



ISES-SETAC  
Europe  
Milan 2011

# Linking sources with outcomes: The science of stressors and receptors

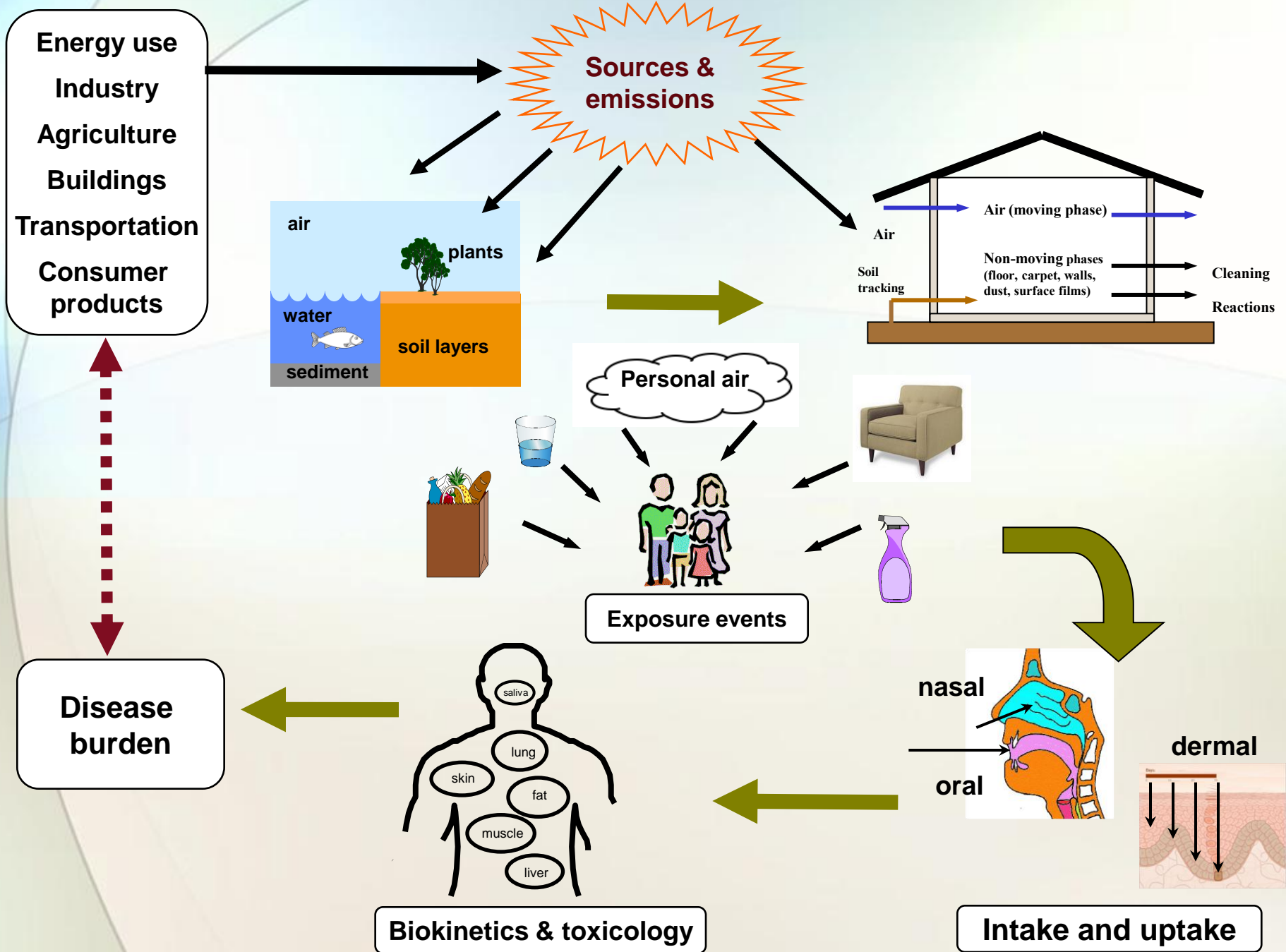
Thomas E. McKone  
University of California and  
Lawrence Berkeley National Laboratory  
Berkeley CA, USA



