Challenges and Opportunities in implementing the Exposome

David M. Balshaw, PhD
Program Director,
Center for Risk and integrated Sciences
National Institute of Environmental Health Sciences
The environmental contribution to ‘complex’ diseases

“Advancing environmental health research offers us the best opportunity for preventing disease – because you can’t change your genes, but you can change your environment.”

Linda S. Birnbaum, Director, NIEHS

The environmental contribution to ‘complex’ diseases

- Environmental Toxicants
- Genetic Vulnerability
- Other Diseases
- Development and Age
- Drugs
- Behavior
- Nutrition

Healthy to Diseased transition...
What is NIEHS doing?

**Strategic Goal 3:** Transforming exposure science

- Advance characterization of environmental exposures through **improved exposure assessment** at both the individual and population levels
- Define and disseminate the **concept of the exposome**
- Create **tools and technologies**, and the research **capacity**, needed to **characterize the exposome**
### The Complexities of Exposure

<table>
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<tr>
<th><strong>Stressor:</strong></th>
<th>Physical, Chemical, Biological, Psycho-social</th>
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<tbody>
<tr>
<td><strong>Source:</strong></td>
<td>Air, Water, Soil, Food, Consumer Products, Drugs</td>
</tr>
<tr>
<td><strong>Place:</strong></td>
<td>Home, School, Work, Neighborhood, Community, City, State, Region</td>
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<tr>
<td><strong>Time:</strong></td>
<td>Fetal, Child, Adolescent, Young Adult, Adult, Older-adults, Elderly</td>
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<tr>
<td><strong>Route of Contact:</strong></td>
<td>Skin, Lungs, Diet</td>
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<tr>
<td><strong>Distribution:</strong></td>
<td>Lungs, Neuro, Skin, GI, other organs</td>
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<td><strong>Targets:</strong></td>
<td>Biological pathways</td>
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The Exposome (Wild, 2005): The totality of exposure an individual is subjected to from conception to death…the ‘environmental’ correlate to the genome.
There are multiple conceptualizations of the EXPOSOME…

<table>
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<th>Conceptualization</th>
<th>Description</th>
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<td><strong>Wild</strong></td>
<td>All life-course environmental exposures from prenatal period onwards; includes internal body processes, external exposures, and lifestyle factors.</td>
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<td><strong>Rappaport and Smith</strong></td>
<td>Total exposures throughout life, where the “environment” is the body’s internal chemical environment and “exposures” are all the biologically active chemicals in this internal environment.</td>
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<tr>
<td><strong>Buck Louis</strong></td>
<td>Mixture of environmental exposures, including man-made and naturally occurring chemicals, physical agents (e.g., noise, vibration, temperature), macro level factors (e.g., population density, sanitation), and lifestyle factors.</td>
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<td><strong>Miller</strong></td>
<td>Measurable environmental influences and cumulative biological responses throughout lifespan; includes exposures from the environment, diet, behavior, and endogenous processes.</td>
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<td><strong>NRC Report</strong></td>
<td>“Eco-exposome” extends concept from point of contact between stressor and receptor, inward into organism and outward to general environment.</td>
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... and a need to develop a unifying conceptual framework.
Common Elements of The Exposome Concept

Measure as much as you can, if not ‘the totality’
• Multiple stressors

Identify stressors that impact health
• Data Driven (untargeted) Discovery

Multi-scale Integration
• Multiple time points
• Exposure and Response
Challenges

**Sociological**
- Advancing and defining the exposome concept
- Integration of different stakeholder perspectives
- Willingness to do untargeted discovery

**Technological**
- Integration external exposure and internal response
- Technologies for multi-analyte exposure assessment
- Conceptual frameworks for data-driven and untargeted analysis
- Advances in statistical methods to handle the complex, interrelatedness, and dynamic nature of exposure data

**Logistical**
- Time scale: Lifetime; Windows of Susceptibility; Prospective vs. Retrospective
- Sample collection, size, power and analysis
- Collaboration and Data sharing
Activities and Opportunities at NIEHS

Promoting the Concept
- Strategic Plan Focus
- Numerous presentations/sessions and symposia

Developing and Translating the Capacity
- Tools and Technologies for multi-scale measurements
- Big Data Science and methods for integration and discovery

Coordination
- Trans-NIEHS and –NIH working groups
- Interagency Coordinating Committee on Exposure Science
- International Coordination with EU Framework 7 Programmes
Thank you for listening.

Any questions?