Toward Understanding the Interplay of Environmental Stressors, Infectious Disease, and Human Health

A Workshop convened by the Standing Committee on the Use of Emerging Science for Environmental Health Decisions

January 15-16, 2019
National Academies of Sciences, Engineering and Medicine
500 5th Street, NW Washington, DC 20001
Room 100
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   • Save the Dates:
     • Single Cell/Single Molecule (March 7-8, 2019)
     • Artificial Intelligence (June 6-7, 2019)
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This workshop will bring together infectious disease, global public health, toxicology, environmental epidemiology, and science policy experts to explore the growing body of research on the links between environmental stressors, infectious disease, and human health. The workshop will feature presentations, panel discussions, and breakout sessions to engage scientists and decision makers in this important, cross-disciplinary issue.

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**Session 1**  **Environmental Exposure and Infectious Disease: Emerging Trends**

**Moderator:** Robert Newman§, The Aspen Institute

- **9:10**  Environmental Health in the Global Health Arena—Keith Martin, Consortium of Universities for Global Health
- **9:40**  A One Health Perspective on Foodborne Illness and Antimicrobial Resistance—Laura Kahn, Princeton University
- **10:10**  The Microbiome and Immune System in Environmental Risk of Infectious Disease—Rodney Dietert, Cornell University
- **10:40**  Break
- **11:00**  Panel Discussion with Session 1 Speakers
- **11:40**  Lunch

§ Member of the Workshop Planning Committee for Toward Understanding the Interplay of Environmental Stressors, Infectious Disease and Human Health.

† Member of the Standing Committee on the Use of Emerging Science for Environmental Health Decisions.

(continued)
TUESDAY, JANUARY 15, 8:30 AM–5:00 PM
(CONTINUED)

SESSION 2 EXPLORING EMERGING EVIDENCE: PEOPLE, POPULATIONS, AND ECOSYSTEMS

Moderator: Margaret Karagas§†, Dartmouth College

12:45 Introductory Remarks by the Moderator

TOPIC 1: CHEMICAL TOXICANTS AND INFECTIOUS DISEASE

12:50 Environmental chemicals, *Staphylococcus aureus*, and antimicrobial resistance—Meghan Davis§, Johns Hopkins University

1:10 Perfluoroalkyl substances and immunosuppressive effects—Implication on infectious diseases and vaccination responses—Berit Granum, Norwegian Institute of Public Health (by webconference)

TOPIC 2: METAL EXPOSURES AND INFECTIOUS DISEASE

1:30 Mercury and Immune Modulation: Is the Inflammasome the Key?—Jennifer Nyland, Salisbury University

1:50 Epidemiological studies of environmental exposure to arsenic and immune-related outcomes—Molly Kile, Oregon State University

2:10 Panel Discussion Part 1
Moderator: Margaret Karagas§†, Dartmouth College

2:40 Break

TOPIC 3: AIR POLLUTION AND INFECTIOUS DISEASES

3:00 The Global Burden of Lower Respiratory Infections Attributable to Ambient and Household Air Pollution: estimates from GBD 2017—Aaron Cohen, Health Effects Institute

3:20 Understanding the molecular mechanisms of how air pollution increases susceptibility to pulmonary infections—Kymberly Gowdy, East Carolina University

3:40 Hot, Urban, and Uncertain: Tackling Environmental Health in an Era of Rapid Global Change—Justin Remais, University of California, Berkeley

4:00 Environmental Stressors, Disasters and Infectious Disease: Implications for Vulnerable Communities—Maureen Lichtveld, Tulane University

4:20 Panel Discussion Part 2
Moderator: Joshua Rosenthal§†, National Institutes of Health

4:50 Day 1 Closing Remarks—David Savitz§, Brown University

5:00 Adjourn Day 1

WEDNESDAY JANUARY 16, 8:30 AM–12:30 PM

8:30 Welcome—Gary Ginsberg§†, New York State Department of Health

SESSION 3 DEVELOPING CROSS-CUTTING RESEARCH STRATEGIES

Moderator: Gary Ginsberg§†, New York State Department of Health

8:35 Reconciling Divergent World Views on Mercury Pollution—Evolving thoughts on interdisciplinary and translational research—Niladri Basu, McGill University

9:00 Overview of the Breakout Activity—Gary Ginsberg§†, NY State Department of Health

BREAKOUT GROUPS

CRITICAL RESEARCH PRIORITIES TO ADVANCE THE SCIENCE
a. Immunotoxicology
b. Epidemiology
c. Disease Ecology
d. Environmental Change

CRITICAL TRANSLATIONAL PRIORITIES TO FACILITATE THE USE OF RESEARCH IN DECISION-MAKING
e. Convergence
f. Community Engagement
g. Education and Training
h. Capacity Building

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(continued)
Emerging Science for Environmental Health Decisions
Committee Business Meeting 1:
2:00pm–4:00pm. This meeting is open to Committee, Government Liaisons, and workshop participants.

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† Member of the Standing Committee on the Use of Emerging Science for Environmental Health Decisions.

Workshop Planning Committee
This workshop was organized by the following experts: Robert Newman, the Aspen Institute; John Balbus, National Institute of Environmental Health Sciences; Meghan Davis, Johns Hopkins University; Gary Ginsberg, New York State Department of Health; Margaret Karagas, Dartmouth College; Melissa Perry, the George Washington University; Joshua Rosenthal, National Institutes of Health; David Savitz, Brown University; John Vandenberg,
Environmental Protection Agency

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Emerging Science workshops are free and open to the public.

About Emerging Science for Environmental Health Decisions
The National Academies’ Standing Committee on the Use of Emerging Science for Environmental Health Decisions (ESEHD) examines and discusses issues on the use of new science, tools, and research methodologies for environmental health decisions. The ESEHD committee is organized under the auspices of Board on Life Sciences and the Board on Environmental Studies and Toxicology of the National Academies of Sciences, Engineering, and Medicine, and sponsored by the National Institute of Environmental Health Sciences.
Panel Discussion Questions

SESSION 1  ENVIRONMENTAL EXPOSURE AND INFECTIOUS DISEASE: EMERGING TRENDS

Moderator: Robert Newman
Panelists: Keith Martin, Laura Kahn, Rodney Dietert

Discussion Questions:

1. How can environmental and infectious disease scientists maximize processes to facilitate collaboration?
   a. What are the key opportunities and existing challenges to break down interdisciplinary barriers?
   b. What emerging changes in science (or advances in science) can facilitate collaboration in new ways?

2. What are the most pressing problems in infectious disease globally for which environmental factors may play a role?

3. What knowledge gaps and emerging challenges prevent us from effectively understand the implication of the environmental stressors on infectious disease burden?

4. The 17 Sustainable Development Goals (SDGs) represent an ambitious global agenda for improving life on earth. Achieving them will require going beyond the usual silos of development and thinking across sectors. How might we use these discussions at the intersection of environmental health and infectious diseases as an example of how to work across disciplines to tackle complex problems?

SESSION 2  EXPLORING EMERGING EVIDENCE: PEOPLE, POPULATIONS, AND ECOSYSTEMS

Panel A Moderator: Margaret Karagas
Panelists: Berit Granum, Meghan Davis, Jennifer Nyland, Molly Kile

1. Do we have the correct conceptual framework?
   a. Are we asking the right questions & appropriately designing research studies, so they can be applicable to medical and public health use?
   b. How do you translate the outcomes of your work to the various stakeholder groups to allow them to make decisions?

2. Are we measuring the right endpoints in animal/human systems to assess and understand how environmental stressors can impair host defense and increase infection?

3. What aspects of your research are being incorporated into other types of investigations on infectious diseases in epidemiologic or occupational studies?
   a. How can this be enhanced?
   b. What are the next steps?
   c. What emerging techniques are priorities to develop?
   d. How can this inform what we do in the future?
Panel B Moderator: Josh Rosenthal
Panelists: Aaron Cohen, Kymberly Gowdy, Justin Remais, Maureen Lichtveld

1) Do we have the correct conceptual framework?
   a. Are we appropriately designing research studies, so they can be applicable to medical and public health use?
   b. How do you translate the outcomes of your work to the various stakeholder groups to allow them to make decisions?

2) Are there particular vulnerabilities (e.g., life stage, underlying disease, nutritional deficiencies, and multiple stressor exposures) that need greater research emphasis?

3) Where do you see the greatest opportunities for scientific and public health advances along the exposure, infection, disease expression continuum?

4) What aspects of your research may be usefully incorporated into other types of research such as occupational studies, land use planning or health services research?
   a. How can this be enhanced?
   b. What are the next steps?
   c. What emerging techniques are priorities to develop?
   d. How can this inform what we do in the future?

SESSION 3  DEVELOPING CROSS-CUTTING RESEARCH AND TRANSLATION STRATEGIES

Please review the details instructions in your meeting book or on the event webpage

SESSION 4  IMPLICATIONS OF THE EMERGING SCIENCE: INFORMING RESEARCH AND POLICY DECISIONS FROM LOCAL TO GLOBAL

Moderator: John Balbus
Panelists: Gary Ginsberg, Helen Petach, Carlos Santos Burgoa, Gina Solomon

1. Given what you heard at this workshop, which challenges stand out the most to you? What issues would you consider bringing before the leadership of your organizations to address?

2. What (if any) aspects of this emerging area of science do you think are ripe enough to change public health practices and risk assessment?

3. Which (if any) aspects of this emerging area of science do you think necessitate developing new, collaborative funding efforts?

4. What mechanisms could be developed so that principal investigators and decision makers can work together to design research and report their data so that it is useful for developing public health protection/risk mitigation programs?

