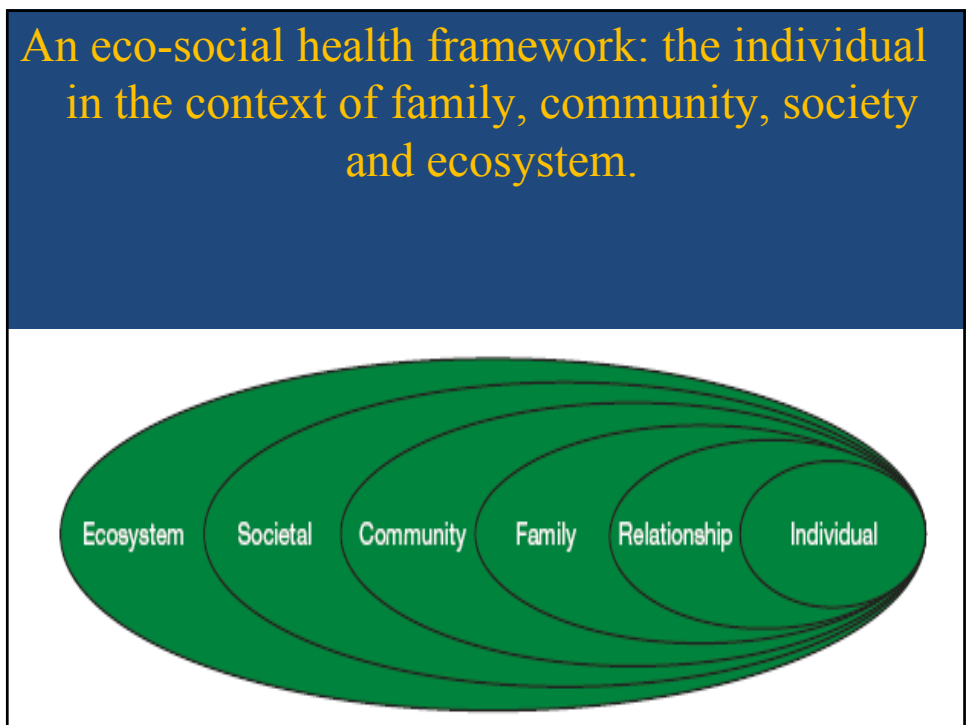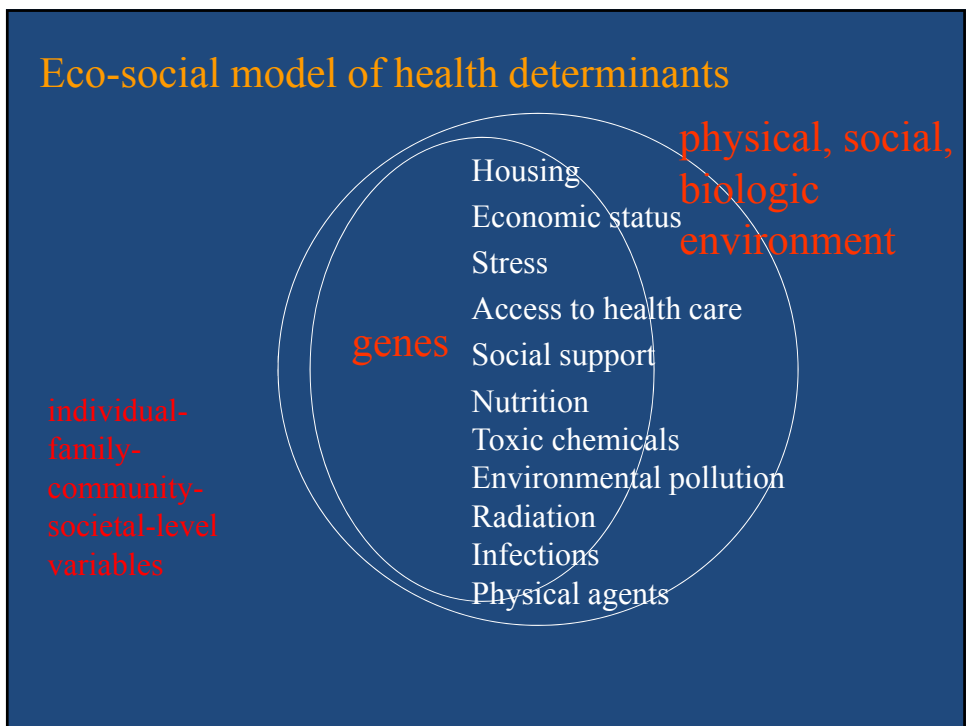# Health and the Environment: A Call to Action