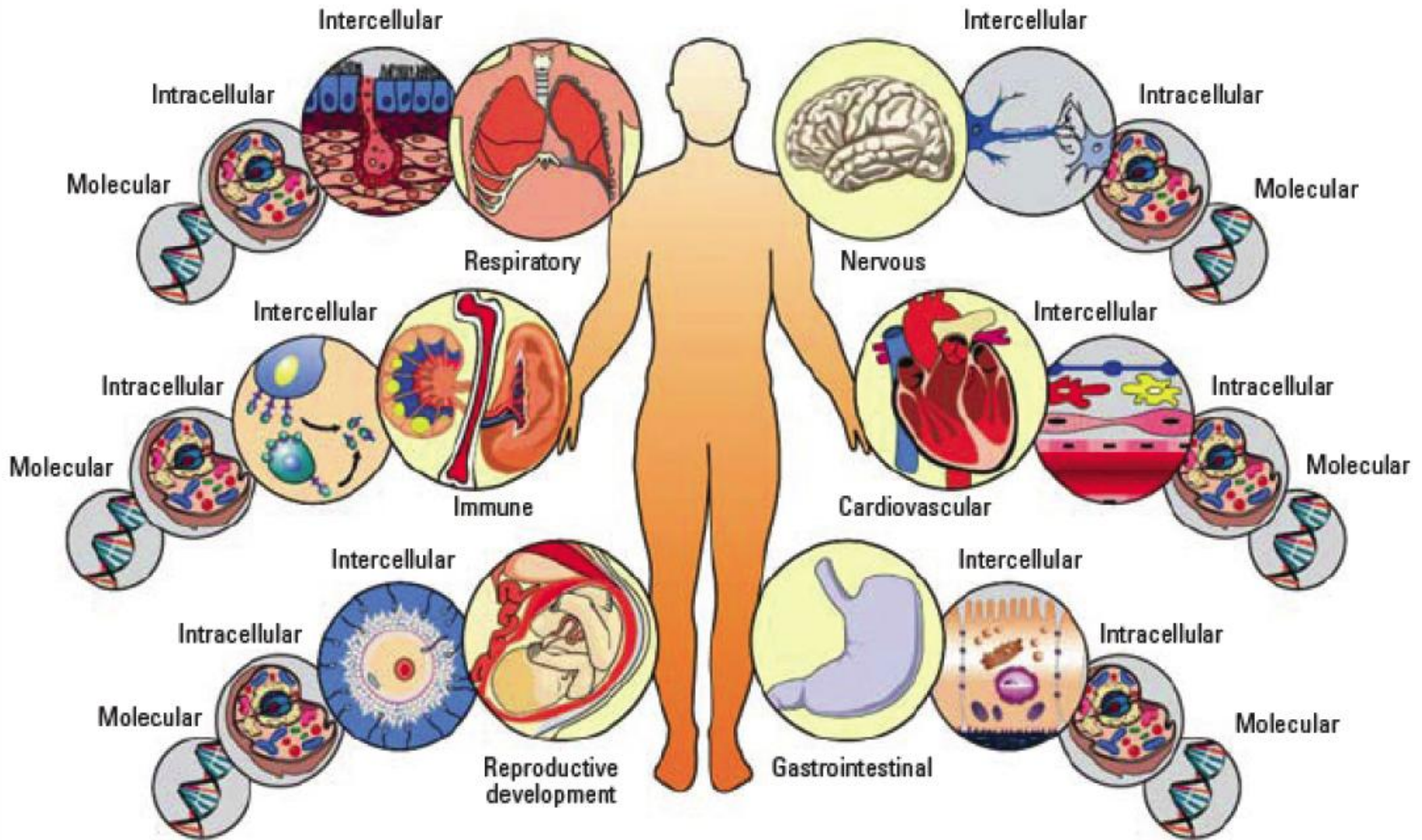
International Society  
of Exposure Science  
*Science for Better Environmental Health*

# Recent Advances as Opportunities

- **Rapidly expanding biomarkers data—the “omics” (in humans, animals, and plants)**
- **Exposure surveys, useful but incomplete data**
- **Geographical positioning (GPS) and information (GIS) technologies to track both people and pollutants**
- **Advances in the theory and applications for environmental chemistry**



# Exposure Biology



The goal of systems biology is to integrate the data so that eventually a model of the whole system can be developed  
RISK ANALYSIS ISSUES & REVIEWS The Newsletter of the Standing Committee on Risk Analysis Issues and Reviews Issue 4  
December 2009