5. Given the multidisciplinary nature of this work, do we need to work with funding agencies to make sure future study sections and peer reviewers are cognizant of and prepared for this emerging area?
Instructions for Session 3 Breakout Discussion Groups

DEVELOPING CROSS-CUTTING RESEARCH AND TRANSLATIONAL STRATEGIES

Instructions:

1) **Select a Breakout Group.** Each discussion group should include 8-10 people. If your first choice is at capacity, please join a group that has fewer participants.
   a) Workshop participants choose to join 1 of 8 breakout discussion groups.
   b) Members of the workshop planning group and the workshop speakers should attend their assigned group to help facilitate the discussion (assignments are at the end of this document).

2) **Assign Roles & Responsibilities.** Please select a discussion lead (facilitator), a time-keeper, a note-taker, and a rapporteur for each group. Some of these roles can be combined.

3) **Review the breakout questions.** The discussion questions have a logical sequence. The response to Question 1 can (and should) generate a long list of ideas. The group should feel free to interpret the questions as they see fit. Quickly clarify any points of confusion.

4) **Individual Brainstorming.** Everyone has a different style of engagement. For Question 1, we encourage your group to allow people to brainstorm for a few minutes on their own.

5) **Group Discussion.** Please carefully allocate time to discuss (even if briefly) all of the questions. Also, please reserve some time to discuss what should be included in your groups’ report back.

6) **Report Back.** Your designated rapporteur will give a 3-minute report back of the group answers. We would like to display as many of your ideas as possible on an overhead screen. But, the report back should focus on the 5-7 issues the group thinks are of greatest priority. To ensure we have time for plenary discussion, the report back should not be a summary of everything the group discussed.

7) **Suggested Agenda.** To help you allocate time, we developed a suggested agenda. If it does not work for your group, that is ok. We recognize that time is a limiting factor. We hope this activity will stimulate continued discussion and action outside the confines of this workshop.

Breakout Groups

**The 4 Expert Advisory Boards on Research Priorities (Breakout Groups):**

A. Immunotoxicology
B. Epidemiology
C. Disease Ecology
D. Environmental Change (global warming, disasters, and other major changes)

**The 4 Expert Advisory Boards on Translational Priorities (Breakout Groups):**

E. Convergence (developing and sustaining multidisciplinary research collaborations)
F. Community Engagement (involving communities in research and policy decisions)
G. Education and Training (ensuring mutual understanding across multiple disciplines and sectors)
H. Capacity Building (facilitate sharing and use of information amongst local, national, and global stakeholders)
CRITICAL RESEARCH PRIORITIES TO ADVANCE THE SCIENCE (Breakout Groups A, B, C, and D)

Fictional Scenario:

The National Agency for People and Planet (NAPP) wants to invest $10 billion over the next 15 years to advance research on the interconnections between environmental exposures and infectious disease. NAPP asked the National Academies of Sciences, Engineering, and Medicine to assemble 4 expert science groups (you) to advise them. The executive leadership at NAPP are trying to decide how to spread their investments in regional, national, and global research. NAPP’s goals are 3-fold: (1) identify critical areas of research that needs investment; (2) outline key dimensions of research that we think are absolutely critical in order for it to be robust and useful for decision makers; and (3) develop an order of priority for their research investments. To this end, each science advisory board is tasked with developing ideas and priorities that NAPP leadership will use to inform their research investment decisions.

The 4 Expert Advisory Boards on Research Priorities (Breakout Groups):

A. Immunotoxicology
B. Epidemiology
C. Disease Ecology
D. Environmental Change (global warming, disasters, and other major changes)

Discussion Questions:

1. The pressing research questions. What are the research questions in [the science focus of this breakout group: immunotoxicology, epidemiology, etc.] that need answers in regards to methods, exposure, endpoints, host resistance, and populations variability, among other scientific dimensions?
2. Multidisciplinary input.
   a. Which of the questions from above need input from other disciplines to develop holistic answers.
   b. Which set of questions needs to be resolved within our field before it can be integrated into multidisciplinary research efforts
3. Timeframe. With sufficient funding, where do you expect science advances/breakthroughs in the near term (0-5 years), midterm (6-10 years), or long-term (beyond 2030)?
4. Impact on decisions. Which of the research questions are most likely to make an impact on (a) medical/clinical practices and interventions; (b) risk assessment; and (c) national or global public health goals and policies.
CRITICAL TRANSLATIONAL PRIORITIES TO FACILITATE THE USE OF RESEARCH IN DECISION-MAKING (Breakout Groups E, F, G, And H)

Fictional Scenario

The National Agency for People and Planet (NAPP) wants to invest $10 billion to implement a collaborative research-to-action investment strategy. NAPP asked the National Academies of Sciences, Engineering, and Medicine to assemble 4 expert multidisciplinary groups (you) to advise them. The executive leadership at NAPP are trying to decide how to spread their investments in translational activities to help ensure that research findings on the interconnections between environmental exposure and infectious disease make a difference. NAPP’s goal is to identify the critical research-to-action components (from the inception of a project, including community engagement, to policy development and decisions) to prioritize for investment. To this end, each multidisciplinary advisory board is tasked with developing ideas and priorities that NAPP leadership will use to inform their research-to-action investment decisions.

The 4 Expert Advisory Boards on Translational Priorities (Breakout Groups):

- **E. Convergence** (developing and sustaining multidisciplinary research collaborations)
- **F. Community Engagement** (involving communities in research and policy decisions)
- **G. Education and Training** (ensuring mutual understanding across multiple disciplines and sectors)
- **H. Capacity Building** (facilitate sharing and use of information amongst local, national, and global stakeholders)

Discussion Questions:

1. **Barriers.** Identify major barriers or hurdles that inhibit effective [the topic of this breakout-group: convergence, community engagement etc.] to conduct, access, or use emerging research on environment pollutant and infectious disease. What makes these challenges particularly sticky (hard to overcome)? [identify 5-7 barriers for your topic]

2. **Opportunities.** What are the institutional/programmatic opportunities that could be leveraged to overcome the barriers?

3. **Time frame.** Given the opportunities and sufficient financial support, what steps could be implemented to overcome the barriers in the near term (0-5 years), midterm (6 -10 years), and long-term (beyond 2030)?
Suggested Agenda

9:05 **Overview of the Breakout Activity**  
   – *Gary Ginsberg*, New York State Department of Health

9:00 **Breakout Group Discussions**

9:10 Introductions & Ice Breaker (5 mins): Name, affiliation, and the name of food that begins with the same letter as your first name.
9:15 Assign roles & responsibilities (2 mins): Volunteers to be a discussion lead to keep the focus on the questions; time-keeper; note-taker; and rapporteur
9:17 Review the questions as a group (3 mins). Quickly clarify any points of confusion.
9:20 Individual brainstorming (5 mins). Use the notepads to jot down your thoughts/responses to Question 1.
   9:35 Discuss Question 2
   9:45 Discuss Question 3
   9:55 Discuss Question 4 [only for the Critical Research Priorities groups]
10:15 Discuss what to include in the report back (5 mins). Group lead (or rapporteur) ensures everyone is on the same page about what to share. Each group will have 3 mins for a report-out. The report-out should focus on priorities. The report-out should not be a summary of everything the group discussed.

10:20 **Break**

10:35 **Plenary Report Backs and Discussion**
   **Moderator:** *Gary Ginsberg*, New York State Department of Health
   10:35 – 11:00 Report Backs. Rapporteur present groups 5-7 top priorities  
   11:00 – 11:30 Plenary Discussion

**Breakout Group Assignments**

b. Epidemiology: Aaron Cohen, Molly Kile, *David Savitz*
c. Disease Ecology: Laura Kahn, Rodney Dietert
d. Environmental Change: John Balbus*, Maureen Lichtveld, Justin Remais
e. Convergence: *Meghan Davis*, Keith Martin, Helen Petach
f. Community Engagement: Nil Basu, *Margaret Karagas*
g. Education and Training: *Melissa Perry*, Josh Rosenthal*

*member of the workshop planning committee
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Background Reading

Session 1 - Background Reading


Session 2 - Background Reading


Continued


Continued

**Related National Academies Activities**


Speaker Abstracts

Session 1 - Environmental Exposure and Infectious Disease: Emerging Trends

Laura Kahn - A One Health Perspective on Foodborne Illness and Antimicrobial Resistance

One Health is the concept that human, animal, and environmental/ecosystem health are linked. This concept provides a useful framework for examining complex infectious disease issues such as foodborne illnesses and antimicrobial resistance. Humans and their domesticated animals constitute approximately 96 to 98 percent of the global terrestrial mammalian biomass. In 2014, the estimated global human (7.2 billion) and livestock animal (29.7 billion) populations produced almost 4 trillion kilograms of fecal matter; animals produced almost 80 percent of it. The total amount is estimated to be increasing by over 52 billion kilograms each year. Sanitation systems primarily focus on human, not animal, waste. Many pathogens causing foodborne illnesses, a major global health issue, come from fecal matter. Global fecal matter contamination of the environment might be adversely affecting the planet’s “resistome,” leading to increasing use of antibiotics, and worsening antimicrobial resistance. More research needs to be done on animal waste contamination of food and the environment, as well as its direct impact on human health. Bacteriophages might play a potentially important role in mitigating the adverse impact of fecally-derived pathogens in the environment. To improve global health, we need more interdisciplinary studies to understand the impact our wastes are having on the planet’s biome.