Ted Schettler MD, MPH
CHA Webinar
Oct. 6, 2010

SCIENCE
& ENVIRONMENTAL
HEALTH
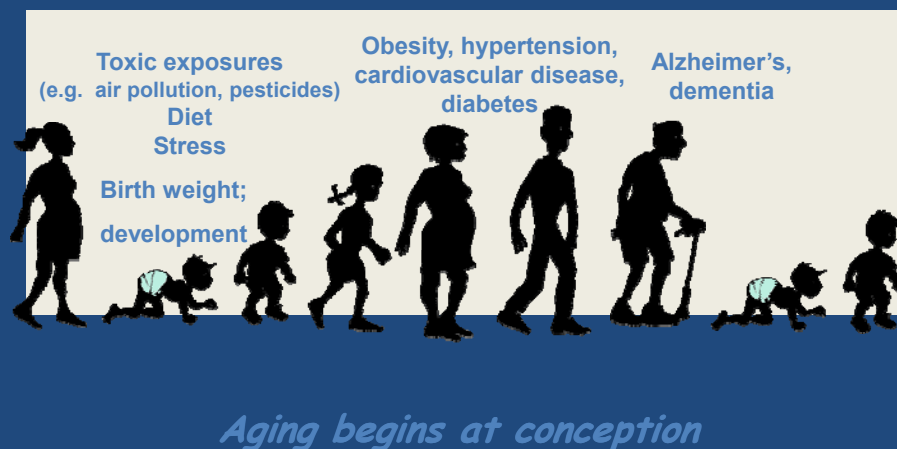NETWORK

www.sehn.org

Outline

- Eco-social model of health
- Environmental factors
  - Environmental chemicals/pollutants
  - Diet/nutrition
  - Built environment
  - Psychosocial environment
- Challenges: aggregate exposures, cumulative impacts
- Responses; opportunities

Eco-social model of health determinants

physical, social, biologic environment

Housing
Economic status
Stress
Access to health care
genes Social support
Nutrition
Toxic chemicals
Environmental pollution
Radiation
Infections
Physical agents

individual-
family-
community-
societal-level
variables

An eco-social health framework: the individual in the context of family, community, society and ecosystem.

Ecosystem | Societal | Community | Family | Relationship | Individual

The eco-social health framework extended to the subcellular level.

Ecosystem | Societal | Community | Family | Relationship | Individual

Individual | Organ system | Cell | Organelle | Cell Signaling

Unique windows of vulnerability

TOXICANTS

INFECTIONS

NUTRITION

GENETICS

SOCIAL ENVIRONMENT

Childhood health, illness

?

Adult health, illness

Cardiovascular disease
Diabetes
Cancer
Neurodegenerative disease
Etc.

Early life experiences can influence later-life health, disease

Toxic exposures
(e.g. air pollution, pesticides)
Diet
Stress

Obesity, hypertension, cardiovascular disease, diabetes

Alzheimer's, dementia

Birth weight;

development

Aging begins at conception

Exposures to environmental chemicals are common

CDC:

Reports on levels of 212 chemicals in a representative sample of the US population

2009

Fourth National Report on Human Exposure to Environmental Chemicals

Executive Summary

Department of Health and Human Services
Centers for Disease Control and Prevention
National Center for Environmental Health

http://www.cdc.gov/exposurereport/
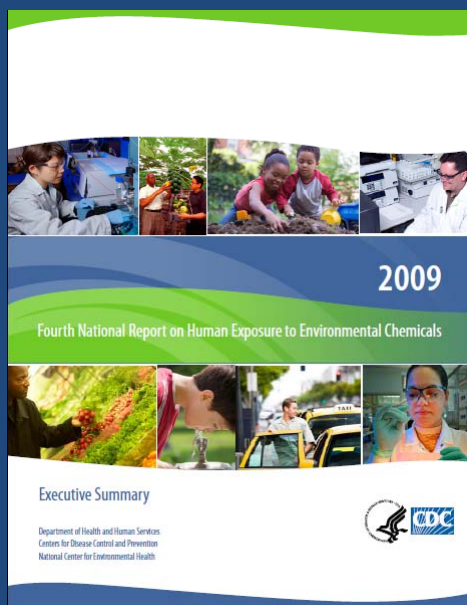
BodyBurden
The Pollution in Newborns