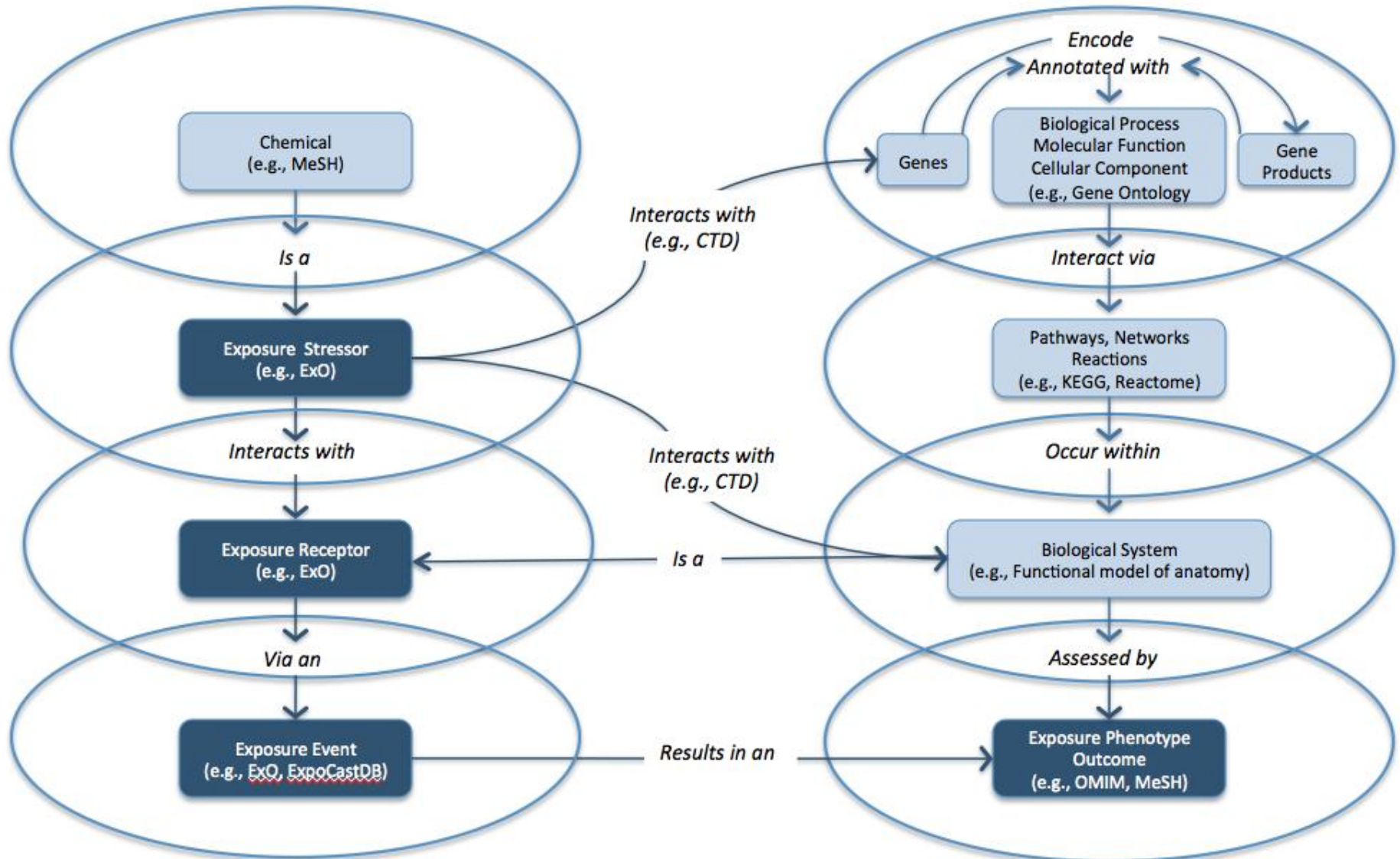
# Organizing Terminology: An Exposure Ontology

An ontology is a controlled vocabulary of well-defined terms with specified relationships between them capable of interpretation by both humans and computers.