Rodney Dietert - The Microbiome and Immune System in Environmental Risk of Infectious Disease

Infectious diseases occur when existing pathogens gain a foothold within the human microbiome and/or when invading pathogens can become established via a portal of entry (e.g., skin, airways, gut, urogenital tract) and evade front-line immune defenses. The status of the underlying immune system is critical as it determines what happens as pathogens are encountered. Environmental factors can modulate status of both the microbiome and/or immune system significantly affecting the risk of disease. As examples, adverse outcomes at the level of the microbiome can include loss of colonization resistance while environmentally-induced immune changes can result in inadequate or improper immune responses to the pathogen. Not surprisingly, important environment-host interactions occur where we are exposed to the external environment. For example, the same portals of entry used by invading pathogens are the same exact routes for our toxicological exposure to xenobiotics. They are
also the physical locations where the majority of the human microbiome is housed. This presentation will focus on how environmental conditions can facilitate optimized immune maturation and host defense against infections or alternatively, tip the scale toward dysbiosis and an increased risk of infectious disease.
Session 2 – Exploring Emerging Evidence: People, Populations, and Ecosystems

Meghan Davis - Environmental chemicals, *Staphylococcus aureus*, and antimicrobial resistance

**Background:** *Staphylococcus aureus*, including methicillin resistant (MRSA) strains, is a colonizing opportunistic Gram-positive bacterial pathogen that causes clinical disease in both humans and animals, and strains may persist in the environment for weeks to months. Colonization with *S. aureus* puts people at risk for progression to infection and may be associated with non-infection outcomes via inflammatory processes.

**Goal:** To use a One Health perspective to discuss linkages among environmental stressors, *S. aureus* colonization, antimicrobial resistance in *S. aureus* strains, and both infection and non-infection outcomes related to *S. aureus* exposure.

**Synthesis:** Our own research and that of other groups has identified that use of chemical products, such as disinfectants, is associated with risk for detection of multidrug-resistant MRSA in household environments, and that other chemical and metals exposures are associated with colonization and/or drug resistance in *S. aureus*. For example, animal feed supplementation with zinc has been linked to the emergence of the CC398 strain of MRSA in livestock in Europe. This strain ultimately has spread to other countries and established circulation in human populations. Further, *S. aureus* exposure through surface dust in the built environment has been implicated as a reservoir for human *S. aureus* colonization and infection and has been associated with worse respiratory disease among children with asthma. Other chemical and metal exposures in the built environment have the potential to modulate this reservoir in the context of either individual pathogens or the microbiome. This may occur via several pathways: 1) environmental stressors may affect the host, altering immune status or host susceptibility to pathogens, 2) environmental stressors may affect the infectious agent, altering virulence characteristics (such as antimicrobial resistance) or microbial population dynamics, or 3) environmental stressors and infectious agents may cause the same disease outcome and operate independently or synergistically.

Berit Granum – Perfluoroalkyl substances and immunosuppressive effects – Implication on infectious diseases and vaccination responses

Perfluoroalkyl substances (PFASs) are synthetic fluorinated compounds that have been widely used in industrial and commercial products because of their water, oil, stain and heat resistant qualities. They are environmental pollutants and are ubiquitously found in nature, wildlife and humans. The main PFAS exposure for humans is through food and beverages, although inhalation and ingestion of indoor dust may also contribute. In several human studies, exposure to PFASs are reported to be associated with a reduced immune responses to childhood vaccinations and an increased risk of infectious diseases such as airways infections and gastric flu, as well as with an increased number of days with fever. These studies give evidence for immunosuppressive effects of PFASs. Some of the exposure-health
associations are seen mainly in girls only, indicating a gender difference in the effect of PFASs on infectious diseases.

Jennifer Nyland – Mercury and Immune Modulation: Is the Inflammasome the Key?

Mercury compounds have long been utilized to treat and combat infectious disease, including to treat syphilis, as a disinfectant, and a preservative. While the ability to modulate the immune response to infection with mercury has been known for centuries, at least through circumstantial evidence, the exact mechanism of action still eludes researchers. A growing body of evidence clearly demonstrates the effects of mercury on the immune system in cellular in vitro, animal models in vivo, and in epidemiological studies. While the evidence supports a role for mercury in modulating the immune system and subsequent responses to infection, inconsistencies within these studies have made drawing conclusions about the specific mechanisms of action difficult. We and others have previously suggested that this lack of concordance may be the result of important interactions with other risk factors including genetic and environmental susceptibility factors. New research into the role of mercury in modulating the inflammasome may hold the key to unlocking the mystery of mercury’s mechanism of modulation of the immune response.

Molly Kile – Epidemiological studies of environmental exposure to arsenic and immune-related outcomes

In vivo and in vitro studies have demonstrated that arsenic is immunotoxic. There is also growing evidence from epidemiological research. In this presentation, we will review epidemiological studies that have examined the association between arsenic exposure and immune functioning. Specifically, we will examine data collected from prospective birth cohorts that have examined the association between arsenic exposure early in life, humoral immunity, and infectious disease risk. We will also examine cross-sectional surveillance data that examined the association between arsenic biomarkers and sero-prevalence of varicella zoster virus, hepatitis A, and hepatitis B. Together, this data suggests that arsenic exposure from environmental exposures modulates immunological functions and that the developing fetus may be the most susceptible to arsenic-related immunotoxicity.

Aaron Cohen – The Global Burden of Lower Respiratory Infections Attributable to Ambient and Household Air Pollution: estimates from GBD 2017

Air pollution exposure in ambient and household environments is associated with a range of infectious disease outcomes in children and adults. These adverse effects include increased incidence and mortality from tuberculosis, increased disease severity and case-fatality from Adult Respiratory Distress Syndrome and epidemic viral infections (e.g., SARS), and increased morbidity and mortality from upper and lower respiratory infections (LRI).

Among the infectious diseases associated with air pollution exposure LRI is by far the largest contributor to disease burden. The Global Burden of Diseases, Injuries, and Risk Factors Study 2017 (GBD 2017) estimated that despite marked declines in age-standardized LRI mortality rates since 1990, LRI was the 4th global leading cause of deaths and DALYs (lost-years-of-healthy-life) in all ages in 2017 with the highest age-standardized rates in Sub-Saharan Africa. LRI was the 2nd leading cause of deaths in children <5 yr. and the 5th leading cause of deaths
in adults >70 yr. Exposure to PM2.5 air pollution from ambient and household air pollution from the burning of solid fuels for cooking contributed to 4.6 million (4.1-5.0) deaths in 2017, of which 0.89 million (0.75-1.04) were due to LRI, two thirds of which were in adults >70 yr. and children <5 yr. Premature mortality from LRI in children < 5 yr. led to 32 million (26-38) years of-life-lost. Age-standardized PM2.5 LRI mortality rates were highest in Southern and sub-Saharan Africa. Global LRI mortality rates attributable to PM2.5, both ambient and household, declined over the past 20-30 years, which declines were particularly marked in children <5 yr. driven by both socio-demographic factors and changes in risk factor exposure. Future reductions in this still sizeable burden will require concerted policy action to reduce exposure to ambient and household air pollution and other LRI risk factors.

Kymberly Gowdy – Understanding the molecular mechanisms of how air pollution increases susceptibility to pulmonary infections

Epidemiological studies strongly associate air pollution exposures and incidence of respiratory infections, which is important since more than 1/3 of the United States population lives in areas exceeding the current National Ambient Air Quality Standards. Though air pollution exposure clearly impairs pulmonary host defense, the specific molecular mechanisms enhancing respiratory pathogen susceptibility remain poorly understood. Defining these mechanisms requires linking molecular pathways modified by environmental pollutants to those critical to host-pathogen interactions. It has been reported that air pollution exposure dampens the phagocytic response of innate immune cells, alters the expression of pattern recognition receptors (PRRs) such as toll-like receptors (TLRs) and scavenger receptors (SRs), and increases the production of proinflammatory cytokines in the lung and systemically. However, how air pollution exposure modulates these critical arms of innate immunity is still unknown. This talk will discuss published and unpublished data of molecular pathways known to drive air pollution-induced health effects and will define specific mechanisms by which ambient pollutants mediate critical host defense functions. Data that will be discussed will integrate both murine and human samples/observations.

Justin Remais – Hot, Urban, and Uncertain: Tackling Environmental Health in an Era of Rapid Global Change

Rising temperatures, expanding megacities, and uncertainty surrounding the future course of global development constitute major challenges for environmental health in the 21st century. Addressing the dynamic and multi-scale environmental determinants of health in this context will require new approaches to exposure science, risk assessment, environmental science, and the investigation of health effects, particularly for environmental pathogens. This talk will detail emerging strategies to measure, model, and project complex biological exposures—and their health consequences—in the presence of rapid social and environmental change. Select results from ongoing NIH- and NSF-funded research focusing on key environmentally mediated infectious diseases in China, Ecuador, Senegal, and California will be discussed, revealing linkages between global climate change, urbanization, infrastructure development, and patterns of disease.
Maureen Lichtveld – Environmental Stressors, Disasters and Infectious Disease: Implications for Vulnerable Communities

Many vulnerable communities around the world face a triple health burden: persistent environmental health threats, historic disparities, and residence in disaster-prone areas. In addition to this cumulative risk they face are post-disaster infectious diseases. This presentation will discuss exemplar case studies of the impact of environmental disruptions on transmission and exposure of infectious disease. Specific emphasis will be placed on examining the consequences at the community level including the role of key social capitals such as health systems. Recommendations for strengthening the science base of these cumulative risk domains will provide building blocks for a future research agenda.
Session 3 – Developing Cross-Cutting Research Strategies

Niladri Basu – Reconciling Divergent World Views on Mercury Pollution – Evolving thoughts on interdisciplinary and translational research

