislation intended to ensure human health and protect the ecosystems on which we rely. Fewer than 5% of the more than 100,000 chemicals used in consumer products have been evaluated for safety, because traditional methods of safety testing are slow (>5 years/compound) and costly (>$5 million/compound).

Indiana University is ideally poised to lead in providing a solution to these problems, which requires emerging research that breaks from outdated, reactive methods, and is guided by a comprehensive and scalable project. By pooling the brainpower and capacity of our experts and facilities, and applying state-of-the-art methods and technology in analytical chemistry, toxicology, quantitative genetic, public health, environmental sciences, and predictive analytics we can dramatically decrease the time and cost of evaluating chemical risks.

We propose such a project that builds on important discoveries and technical advances of the past decade, particularly the: (1) ability to rapidly identify genes, metabolites and bio-molecular interactions that are altered by chemical challenges, (2) availability of genomes for many animals, (3) improved analytical methods that allow for detection of chemicals in exceedingly small quantities, (4) exponential increases in computational power to identify predictive patterns in massive data sets, and (5) many studies underscoring the similarity across animals of biological processes that are highly relevant to human toxicology. We will focus our initial studies on agrochemicals, because they represent an important sector of Indiana's chemical industry and are important for the state's economy. For a select group of pesticides, we will initiate studies in five thematic research areas: Alternative testing, Molecular and mechanistic studies, Predictive toxicology, Chemical analysis and exposure, and Integrative risk. These studies will move beyond traditional endpoints (e.g., mortality, growth, reproductive decline) to identify the mechanisms that underlie the toxic response, quantitatively link these mechanisms to chemical dose, develop computational tools for predicting chemical effects across the Tree of Life, and develop risk estimates that safeguard human health and protect the environment. This emerging approach allies with the Nation Research Council call for a complete redesign and update of the field.

We have three goals for these studies: develop our emerging approach and demonstrate that it is sound; prove the independent research areas can work together to tackle large problems, and establish a sustainable multidisciplinary research program that is positioned to scale to meet global needs.

Please submit to earprogram@indiana.edu