Many sciences (chemistry, urban planning, genomics, medicine, etc) have established ontologies

# Proposed Exposure Ontology

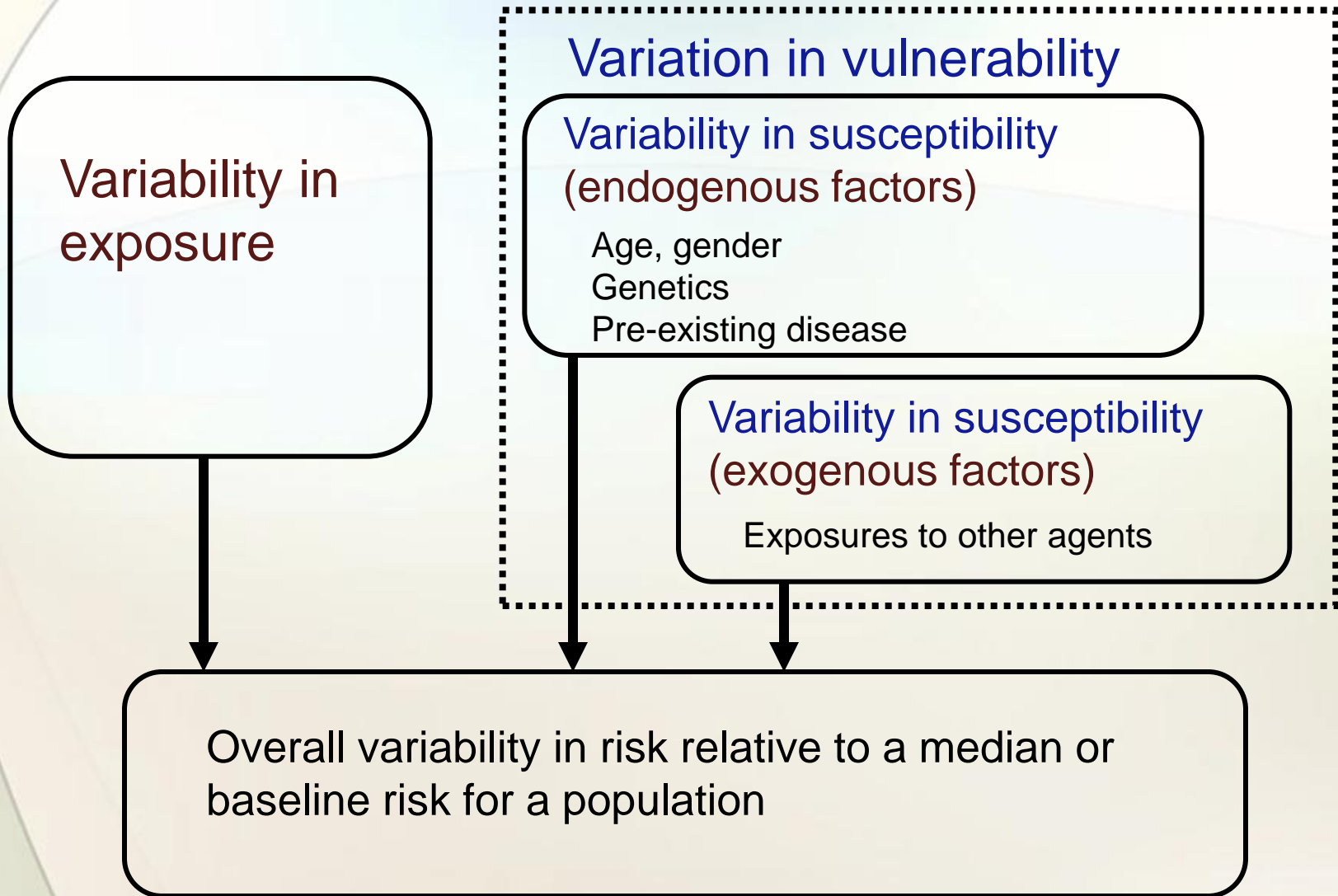
Mattingly et al. 2011. Design and evaluation of ExO: An ontology for exposure science. *Environmental Health Perspectives* (in press).



# Elements of Exposure Science

- **Exposure Stressors**
  - What are they and how do they relate to outcome
  - Chemical, physical, biological agents and/or
  - Social, economic, psychological?
- **Exposure Receptors**
  - Humans (individuals, populations, communities, etc)
  - Building, water resources, ecosystems, species, forests,
  - organs, tissues, cells
- **Exposure Events**
  - Space, time, and locations (global, regional, local, individual, internal)
- **Exposure Outcome**