Mercury pollution research has afforded me a lens to (try and) understand the world. On one hand, the research community has skillfully documented—through thousands of papers over several decades—mercury’s unequivocal harmful impacts. These in turn have helped increase understanding of how humans and societies as well as animals and ecosystems respond to environmental threats. However, in certain contexts mercury’s presence is associated with matters deemed beneficial to public health, economic security and community well-being, and these tend to both complicate and confound as well as deepen and expand understanding. Here I outline some of my journeys with mercury pollution, and dwell specifically on my experiences with gold miners in Africa, Indigenous communities in the Arctic, and the regulatory management of chemicals. In doing so, I will detail my evolving perspectives on drivers and barriers, as well as strategies and tools concerning research that is collaborative, interdisciplinary, and translational.
Toward Understanding the Interplay of Environmental Stressors, Infectious Disease and Human Health

Workshop Participant Biographies

Dr. Nil Basu holds a Canada Research Chair (CRC) in Environmental Health Sciences at McGill University (Montreal, Canada) where he is an Associate Professor. The goal of Dr. Basu’s research is to take an ecosystem approach to community, occupational, and environmental health whereby evidence is collected, scrutinized, and compared from both humans and ecological organisms. Dr. Basu’s research is both inter-disciplinary (bridges environmental quality and human health) and inter-sectoral (most projects driven by stakeholder needs, notably government and communities), and increasingly he has assumed national and international leadership positions to bring together diverse teams to tackle grand challenges in the field (e.g., toxicity testing in the 21st century, mercury pollution, gold mining). Research activities are situated at the interface of science and policy with notable involvements with the UN Minamata Convention, Canada’s Chemicals Management Plan, and the Lancet Commission on Pollution and Health. The work has been supported by more than $35M in research funding, resulted in >150 peer-reviewed papers and afforded training opportunities to over 100 students.

Dr. Linda Birnbaum** became the Director of the National Institute of Environmental Health Sciences (NIEHS), one of the National Institutes of Health (NIH), and the National Toxicology Program (NTP) on January 18, 2009. In these roles Birnbaum oversees federal funding for biomedical research to discover how the environment influences human health and disease. Several advisory boards and councils provide Birnbaum and NIEHS/ NTP staff with input to accomplish this large task. Birnbaum is the first toxicologist and the first woman to lead the NIEHS/NTP. She has spent most of her career as a federal scientist. Birnbaum has received numerous awards and recognitions, including being elected to the Institute of Medicine of the National Academies, in October 2010, one of the highest honors in the fields of medicine and health. Birnbaum’s own research and many of her publications focus on the pharmacokinetic behavior of environmental chemicals; mechanisms of actions of toxicants, including endocrine disruption; and linking of real-world exposures to health effects. Birnbaum also finds time to mentor the next generation of environmental health scientists. For example, she serves as an adjunct professor in the Gillings School of Global Public Health, the Curriculum in Toxicology, and the Department of Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill, as well as in the Integrated Toxicology Program at Duke University. A native of New Jersey, Dr. Birnbaum received her M.S. and Ph.D. in microbiology from the University of Illinois at Urbana-Champaign.

Dr. John Balbus**, serves as a senior advisor to the Director on public health issues and directs the NIEHS-WHO Collaborating Centre for Environmental Health Sciences. He also leads NIEHS efforts on climate change and human health. In this capacity he serves as HHS principal to the U.S. Global Change Research Program, for which he also co-chairs the Interagency Cross-Cutting Group on Climate Change and Human Health. Dr. Balbus' background combines training and experience in clinical medicine with expertise in epidemiology, toxicology, and risk sciences. He has authored studies and lectures on global climate change

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and health, transportation-related air pollution, the toxic effects of chemicals, and regulatory approaches to protecting susceptible subpopulations. Before joining the NIEHS, Dr. Balbus was Chief Health Scientist for the non-governmental organization Environmental Defense Fund. He served on the faculty of The George Washington University, where he was founding Director of the Center for Risk Science and Public Health, founding co-Director of the Mid-Atlantic Center for Children's Health and the Environment, and Acting Chairman of the Department of Environmental and Occupational Health. He maintains an adjunct faculty appointment at the Milken Institute School of Public Health at the George Washington University. Dr. Balbus received his A.B. degree in Biochemistry from Harvard University, his M.D. from the University of Pennsylvania, and his M.P.H. from the Johns Hopkins School of Public Health. In addition to current membership on the National Academy of Medicine Roundtable on Environmental Health Sciences, Research and Medicine, Dr. Balbus has also served as a member of the EPA Science Advisory Board, the National Research Council's Board on Environmental Studies and Toxicology and the EPA Children's Health Protection Advisory Committee.

Dr. Aaron Cohen is Consulting Principal Scientist at the Health Effects Institute, a position he has held since his retirement from HEI in May 2016. Prior to retirement Dr. Cohen developed and managed for 26 years HEI’s US and international epidemiologic research programs on the adverse health effects of air pollution. He now provides strategic advice on the development and conduct of HEI's global health research and plays a leading role in the development of estimates of the global burden of disease due to air pollution as part of Global Burden of Disease (GBD) Collaboration. Since 1999 he has served as a Temporary Advisor to the World Health Organization on the evaluation of epidemiologic evidence, health impact assessment, and air quality guideline development and served as a member of International Agency for Research on Cancer working groups on diesel exhaust and outdoor air pollution. In 2017, he received the John Goldsmith Award for sustained and outstanding contributions to the knowledge and practice of environmental epidemiology from International Society for Environmental Epidemiology. Dr. Cohen holds a D.Sc. in Epidemiology (1991), and Masters in Public Health (1985) from the Boston University School of Public Health, where he is adjunct Assistant Professor of Environmental Health. He is also Affiliate Professor of Global Health at the Institute for Health Metrics and Evaluation at the University of Washington.

Dr. Meghan Davis, is an Assistant Professor in Environmental Health and Engineering at Johns Hopkins Bloomberg School of Public Health. The goals of her research are to reduce microbe-mediated diseases in humans and animals, to combat the rise of antimicrobial resistance on local and global scales, and to promote systematic methods for One Health epidemiologic research. She received her D.V.M. from the University of California at Davis School of Veterinary Medicine in 2000, and her M.P.H. and Ph.D. from Johns Hopkins Bloomberg School of Public Health in 2008 and 2012, respectively.

Dr. Rodney Dietert is a Professor in the Department of Microbiology and Immunology at Cornell University. During his 41 years at Cornell, Rodney directed the Graduate Field of Immunology, the Institute for Comparative and Environmental Toxicology, and the Program on Breast Cancer and Environmental Risk Factors. He also served as a Senior Fellow in Cornell’s Center for the Environment. His research has focused on: 1) protection of the immune system during early life, 2) the interconnectivity of human diseases and, 3) the role of the microbiome in human health. In addition to his more than 300 scientific publications, Rodney is founding editor of the Comparative Immunology book series for CRC Press and the Molecular and Integrative Toxicology book series for Springer. His authored books include: Strategies for

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**Dr. Kymberly Gowdy** is an Assistant Professor in the Department of Pharmacology and Toxicology at the Brody School of Medicine at East Carolina University. Dr. Gowdy has held this position since 2014. Prior to her faculty position, Dr. Gowdy trained at the National Institute of Environmental Health Sciences and Duke University. Her current research program focuses on understanding the molecular mechanisms behind the adverse health effects of air pollution. She is currently funded by the National Institutes of Health and the Health Effects Institute. Additionally, she is the current president of the North Carolina Society of Toxicology and an active member of the Society of Toxicology and American Thoracic Society. In 2015, Dr. Gowdy was awarded the Walter A. Rosenblith New Investigator Award by the Health Effects Institute. Dr. Gowdy holds a Ph.D. in Immunology and Toxicology (2008), and Master’s in Science (2004) from North Carolina State University. She has authored more than 30 peer reviewed publications investigating how air pollution can alter the pulmonary immune response, increasing susceptibility to infectious and inflammatory lung diseases.

**Dr. Gary Ginsberg** is Director of the Center for Environmental Health at the New York State Department of Health. He serves on a number of national committees including US EPA’s Science Advisory Board (2008-present) and the National Academies’ Biomonitoring committee (2004-2006), USEPA Risk Methods committee which produced Science and Decisions (2006-2008), and Inorganic Arsenic Risk Assessment committee (2012-2015). He also served on USEPA’s Children’s Health Protection Advisory Committee (2004-2009) and has been an external reviewer on a number of USEPA IRIS documents. Dr. Ginsberg has been called on by other federal agencies to provide reviews including OSHA (silica workplace standard), CPSC (cadmium in children’s jewelry), and FDA (dental amalgam). His risk assessments on fish contaminants, synthetic turf fields, acrylamide, cadmium, and assessments pertaining to risks in children and those with genetic polymorphisms have been published in peer reviewed journals. Dr. Ginsberg co-authored a book for the lay public called “What’s Toxic, What’s Not” (Berkeley Books, 2006). Dr. Ginsberg is a member of the standing committee, ESEHD, that this activity stems from.

**Dr. Berit Granum** is a senior scientist at the Department of Toxicology and Risk assessment, Norwegian Institute of Public Health. Granum’s main area of research is environmental factors in the aetiology of immunological diseases (allergy, asthma, and immunosuppression). Her main focus the last years has been on persistent pollutant such as perfluoroalkyl substances (PFASs), but she is also involved in exposome research. Granum performs risk assessment at both a national and international level (Norwegian Scientific Committee for Food and Environment, Climate and Pollution Agency, and European Commission’s Scientific Committee on Consumer Safety). Granum was a part of the group that peer reviewed the draft National Toxicology Program (NTP) monograph on immunotoxicity associated with exposure to PFOA or PFOS, and the group that peer reviewed the Harmonization Project Document No. 10: Guidance for Immunotoxicity Risk Assessment for Chemicals at the WHO/IPCS International Workshop on Immunotoxicity Risk Assessment for Chemicals. Granum was awarded the Voksentoppen’s research prize in 2000, a prize that goes to a person who has made a significant contribution in the field of asthma, allergology, chronic lung diseases and environmental related diseases in children. Granum has published 47 scientific papers in peer-reviewed journals and 45 scientific reports. Her publications reflects her research within the field of immunotoxicology and risk assessment work.

