Research Progress on the RBHS Environmental and Occupational Health Signature Program (2014-2015)

During the first year of Signature Program designation EOHSI convened a working group to identify initiatives that would encompass on-going research programs in environmental health at Rutgers. The initial working group included Drs. Ken Reuhl, Mark Robson, Paul Lioy, Cliff Weisel, and Keith Cooper. This group identified three broad areas of strength: Toxic Air Pollutants and Assessment Tools (including nanoparticles, greenhouse gases, industrial contamination, as well as novel assessment devices and sensors); Pathogenesis of Environmental Disease (including mechanisms of toxicant action, individual responses to chemical exposures, contribution of co-morbidities, and public health policies), and Global Environmental Health. The committee felt that these themes were sufficiently ambitious starting points for broader Signature Program development.

Initial steps were to identify what programs were already operating at Rutgers. Investigators from the New Brunswick and Piscataway campuses were queried regarding their work and, importantly, whether they would be interested in joining a campus-wide initiative under the Signature Program banner. Responses were generally positive, although there was considerable caution regarding commitments until the implications of the RCM budgeting plan could be evaluated. Discussions are continuing.

Research efforts of the Signature Program over the past eight months have been directed toward establishing relationships between EOHSI and other programs in RBHS and across the university. Some of the initial successes have been in the three areas identified by the Working Group are summarized below.

**Toxic Air Pollutants and Assessment Tools:** First, initiation of the signature program called the Rutgers Commuter and Community Cohort Study (RC³). This activity leverages New Jersey’s unique transportation environment to study the influence of traffic and commuting on personal and public health. Key features of this include the state’s varied geography and development patterns, dense and diverse population, reliance on commuting, extensive health databases, and the multidisciplinary academic strengths of Rutgers University (RU) at the EOHSI, the Bloustein School, Institute for Health Policy, and the NJ Department of Health (NJDOH). The research team includes environmental health professionals in exposure science, biomedicine, and epidemiology, as well as experts in transportation, health systems, and survey research. They have the following specific aims: 1. Characterize commuting behavior among current RU employees and local communities; 2. Use dispersion modeling, geographic information system (GIS) mapping, and time-activity data to estimate current exposure to diesel particulate matter among Rutgers University employees and local community members who reside near and commute on the transportation “corridor” between New York City and Philadelphia, and; 3. Translate our prior experimental discoveries about biological effects to real-world population exposures by testing associations between estimated exposure to traffic air pollution, and nitrite, a biomarker of oxidative stress, in exhaled breath condensate (EBC). To date, the team has received funding from the NJ Health Foundation and pilot funding from the Center for Environmental Exposure and disease (CEED). The initial step in forming the cohort was the creation of a Rutgers faculty/staff web-based survey of commuting behavior that has been pilot-tested and is ready to roll out early in the fall (2015) semester, and modeling for exposure to traffic-pollutants is underway.

A second new initiative focuses on the lung microbiome. A working group of microbiologists, exposure scientists and pulmonary physicians has been created to develop research initiatives
examining the lung microbiome. It has been funded for the first two years by Rutgers University through the RBHS TEAM SCIENCE INITIATIVE. A full day workshop on New Research on the Lung Microbiome was held in May and attended by approximately 100 investigators. The workshop, organized by Dr. Weisel with support from the working group, included key ideas and avenues of investigation from leaders in the field. Pilot data were presented on different approaches to collecting the lung microbiome, the influence of co-morbidities (g., cystic fibrosis), the lung microbiome of neonates during lung development and the influence of air pollutants on the lung microbiome. Formal research proposal submissions are being planned for next year.

Finally, an application was selected for inclusion in the Rutgers offerings to the Benefunder. It is a multidisciplinary collaboration that includes clinical psychology, computer and chemical engineering, and environmental health sciences to better understand, and ultimately treat child and adolescent mental health concerns. The project proposes to address critical gaps in the identification and management of two of the most debilitating mental health disorders in youth: anxiety and depression disorders. The proposal to Benefunder will involve deploying novel mobile assessment tools to collect real-time information on personal behavior, biological mechanisms, and exposure to chemical and physical factors contributing to youth (ages 11-18) anxiety and mood problems.

**Pathogenesis of Environmental Disease:** Mechanistic studies of environmental diseases have been a long-standing strength of EOHSI. A number of highly successful and well-funded research groups already exist. These include:

- **The CounterACT Center**, a multi-university collaborative program, examines the biology of mustard chemical warfare agents. Now in its 10th year, the CounterACT Center has advanced understanding of the skin vesicant effects, corneal damage and pulmonary injury associated with exposure to these agents, and has developed protective agents to limit vesicant injury. The Center is led by Dr. Jeffery Laskin and Donald Gerecke.

- **Efflux transporters in drug action and toxicology** examine how cells manage the removal of drugs and toxicants from the cytoplasm. These transporters are critical for protecting the cell against agents that accumulate within cells. Led by Drs. Lauren Aleksunes and Grace Guo, these investigators examine novel transporter systems in the placenta, kidney, liver and brain.

- **Pulmonary effects of toxicants**, led by Drs. Deborah Laskin and Andrew Gow, have made major contributions to unraveling the mechanisms underlying pulmonary fibrosis following injury. Their work has explored the contribution of nitric oxide and subpopulations of inflammatory cells in the regulation of collagen formation in the lung.