# Variability, Susceptibility, Vulnerability



# Multiple Stressors

- **Cumulative impacts from multiple substances with the same mode of action**

The issue of cumulative exposure, aggregate risk

- **Staged sequence of harm caused by stressors with different modes of action**

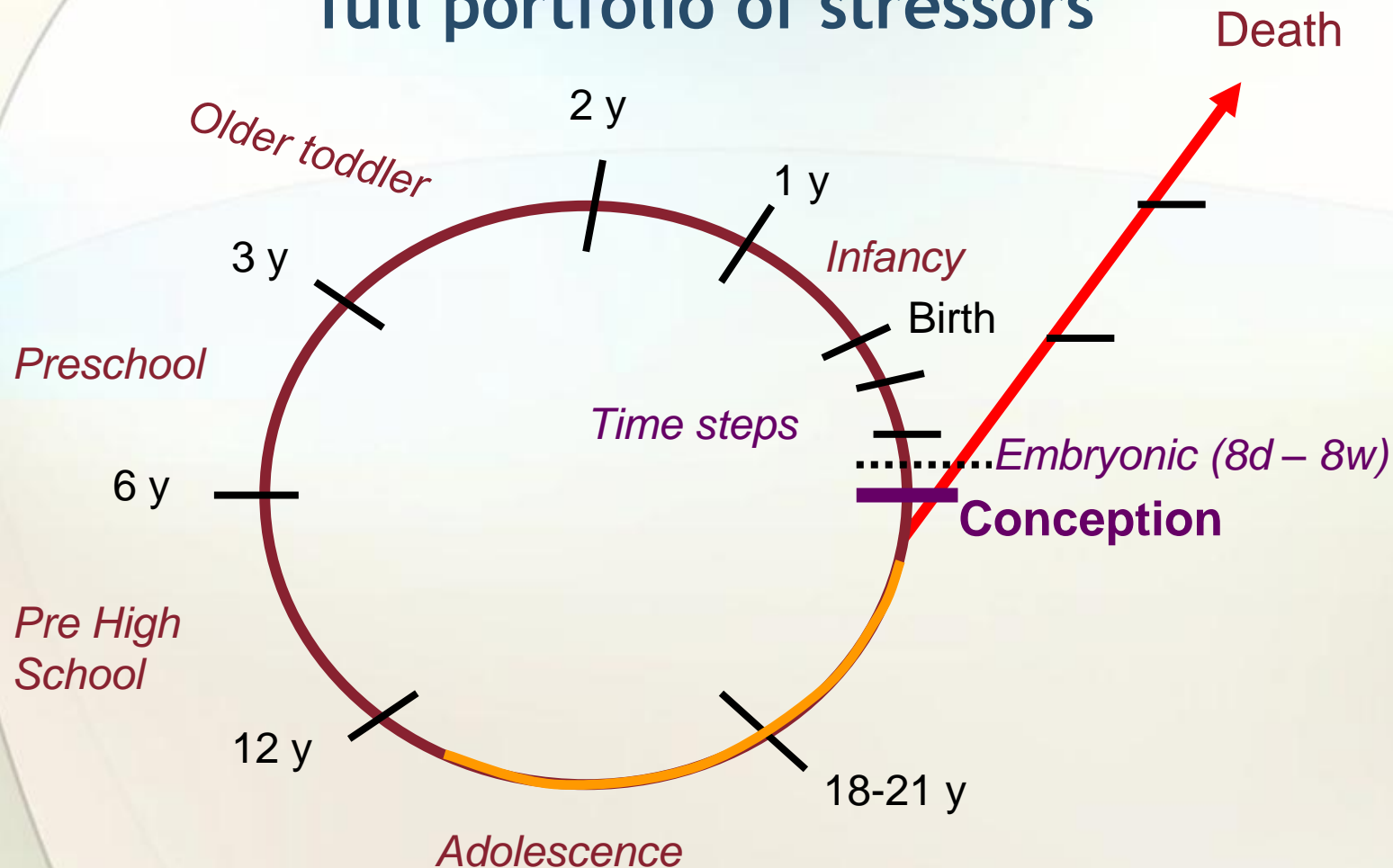
Synergy can be negative/positive/additive/unknown

- **Stressors with two modes of action—one good one bad**

Alcohol, breast milk (PCBs), etc

# Exposome

A lifetime narrative of exposure events to a full portfolio of stressors



Modification of a diagram used in 2002 by Dr. Larry Needham to explain the goals of biomonitoring to the California Environmental Health Tracking Expert working group.