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**Dr. Laura Kahn** is a physician and research scholar with the Program on Science and Global Security at the Woodrow Wilson School of Public and International Affairs, Princeton University. In April 2006, she published *Confronting Zoonoses, Linking Human and Veterinary Medicine* in the Center for Disease Control and Prevention’s (CDC) *Journal of Emerging Infectious Diseases* which helped launch the One Health Initiative (http://www.onehealthinitiative.com) seeking to improve the health of all species by recognizing the inherent links between human, animal, and environmental/ecosystem health. She is the author of *One Health and the Politics of Antimicrobial Resistance*, published in June 2016 by Johns Hopkins University Press. An April 2017 book review in CDC’s journal *Emerging Infectious Diseases* described the book as “an essential primer for anyone who chooses to grapple with this challenging but crucial public health issue.” Dr. Kahn is a fellow of the American College of Physicians (ACP) and is a recipient of the New Jersey Chapter’s Laureate Award. In 2014, she received a Presidential Award for Meritorious Service from the American Association of Public Health Physicians, and in 2016, the American Veterinary Epidemiology Society (AVES) awarded her with their highest honor for her work in One Health: the K.F. Meyer-James H. Steele Gold Head Cane Award.

**Dr. Margaret R. Karagas** is Professor and Department Chair of Epidemiology at the Dartmouth College Geisel School of Medicine, and Director of the Children's Environmental Health and Disease Prevention Research Center and Center of Molecular Epidemiology at Dartmouth. She also currently leads a project in the Dartmouth Superfund Program. Dr. Karagas’ research encompasses interdisciplinary studies to illuminate the etiology of human cancers, along with adverse pregnancy and children's health outcomes. Her work seeks to identify emerging environmental exposures, host factors, and mechanisms that impact health from infancy to adult life, and to apply novel methods and technologies to understand disease pathogenesis. Among her current investigations are population-based studies of bladder and keratinocyte cancers in the US and the contribution of widespread exposures such as drinking water contaminants and infectious agents. Further, she has established a cohort of pregnant women and their offspring in New Hampshire to assess the sources and potential health impacts of environmental exposures on childhood infection, allergy/atopy, growth, and neurodevelopment through the Children’s Center. The cohort entails multiple collaborative studies of exposure biomarkers, individual susceptibility, and biological response to environmental agents including the developing microbiome and immune response. Dr. Karagas is a member of the standing committee, ESEHD, which this activity stems from. Dr. Karagas received her Ph.D. from the University of Washington.

**Dr. Molly Kile** is an environmental epidemiologist whose research focuses on understanding how exposures to chemicals influence human health. She is also interested in how chemicals interact with host factors (e.g. behavior, diet, microbiota, genetic and epigenetic) to modify susceptibility to disease. She received her doctoral degree from Harvard School of Public Health in 2006 and is currently an Associate Professor at the College of Public Health and Human Sciences at Oregon State University. The majority of her research to date has been evaluating the health effects associated with arsenic exposure. She been involved with many epidemiological studies conducted in Bangladesh that have looked at a variety of health outcomes including skin lesions, reproductive outcomes, neurodevelopmental outcomes, and metabolic diseases. She is also the director of the Community Engagement Core of Oregon State University's Superfund Research Center where she works with Native American Tribes to investigate their concerns regarding environmental pollution.

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Dr. Maureen Lichtveld, a member of the National Academy of Medicine, has over 35 years of experience in environmental public health and is Professor and Chair, Department of Global Environmental Health Sciences, Tulane University, School of Public Health and Tropical Medicine. She holds an endowed chair in environmental policy. Her research focuses on environmentally-induced disease, health disparities, environmental health policy, disaster preparedness, public health systems, and community resilience. Lichtveld’s track record in community-based participatory research includes the impact of chemical and non-chemical stressors on communities facing environmental health threats, disasters, and health disparities. As Director, Center for Gulf Coast Environmental Health Research, Leadership, and Strategic Initiatives, she serves as PI of several Gulf Coast-associated environmental health research and capacity building projects. Dr. Lichtveld is a member of the National Advisory Environmental Health Sciences Council of the NIH National Institute of Environmental Health Sciences; the U.S. EPA Scientific Advisory Board; the NAS Board on Global Health and the Roundtable on Environmental Health Sciences, Research, and Medicine, the NAS Committee on Measuring Community Resilience Consensus Study, and the Advisory Committee for the NASEM-wide Climate Communications Initiative. She also chairs the Editorial Board of the American Journal of Public Health.

Dr. Keith Martin is the founding Executive Director of the Consortium of Universities for Global Health (CUGH), based in Washington, DC. Advancing Planetary Health-One Health and Environmental Health efforts within CUGH has been one of his primary areas of focus. Between 1993 and 2011, Dr. Martin served as a Member of Parliament in Canada’s House of Commons representing a riding in British Columbia. During that time he held shadow ministerial portfolios in foreign affairs, international development, and health. He served as Canada’s Parliamentary Secretary for Defense and in 2004 was appointed to the Queen’s Privy Council. His primary areas of interest are global health, foreign policy, international development, conservation and the environment. As a parliamentarian he founded Canada’s first all-party Conservation Caucus, a platform that connected leading environmental and conservation scientists with policymakers. Dr. Martin has been on numerous diplomatic missions to areas in crisis including Sudan, Zimbabwe, Mali, Niger, Sierra Leone, Colombia, and the Middle East. He served as a physician on the Mozambique border during that country’s civil war and has travelled widely in Africa. He spent many years volunteering on conservation efforts in South Africa. He has authored more than 170 published editorial pieces and has appeared frequently as a commentator on television and radio.

He is a member of the Lancet Commission on Pollution and Health. He sits on the board of the Jane Goodall Institute (USA), the editorial board of the Annals of Global Health and is an adviser to the International Cancer Expert Corps, The Global Sepsis Alliance, McGill University’s Global Health Programs, and Seed Global Health. Born in England, Dr. Martin now lives in Washington, DC.

Dr. Robert Newman is a pediatrician with more than 25 years of experience in Global Health and Development as a leader, policy maker, epidemiologist, program implementer, researcher, and clinician. He has particular interests in malaria, HIV, TB, immunizations, NCDs, health systems development and transition, maternal-child health, health security, and One Health, and has worked extensively in Africa, the Americas, Asia, and Europe. He currently serves as Director of AMP Health at the Aspen Institute, working with Ministries of Health in Africa to build leadership and management capacity. Prior to this, he was Vice President and Global Head for Tuberculosis at Johnson & Johnson Global Public Health, where he led enterprise-wide efforts to achieve a world free of the burden of TB. From 2015–2017, Dr. Newman served as the Country Director for the U.S. Centers for Disease Control and Prevention (CDC) in Cambodia, overseeing activities related to HIV and AIDS, TB, health security, outbreak response, health systems strengthening, and capacity building. From 2009-2014, Dr. Newman served as Director of the Global

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Malaria Program at the World Health Organization, where he launched major global initiatives to increase malaria diagnostic testing, combat antimalarial drug resistance, and prevent the spread of insecticide resistance. He subsequently served as Managing Director for Policy and Performance at Gavi, the Vaccine Alliance, where he oversaw organizational strategy setting, performance metrics, market shaping, policy development, business planning, monitoring and evaluation, and risk management. He previously spent 9 years in the Malaria Branch at CDC, including serving as the CDC team lead for the U.S. President’s Malaria Initiative from 2006 to 2009. Dr. Newman is a newly appointed member to the National Academies’ Board on Life Sciences. He received his B.A. in English Literature from Williams College, his M.D. from Johns Hopkins University School of Medicine, and his M.P.H. from the University of Washington School of Public Health. He completed his residency in Pediatrics at the University of Washington-Seattle Children’s Hospital in 1996, and stayed on to complete a National Research Service Award fellowship in General Pediatrics in 1998. He has published 69 peer-reviewed articles in the field of infectious diseases.

**Dr. Jennifer Nyland** is an Assistant Professor of Biological Sciences and Director of the Henson Honors Program in Science and Mathematics at Salisbury University, Salisbury, MD. She is a chemist (Cornell University, B.A.), immunologist (SUNY Upstate Medical University, Ph.D.), and immunotoxicologist (Johns Hopkins Bloomberg School of Public Health, post-doctoral fellowship) with research interests in these areas. Dr. Nyland’s research focuses on the impacts of metals exposures on the immune system. Specifically, her lab utilizes in vitro cell culture studies and in vivo mouse models of infection and autoimmune disease to explore the impacts of environmentally-relevant mercury and arsenic exposures on mechanisms of immune modulation and disease progression.

**Dr. Melissa Perry** is Professor and Chair of the Department of Environmental and Occupational Health in the Milken Institute School of Public Health at the George Washington University (GWU). Before joining GWU, she spent 13 years on the Harvard School of Public Health’s Department of Environmental Health faculty. As an environmental and occupational epidemiologist, Dr. Perry’s research focuses on the health impacts of environmental chemicals with particular focus on reproduction, and on the prevention of occupational injuries and disease. Her lab at GW examines environmental impacts on sperm and male fertility. She is the Chair of the Board of Scientific Counselors for the National Center for Environmental Health/Agency for Toxic Substances and Disease Registry of the Centers for Disease Control and Prevention; co-chair of the National Academies of Sciences’ Committee on Emerging Science for Environmental Decisions; a Fellow of the Collegium Ramazzini; and a member of the Technical Advisory Board for the Center for Construction Research and Training (CPWR). She has served as President of the American College of Epidemiology and as a standing member of the National Institute for Occupational Safety and Health study section. She is currently an associate editor of Environmental Health Perspectives and an editorial board member of Environmental Health. She received her B.A. from the University of Vermont, and her M.H.S. and Sc.D. from The Johns Hopkins University School of Hygiene and Public Health.