- **Chemical carcinogenesis and chemoprevention**, led by Dr. Helmut Zarbl, has discovered the mechanism by which disruption of circadian rhythm contributes to cancer development in humans and rodents, and provide a mechanistic link between chemoprevention and restoration of circadian rhythm. His studies showed that DNA damage response and repair genes are regulated by circadian rhythm. Subsequent studies have shown that methylselenocysteine (MSC) offers protection by restoring epigenetic regulation via its effects on Sirtuin 1 protein deacetylase activity. A MSC intervention trial has been initiated to determine if MSC could also restore rhythm in shift workers known to have an elevated risk of mammary cancer.
Development of analytical methods represents a unique strength of EOHSI. The unifying goal of the group, led by Dr. Brian Buckley, is the identification of biomarkers of exposure. The group has used MS methods, as well as the latest isolation techniques, to quantify analytes in biological and environmental matrices. Methods have been developed to quantitate compounds such as bisphenol A and their replacements, zeranols, mold VOCs and panels of bile acid metabolites.

Global Environmental Health: RU has made a significant investment in Global Environmental Health. Several programs have developed strong international partnerships and developed population cohorts. To date, there has been little central coordination of these efforts. The Signature Program represents an opportunity to develop a cohesive approach to these efforts. Some of the major international health programs are:

- STRIDE Project – SEBS
  STRIDE is a program designed to engage and aid Philippine industries define, articulate and communicate on the specific demand for science, technology and innovation services; enhance the capacity of current and future university faculty to respond to this demand with research and innovation by directly exposing them to the US model; and improve university policies and management to create more supportive research and technology transfer ecosystems and industrial and national structures for sustainability.

- Air Pollution Effects on Human Anti-mycobacterial Immunity - SPH
  This research project, headed by Dr. Stephan Schwander, attempts to understand the role of air particulate exposure on human susceptibility to infection with tuberculosis causing mycobacteria. The project aims to assess the impact of short- and long-term ambient exposure, seasonal variability and physicochemical characteristics of PM 2.5 from Mexico City on cellular toxicity, pro- and anti-inflammatory cytokine production, mRNA expression and M.tb uptake and growth control. This research project has major global environmental health implications as air pollution exposure increases globally.

- Dominican Republic Outreach Project – SPH
  Students and faculty from the Rutgers School of Public Health visit the Dominican Republic to provide public health services to extremely poor communities in underserved rural areas. This activity is part of a 3 credit course where students spend a portion of the semester reading and preparing for the trip, help in the impoverished areas, and then return to complete papers and projects.

- International Collaboration on Global Issues – EOHSI
  There is a 2 year research partnership between Rutgers, University of Reading and Chongqing University in China which aims to investigate the impact of ambient air pollution on indoor air quality, particularly in China. Dr. Howard Kipen from DEOM is PI. The Rutgers project will investigate the impact of ambient air pollution on indoor exposure through both direct and indirect effects on indoor air chemistry, and whether exposure can be modified by the use of commercial air cleaners.

- Thai Fogarty ITREOH Center - SEBS
  The project provides training and research opportunities in a partnership between Chulalongkorn University in Thailand and Rutgers. Other collaborating institutions include the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Health and Senior Services (NJDHSS), Wake Forest University School of Medicine, the Centers for Disease Control and Prevention (CDC), the National Institute of
Environmental Health Sciences (NIEHS), the US Geological Survey (USGS) and the Thai-US Fulbright Foundation. The training and research are accompanied by in country, short and long term training opportunities and opportunities in the US for graduate degrees, visiting scholars and training with partner institutions. The major theme of the Center is health consequences of pesticide exposure.

- Global institute for Bioexploration (GIBEX) – SEBS
  This research project, headed by Dr. Ilya Raskin, seeks to create a new drug development process ensuring that poorer countries can benefit from drug discoveries found within their borders. The scientists are traveling to countries around the world to train local scientists in drug discovery tools and technologies.

- Germany - SEBS
  Dr. Eric Lam is researching the development of genetically-modified foods that can deliver protection from infectious diseases. Immunization may one day be revolutionized as crops may be able to deliver antimicrobial agents thus giving populations in poorer and less developed countries an opportunity to access modern drugs.

Future Directions

As the Signature Program enters its second year, additional participants will be recruited to enhance the diversity of expertise available to collaborative projects. With the beginning of the new budget year and resolution of uncertainties regarding RCM, investigators have signaled their desire to become involved in the Signature Program. We are working closely with bioengineering in the area of nanoparticle bioavailability and health effects, the Institute of Marine and Coastal Waters to utilize the Slocum Glider for biomonitoring of New Jersey waters for toxicants, and RBHS units to examine the interface between pollution exposures and health outcomes. Rutgers-SPH is becoming more heavily involved in epidemiology/patient cohort projects and their participation opens numerous avenues for cohort-based studies previously unavailable.

Three immediate aims for Academic Year 2016 are:

i) Identify new faculty in the environmental health sciences

ii) Identify 1-3 large grant opportunities that will require significant collaborative involvement, yielding unified investigative teams for ‘common cause’ efforts

iii) Develop a central ‘council’ of investigators to develop and coordinate Environmental and Occupational Health efforts across Rutgers