# Hypothesis-Based Research in Exposure Science

**Must be built on refutable hypotheses--Avoid theories/models that are “immune to refutation” [Oreskes]**



**Human exposure is an open system,** one where all parameters are not and often cannot be identified and known in adequate detail

At best, we can confirm (not prove) hypotheses--that is, predicted exposures are consistent with those observed

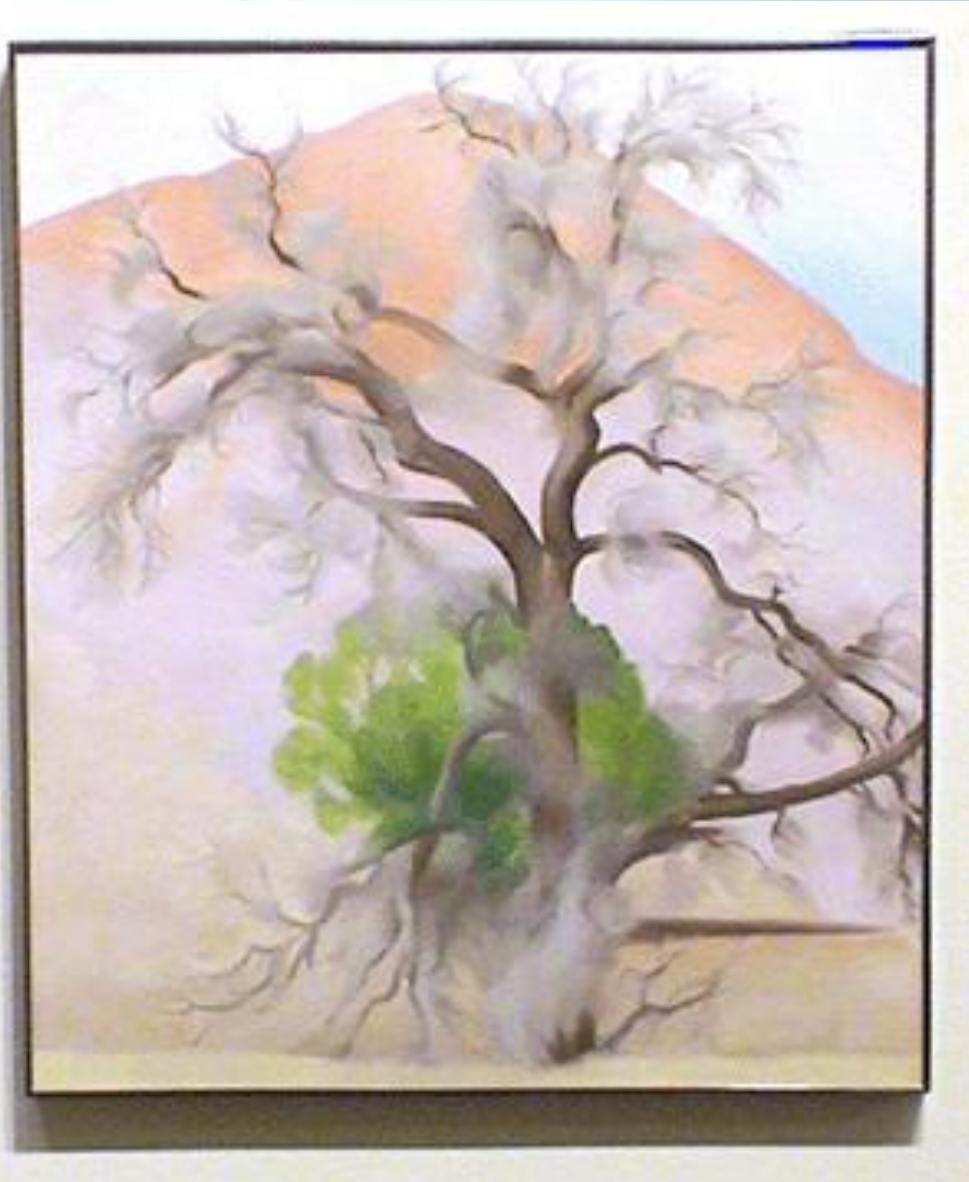
# Where from Where to?

- **The past: exposure assessment—predominantly descriptive**
- **The future of exposure science—hypothesis-based research**
  - **Ontology**
  - **Exposome—exposure narrative**
  - **Exposure Science in the 21<sup>st</sup> Century**

# Managing Lots of Information



# Perspective from an Artist



"Nothing is less real than realism ... It is only by selection, by elimination, by emphasis that we get at the real meaning of things."

-- Georgia O'Keeffe

(from a talk by Pasky Pascual of EPA)

# Thank you

temckone@lbl.gov

Funded in part by the American  
Chemistry Council Long Range  
Research Initiative