**Dr. Helen Petach** (Cornell University), is Senior Science Advisor in USAID’s Office of Maternal and Child Health, Bureau of Global Health with a focus on identifying evidence-based interventions to improve maternal and child health outcomes. Dr. Petach is the Bureau of Global Health’s point of contact for household air pollution programs, managed the research studies on the adoption of clean household fuels, and supports the WHO on the Clean Household Energy Solutions Toolkit. Previously, Dr. Petach served as the Senior Director of Scientific Affairs at SomaLogic, a clinical diagnostics company and as Senior Technical Manager at Hewlett-Packard managing the mobile technology data analytics team.

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**Dr. Joshua Rosenthal** is a Senior Scientist at the Fogarty International Center of the U.S. National Institutes of Health (NIH). He is an ecologist with a longstanding interest in the integration of public health, environment, and international development. Dr. Rosenthal leads NIH research and policy activities in Household Air Pollution research, including the Clean Cooking Implementation Science Network, and a multi-national trial to define the health benefits achievable through a clean cooking intervention in low and middle income countries. He founded and co-leads the NIH Climate and Health working group, is a project scientist on the NIH-CDC-IDRC supported GEOHealth program (Global Environmental and Occupational Health) and is the NIH Management lead for the Global Alliance for Chronic Diseases. Dr. Rosenthal completed his Ph.D. and post-doctoral research at the University of California, Berkeley. In 2011, Dr. Rosenthal was a Senior Fulbright Fellow at the University of Buenos Aires, Argentina and has since served as the Deputy Director of the Fogarty International Center and Director of the Division of International Training and Research. Dr. Rosenthal has authored a wide variety of technical, policy and popular publications, including research reports, research topic reviews, global health program analyses, editorials, magazine articles and one edited book, and is an Executive Editor for the journal *EcoHealth*.

**Dr. Justin Remais** is Associate Professor and Head of Environmental Health Sciences in the School of Public Health at the University of California, Berkeley. His research examines the spatial and temporal characteristics of environmental hazards in both domestic and international settings, with a focus on the transmission of environmental pathogens. He has methodological expertise in geospatial, statistical and mathematical modeling methods for microbial risk assessment, and he leads a cluster of studies examining the dynamics of infectious disease transmission in changing environments. His group studies major environmental and social forces that are influencing the spread of infectious diseases both in domestic and developing country settings, including unplanned urbanization, climate change, prolonged drought, and the industrialization of agriculture. His current funded research is focused on infectious diseases of global significance that affect billions of people in rapidly changing tropical, sub-tropical and temperate regions, including TB, schistosomiasis, leptospirosis, West Nile Virus, coccidioidomycosis, and enteric infections. Remais received his Master’s in Civil and Environmental Engineering, and his Ph.D. in Environmental Health Sciences, both from the University of California, Berkeley.

**Dr. Carlos Santos Burgoa** is a Professor in the Department of Global Health, where he also serves as the Program Director for the Global Health Policy MPH program. He is raising awareness of the importance for equity and development of the regulatory public health function within the health systems, and seeking to advance their performance; his emphasis is on Latin-American countries institutional capacity, and in regional and global health organizations. Of special interest are the implications of international trade and other global agreements, on regulation to protect the population from avoidable exposure to risks. He was previously Dean of the School of Public Health of Mexico at the National Institute of Public Health, Director General of the Health Environment and Work Institute – a private consulting and research firm –, Director General at Mexico’s Ministry of Health, and Senior Advisor and Acting Department Director at the Pan American Health Organization (the regional WHO organization). He was a country representative to NAFTA side Agreements, to the Earth Summit of Johannesburg (2002), and to bilateral environmental, food and drugs negotiation with USA and Canada. As an international officer, he contributed to several regional strategies and resolutions (Health and Human Security, Urban Health, Non-communicable Diseases, Childhood Obesity, and the draft Environmental Health Strategy), and to three world summits negotiation of the outcome documents from the UN-High Level Meeting on Non-Communicable Diseases, the regional consultation for the World Conference on Social Determinants of

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Dr. David Savitz, is Professor of Epidemiology in the Brown University School of Public Health, with joint appointments in Obstetrics and Gynecology and Pediatrics in the Alpert Medical School. His epidemiological research has addressed a wide range of many important public health issues including environmental hazards in the workplace and community, reproductive health outcomes, and environmental influences on cancer. He has done extensive work on health effects of nonionizing radiation, pesticides, drinking water treatment by-products, and perfluorinated compounds. He has served as editor at the American Journal of Epidemiology and Epidemiology, and as a member of the Epidemiology and Disease Control-1 study section of the National Institutes of Health. He was President of the Society for Epidemiologic Research and the Society for Pediatric and Perinatal Epidemiologic Research and North American Regional Councilor for the International Epidemiological Association. Dr. Savitz is a member of the National Academy of Medicine. From 2013-2017 he served as Vice President for Research at Brown University. He came to Brown in 2010 from Mount Sinai School of Medicine, where he had served as the Charles W. Bluhdorn Professor of Community and Preventive Medicine and Director of Disease Prevention and Public Health Institute since 2006. Earlier, he taught and conducted research at the University of North Carolina School of Public Health and at the Department of Preventive Medicine and Biometrics at the University of Colorado School of Medicine. Dr. Savitz received his undergraduate training in Psychology at Brandeis University, a Master’s degree in Preventive Medicine at Ohio State University in 1978, and a Ph.D. in Epidemiology from the University of Pittsburgh Graduate School of Public Health in 1982.

Dr. Gina Solomon is a Clinical Professor of Medicine in the Division of Occupational and Environmental Medicine at UCSF. She is also a Principal Investigator at the Public Health Institute. From 2012-2017 she was appointed by Governor Brown as the Deputy Secretary for Science and Health at the California Environmental Protection Agency. Dr. Solomon served as the director of the occupational and environmental medicine residency program at UCSF from 2008-2012, the associate director of the UCSF Pediatric Environmental Health Specialty Unit from 2003-2009, and as a Senior Scientist at the Natural Resources Defense Council (NRDC) from 1996-2012. She serves on the U.S. Environmental Protection Agency’s Board of Scientific Counselors and on the National Academy of Science (NAS) Board on Environmental Studies and Toxicology and the NAS Committee on Emerging Science for Environmental Health Decisions. Dr. Solomon’s work has encompassed cumulative impacts and environmental justice, new tools in toxicology, the health effects of diesel exhaust, endocrine disrupting chemicals, pesticides, environmental contaminants in New Orleans after Hurricane Katrina, the health implications of the 2010 Gulf oil spill, refinery safety, and the health effects of climate change. Dr. Solomon received her bachelor's degree from Brown University, a doctorate of medicine from the Yale University School of Medicine, and a master’s degree in public health from the Harvard School of Public Health.

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Organizing Committee on Toward Understanding the Interplay of Environmental Stressors, Infectious Disease, and Human Health

Dr. Robert Newman (Chair)
Director
Aspen Management Partnership for Health
The Aspen Institute

Dr. John M. Balbus
Senior Advisor for Public Health
National Institute of Environmental Health Sciences
National Institutes of Health

Dr. Meghan Frost Davis
Assistant Professor
Bloomberg School of Public Health
Johns Hopkins University

Dr. Gary Ginsberg
Director
Center for Environmental Health
New York State Department of Health

Dr. Margaret Karagas
James W. Squires Professor and Chair
Department of Epidemiology
Geisel School of Medicine
Dartmouth College

Dr. Melissa Perry
Professor and Chair
Department of Environmental and Occupational Health
Milken Institute School of Public Health
The George Washington University

Dr. Joshua P. Rosenthal
Senior Scientist
John E. Fogarty International Center
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Dr. David A. Savitz
Professor
Department of Epidemiology
Brown University School of Public Health

Dr. John Vandenberg
Director of Research Triangle Park Division
National Center for Environmental Assessment
Environmental Protection Agency
About the Standing Committee

The National Academies’ Standing Committee on Use of Emerging Science for Environmental Health Decisions (ESEHD) examines and discusses issues on the use of new science, tools, and research methodologies for environmental health decisions. Workshops organized by ESEHD provide a public venue for communication among government, industry, environmental groups, and the academic community about scientific discoveries and advances in methods and approaches that can be used in the identification, quantification, and control of environmental impacts on human health. The ESEHD committee is organized under the auspices of Board on Life Sciences and the Board on Environmental Studies and Toxicology of the National Academies, and sponsored by the National Institute of Environmental Health Sciences.

Committee Statement of Task

The Standing Committee will examine, explore, and consider issues on the use of emerging science for environmental health decisions. The Committee will provide a public venue for communication among government, industry, environmental groups, and the academic community about scientific advances in methods and approaches that can be used in the identification, quantification and control of environmental impacts on human health. The topics covered will explore new developments in the life sciences, bioinformatics, modeling, and risk or decision analyses that could be applicable to environmental health decision making. Specifically, the Committee will consider topics that fall within the following four themes: 1) emerging scientific tools or data that may address existing issues in environmental health; 2) emerging areas of science that have not traditionally been applied to environmental health research and issues; 3) current and pressing environmental health issues for which new science, tools, or data may offer new insights, approaches, or solutions; and 4) practical issues facing the environmental health science community as it deals with the emerging science.

The Standing Committee will accomplish its task by convening public meetings of invited experts to inform the Committee and the sponsor about key scientific issues relevant to the use of emerging scientific information, knowledge, and approaches in regulation, disease prevention, education and personal choice, and clinical intervention and management of diseases caused and/or modified by environmental factors. Attendees in the public meetings will include members of government, industry, environmental groups, and the academic community. These public meetings will also be made available to a broader audience via the internet, and highlights of the discussions will be included in short workshop summaries prepared by staff. Specific topics will be selected by the Standing Committee after considering input from NIEHS and its federal partners. The Standing Committee itself will not issue reports, but the Committee may develop recommendations for consideration of future studies that would require separate approval and funding. Should the sponsor and Committee agree that particular issues need more detailed treatment in the form of consensus studies or meetings with reports, such projects will be approved separately by the Academies and will follow the usual Committee formation and report review procedures under the Standing Committee’s oversight. The cost estimate provides for funding of the Standing Committee activity, including public meetings and short workshop summaries.
STANDING COMMITTEE ON THE USE OF EMERGING SCIENCE FOR ENVIRONMENTAL HEALTH DECISIONS

Dr. Kim Boekelheide (Co-chair)
Professor of Medical Science
Director of Superfund Research
Brown University

Dr. Melissa Perry (Co-chair)
Professor and Interim Associate Dean
The George Washington University

Dr. Lesa Aylward
Principal
Summit Toxicology, LLP

Dr. Weihsueh Chiu
Professor
Texas A&M University

Dr. Kevin Elliott
Associate Professor
Michigan State University

Dr. Gary Ginsberg
Director
Center for Environmental Health
New York State Department of Health

Dr. Norbert Kaminski
Professor
Director of the Institute for Integrative Toxicology
Michigan State University

Dr. Margaret Karagas
James W. Squires Professor and Chair
Geisel School of Medicine
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Dr. Patrick McMullen
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ScitoVation

Dr. Gary Miller
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Dr. Kristi Pullen Fedinick
Staff Scientist
Natural Resource Defense Council

Dr. Reza J. Rasoulpour
Toxicology and Risk Assessment Leader
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Dr. Gina M. Solomon
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Dr. William Farland
Senior Vice President for Research
Colorado State University

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STANDING COMMITTEE ON THE USE OF EMERGING SCIENCE FOR ENVIRONMENTAL HEALTH DECISIONS

Committee Biographies

Kim Boekelheide, Ph.D. (co-chair) is professor of Pathology and Laboratory Medicine at the Brown University School of Medicine. He received his B.A. from Harvard University, and M.D. and Ph.D. from Duke University. His research examines fundamental molecular mechanisms by which environmental and occupational toxicants induce testicular injury. Current projects include the development of novel in vitro approaches to safety assessment, use of xenotransplantation approaches for human-relevant toxicity testing, and the discovery of sperm molecular biomarkers that reflect testicular injury. He is Director of the Brown University Superfund Research Program. His research has been continuously funded by the National Institute of Environmental Health Sciences since 1985, and he has received several awards including a Burroughs Wellcome Toxicology Scholar Award (1994-1999).

Melissa Perry, ScD, MHS, (co-chair) is Professor and Chair of the Department of Environmental and Occupational Health in the Milken Institute School of Public Health at the George Washington University (GWU). Before joining GWU, she spent 13 years on the Harvard School of Public Health's Department of Environmental Health faculty. As an environmental and occupational epidemiologist, Dr. Perry's research focuses on the health impacts of environmental chemicals with particular focus on reproduction, and on the prevention of occupational injuries and disease. Her lab at GW examines environmental impacts on sperm and male fertility. She is the Chair of the Board of Scientific Counselors for the National Center for Environmental Health/Agency for Toxic Substances and Disease Registry of the Centers for Disease Control and Prevention; co-chair of the National Academies of Sciences’ Committee on Emerging Science for Environmental Decisions; a Fellow of the Collegium Ramazzini; and a member of the Technical Advisory Board for the Center for Construction Research and Training (CPWR). She has served as President of the American College of Epidemiology and as a standing member of the National Institute for Occupational Safety and Health study section. She is currently an associate editor of Environmental Health Perspectives and an editorial board member of Environmental Health. She received her BA from the University of Vermont, and her MHS and ScD from The Johns Hopkins University School of Hygiene and Public Health.

Lesa L. Aylward, Ph.D., is an Honorary Associate Professor with a joint appointment between Queensland Children’s Medical Research Institute and the National Research Center for Environmental Toxicology (Entox) and a Principal at Summit Toxicology, LLP. Dr. Aylward’s research interests include the development and application of toxicokinetic models and the use of biomonitoring for tracking exposure to chemicals in the environment, foods, and consumer products. She has published extensively on the development of tools for the interpretation of
biomonitoring data in a risk assessment context and the use of biomonitoring as an exposure assessment tool in epidemiological studies. Her current research interests include evaluation of the sources of and factors influencing inter- and intra-individual variation in chemical biomarker concentrations with a focus on the design and implementation of biomonitoring for exposure characterization in epidemiological studies. She has several current collaborations with Entox researchers on the use of human biomonitoring to characterize chemical exposures in the Australian general population and in occupationally exposed groups.

**Weihsueh Chiu**, Ph.D., is a professor in the Department of Veterinary Integrative Biosciences at the Texas A&M University. His research focuses on the development of quantitative, data-driven approaches for understanding and predicting the human health effects of environmental chemicals. Specifically, his research applies computational and statistical methods to transform data into knowledge used to protect public health. He also has an interest in approaches to estimate the variability in individual susceptibility to environmental exposures, so as to better protect sensitive subpopulations.

**Kevin Elliott**, PhD, is an Associate Professor at Michigan State University with joint appointments in Lyman Briggs College, the Department of Fisheries and Wildlife, and the Department of Philosophy. He received his PhD in History and Philosophy of Science from the University of Notre Dame. His research lies at the intersection of the philosophy of science and practical ethics, with an emphasis on critically examining the ways in which ethical and social values influence science and technology. Much of his work has focused on policy-relevant areas of research on environmental pollution. Since 2014, he has been serving as a member of the Advisory Council for the National Institute of Environmental Health Sciences, and he is the Program Chair for the 2018 Biennial Meeting of the Philosophy of Science Association. He has authored a wide range of articles and book chapters and has published two books with Oxford University Press: *Is a Little Pollution Good for You? Incorporating Societal Values in Environmental Research* (2011) and *A Tapestry of Values: An Introduction to Values in Science* (2017). He has co-edited two other books: *Exploring Inductive Risk: Case Studies of Values in Science* (with Ted Richards, Oxford University Press, 2017) and *Current Controversies in Values and Science* (with Dan Steel, Routledge Press, 2017).

**Gary Ginsberg**, Ph.D., is Director of the Center for Environmental Health New York State Dept of Health and a lecturer at the Yale School of Public Health. Prior to this he was a toxicologist for the Connecticut Department of Public Health. He serves on a number of national committees including US EPA’s Science Advisory Board (2008-present) and the National Academies’ Biomonitoring committee (2004-2006), USEPA Risk Methods committee which produced Science and Decisions (2006-2008), and Inorganic Arsenic Risk Assessment committee (2012-2015). He also served on USEPA’s Children’s Health Protection Advisory Committee (2004-2009) and has been an external reviewer on a number of USEPA IRIS documents. Dr. Ginsberg has been called on by other federal agencies to provide reviews including OSHA (silica workplace standard), CPSC (cadmium in children’s jewelry) and FDA (dental amalgam). His risk assessments on fish contaminants, synthetic turf fields, acrylamide, cadmium, and assessments pertaining to risks in children and those with genetic polymorphisms have been published in peer reviewed journals. Dr. Ginsberg co-authored a book for the lay public called “What’s Toxic, What’s Not” (Berkeley Books, 2006). Dr. Ginsberg is a member of the standing committee, ESEHD, that this activity stems from.
Norbert E. Kaminski, PhD, is the Director of the MSU Institute for Integrative Toxicology and a Professor in the Department of Pharmacology and Toxicology. Dr. Kaminski is a member of the Society of Toxicology and Immunotoxicology Specialty Section, the American Association of Immunologists and the International Cannabinoid Research Society. He served as President of the SOT from 2014-2015. Dr. Kaminski currently serves on the NIEHS National Advisory Environmental Health Sciences Council, and is on the External Advisory Committee of the Oregon State University Superfund Center Grant. Dr. Kaminski was an Associate Editor for the Journal of Pharmacology and Experimental Therapeutics and was also on the editorial board for Toxicological Sciences, International Immunopharmacology, and Nonlinearity in Biology-Toxicology-Medicine. He has served on various scientific advisory committees including the National Academy of Sciences Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides, the U.S. Environmental Protection Agency Science Advisory Board for the Dioxin Reassessment Review, the Health Effects Task Group for NSF International, and the National Academy of Sciences Committee to review EPA’s Exposure and Human Health Reassessment of TCDD and Related Compounds. Dr. Kaminski served on the Board of Trustees for the International Life Sciences Institute-Health and Environmental Sciences Institute from 2003 to 2012. Dr. Kaminski is a faculty trainer for the NIEHS training grant.

Margaret R. Karagas, PhD, is Professor and Department Chair of Epidemiology at the Dartmouth College Geisel School of Medicine, and Director of the Children’s Environmental Health and Disease Prevention Research Center and Center of Molecular Epidemiology at Dartmouth. She also currently leads a project in the Dartmouth Superfund Program. Dr. Karagas’ research encompasses interdisciplinary studies to illuminate the etiology of human cancers, along with adverse pregnancy and children’s health outcomes. Her work seeks to identify emerging environmental exposures, host factors and mechanisms – that impact health from infancy to adult life, and to apply novel methods and technologies to understand disease pathogenesis. Among her current investigations are population-based studies of the temporal increases in the incidence rates keratinocyte cancers in the US and the contribution of widespread exposures such as indoor tanning, as well as drinking water contaminants. More recently she established a cohort of pregnant women and their offspring in New Hampshire to assess the sources and potential health impacts of arsenic and other factors i.e., on childhood infection, allergy/atopy, growth and neurodevelopment through the Children’s Center. The cohort entails multiple collaborative studies of exposure biomarkers, individual susceptibility, and biological response to environmental agents including the developing microbiome and immune response. Dr. Karagas received her Ph.D. from the University of Washington.

Patrick McMullen, PhD, has a keen interest in leveraging high-content biological experiments (gene expression studies, high-throughput screens, imaging, and other sources) into a mechanistic understanding of the underlying biology. His background in molecular biology, engineering and programming has been instrumental in interpreting and communicating complex data problems in diverse applications. He manages a diverse computational biology team that uses modeling and high-content data to deepen our understanding of how chemicals interact with biological systems. His group combines expertise and tools from different disciplines to develop innovative strategies for using large-scale data to solve problems related to chemical and drug safety and efficacy.
Gary Miller, PhD, is a Professor of Environemental Health Sciences and Vice Dean for Research Strategy and Innovation at Columbia University. He completed his doctoral training in Pharmacology and Toxicology and postdoctoral training in Molecular Neuroscience. His research has focused on environmental factors involved in the development of neurodegenerative conditions, such as Parkinson’s disease. His laboratory works at the interface of neuroscience and toxicology, using a wide variety of experimental techniques. Dr. Miller was previously Director of the Emory HERCULES center, an NIEHS-funded center focused on the exposome, the environmental analogue to the genome. He also served as Director of Emory’s NIEHS-funded T32 Training Grant in Environmental Health Sciences and Toxicology. Dr. Miller received the Achievement Award from the Society of Toxicology and previously was Editor-in-Chief of Toxicological Sciences, the official journal of the Society of Toxicology.

Kristin Pullen-Fedinick, PhD., is a staff scientist in the Health and Environment Program at the Natural Resources Defense Council and a Professorial Lecturer in the Department of Environmental and Occupational Health of the Milken Institute School of Public Health at The George Washington University. Kristi Pullen Fedinick’s research career includes experience in molecular, structural, and computational biology; biochemistry; and population health. Prior to joining NRDC, she worked as a scientist for a Chicago-based environmental non-profit, where she focused on air and drinking water quality, science communications, and environmental justice. Her current work focuses on the use of high-throughput technologies, predictive toxicology, and computational approaches to chemical risk assessments. Additional work includes the geospatial and statistical analysis of chemicals in the environment, with a particular emphasis on drinking water, and on the disproportionate impact of chemical exposures in vulnerable populations. She holds a bachelor’s degree in biochemistry and molecular biology from the University of Maryland, Baltimore County, and a PhD in molecular and cell biology from the University of California, Berkeley. She was a Robert Wood Johnson Foundation Health and Society Scholar at the Harvard School of Public Health.

Reza J. Rasoulpour is the Leader of Global Regulatory for the Crop Protection Business Platform, within Research & Development, for the Agriculture Division of Dow-DuPont, as a heritage Dow AgroSciences (DAS) employee. His current responsibilities include leading a team of global regulatory scientists, global chemical legislation and hazard communications, and regulatory program managers to deliver strategic guidance to the crop protection business and be the conduit between the business and regional regulatory teams and the global regulatory sciences organization. Previously, Rasoulpour was the Global Leader for the Predictive Safety Center at DAS, which he helped establish as a cross-disciplinary team of regulatory scientists who partner with R&D Discovery to design products with more favorable environmental and human health safety profiles. Dr. Rasoulpour joined Dow in 2007 with a background in reproductive toxicology and molecular biology. Dr. Rasoulpour’s primary research focus has been in leading in silico, in vitro, and in vivo approaches to discover and develop products with a more favorable human health and environmental profile. Areas of exploration have included toxicogenomic, epigenetic, toxicokinetic, and systems biology research programs to accelerate pipeline product development as well as investigative mode-of-action research to characterize molecular mechanisms and their impact to product safety assessment. Dr. Rasoulpour currently serves as an appointed member on the National Academy of Sciences (NAS) Emerging Science for Environmental Health Decisions standing committee (2016 to present) as well as the NAS Board of Environmental Studies and Toxicology (2017 to present), he is on the editorial board of the Environmental and Molecular Mutagenesis
journal (2017 to present), was nominated to the Society of Toxicology Membership Committee (2016 to present), and served as Jr/Sr Councilor of the Reproductive and Developmental Toxicology Specialty Section for SOT (2014-2015). He has organized numerous symposia and workshops at the Society of Toxicology meetings, has served as an invited speaker and panelist for scientific sessions at the National Academy of Sciences, ICCA-LRI workshops, ILSI-HESI, ECETOC, Crop Life America, Society for Toxicologic Pathology, and the Teratology Society. To date, he has authored/coauthored 39 peer-reviewed publications to the scientific literature, as well as authored a book chapter on the topic of male reproductive biology. Dr. Rasoulpour earned a B.S. from the University of Connecticut, where he received the title of University Scholar, the university’s highest academic honor. He then embarked on researching reproductive toxicology in the laboratory of Kim Boekelheide and was awarded his Ph.D. from Brown University.

Gina M. Solomon, M.D., M.P.H., is a principal investigator at the Public Health Institute in Oakland, California, and a Clinical Professor of Medicine at the University of California, San Francisco. She served as the Deputy Secretary for Science and Health at the California Environmental Protection Agency from 2012-2017. Dr. Solomon’s work has spanned a wide array of areas, including children’s environmental health, reproductive toxicity, cumulative impacts, and the use of novel data streams to screen chemicals for toxicity. Her work has also focused on exposure science for air pollutants, pesticides, mold, and metals in soil, and on the health effects of climate change. She was involved in the aftermath of Hurricane Katrina, the Gulf oil spill, and the Chevron Richmond explosion and fire, and she successfully spearheaded regulations to improve refinery safety in California. Dr. Solomon has served on multiple boards and committees of the National Academies, the EPA Science Advisory Board, and the National Toxicology Program’s Board of Scientific Counselors. She also serves on the EPA Board of Scientific Counselors Chemical Safety for Sustainability subcommittee. Dr. Solomon received her MD from Yale and completed her MPH and her residency and fellowship training in internal medicine and occupational and environmental medicine at Harvard.
Upcoming Workshops

The Promise of Single Cell and Single Molecule Analysis Tools to Advance Environmental Health Research; March 7-8, 2019

This workshop will explore the current status of this rapidly evolving field of study, review the preliminary use of single cell and single molecule analysis tools in environmental health studies, and investigate the resources needed to make the data generated most useful to the biomedical and public health fields and to regulatory decision makers.


Workshop organizing committee: Norbert Kaminski (Chair), Michigan State University; Lesa Aylward, Summit Toxicology; Sudin Bhattacharya, Michigan State University; Kim Boekelheide, Brown University; M. Selim Ünlü, Boston University; Ramnik Xavier, Harvard Medical School.

NAS Staff Lead: Andrea Hodgson, Board on Life Sciences; Keegan Sawyer, Board on Life Sciences

Emerging Advances in Artificial Intelligence for Environmental Health Research and Decisions; June 6-7, 2019

An ad hoc committee will organize and convene a public workshop to discuss how artificial intelligence (AI) and machine learning (ML) can be leveraged to advance environmental health research and inform decisions. The workshop will explore emerging applications and evidence on the use of AI and machine learning to improve data processing methods, predictive models, and discovery in environmental health.

The workshop will also examine the implications AI and machine learning for decision-making, considering factors that may affect confidence in decisions, such as a clearly defined scientific process and workflow, bias in available data, algorithmic transparency and interpretability, and the capability to detect false results. The workshops will include presentations and panel discussions on important environmental health topics such as:

- Characterizing and monitoring sources of pollution
- Predicting chemical toxicity
- Identifying hazards
- Estimating human exposures
- Understanding relationships between exposures and biological effects

Workshop organizing committee: To be announced in late January

NAS Staff Lead: Ben Wender, Board on Mathematical Sciences and Analytics and the Board on Energy and Environmental Systems; and Elizabeth Boyle, Board on Environmental Studies and Toxicology; Keegan Sawyer, Board on Life Sciences
Have an Idea for a Future Workshop Topic?

Please share it with us.

The Standing Committee on Emerging Science for Environmental Health Decisions (ESEHD) is a forum that examines the potential to use new science, tools, and research methodologies to inform environmental health decisions. Our workshops provide a venue for government agencies, industry representatives, environmental groups, and the academic community, among others to explore promising scientific discoveries and advances that facilitate the identification, quantification, and control of environmental stressors on human health. We focus our discussions on how the emerging science may be used by consumers, public health officials, policy makers, regulators, or others to make more informed decisions.

The standing committee needs the ingenuity of scientists and policy experts from all disciplinary backgrounds. We welcome your ideas for workshop topics that address any of the following:

- New scientific tools, technologies, data, or methodologies that have the potential to address environmental health questions
- New scientific advances or discoveries developing that has the potential to transform how environmental health questions are addressed
- Scientific disciplines or technologies that traditionally have not been widely applied or integrated into environmental health research

Share your idea.

Your Name & Affiliation:

What topic or questions should we consider for a future workshop?

How does your suggestion bring together “emerging science” and “environmental health decisions”??

Who are some key experts or groups we might talk with to further develop this topic?

What are some other suggested resources that could help us explore this topic further (i.e. research publications, news articles, videos, agency programs, etc.)?

May we contact you if we have any questions? If yes, please provide your email address.

Please submit your form to an ESEHD staff member, or email us your ideas at eseh@nas.edu