A benchmark investigation of industrial chemicals, pollutants, and pesticides in human umbilical cord blood

www.ewg.org

10 random specimens of cord blood

Environmental Working Group; 2004

Body burden: the pollution in newborns

- Tested for 413 chemicals
- 287 chemicals detected; 200 average
- Carcinogens,
- Developmental toxicants
  - Birth weight
  - Birth defects
  - Impaired neurodevelopment, etc.
- Impacts of this mixture unstudied and unknown

Manifestations of abnormal development

- Fetal death
- Low birth weight; e.g. maternal smoking, air pollution, some pesticides
- Birth defects; e.g., pesticides, solvents
- Cancer; leukemia and maternal pesticide exposures, paternal exposure to carcinogens
- "Functional" abnormalities; e.g., neurodevelopment; reproductive, immune, respiratory, and cardiovascular systems, etc.
- Increased susceptibility to adult disease

Neurodevelopmental problems

- Nearly 17% of children under age 18 in the US suffer from one or more developmental disabilities
- Learning disabilities alone affect 5-10% of children in public schools
- ADHD conservatively affects 3-8% of all school children; CDC reported 7.8% in 2003 (ages 4-17)
- Marked increase in autism spectrum disorders not fully explained by changes in diagnostic criteria or increased reporting

Lead, alcohol, nicotine

- Alcohol – hyperactivity, cognitive deficits
- Nicotine – IQ deficit, learning and attention deficits
- Lead – impaired IQ, learning, attention; hyperactivity, impulsiveness, aggression; failure to complete school, trouble with the law (males more susceptible to behavioral effects; steeper drop in cognition at lower levels)
- Tobacco plus lead: 8 fold increase in ADHD risk

Lead

Cumulative occupational exposure

- ↑ cognitive impairment Shih 2007
- 2x risk Parkinson's Coon 2006

Cumulative community exposure

- ↑cognitive impairment Shih 2006
- Up to 15 years inc. cognitive aging (MMSE) Weisskopf 2004
- Impacts are greater in people living in stressful neighborhood Glass, 2009

Animal studies of early life exposure

- Rodents: Late-life Alzheimer's markers: amyloid precursor protein , amyloid B (Basha 2005, Lahiri 2007)
- Primates: same plus plaques (Wu, J Neurosci, 2008)
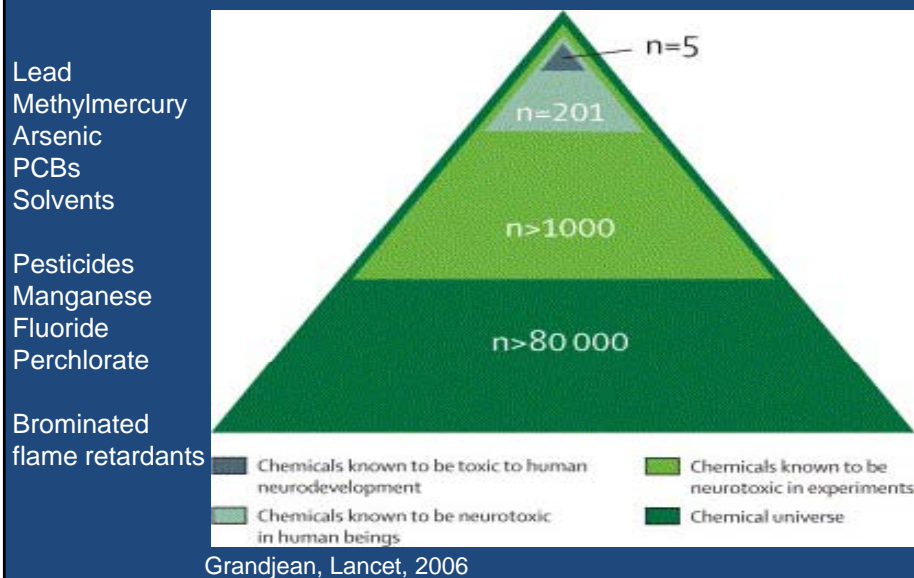
Additional neurodevelopmental hazards

- Methylmercury
- Polychlorinated biphenyls (PCBs)
- Pesticides—e.g. organophosphates
- Brominated flame retardants
- Perchlorate
- Organic solvents (in addition to ethanol)
- Arsenic, manganese
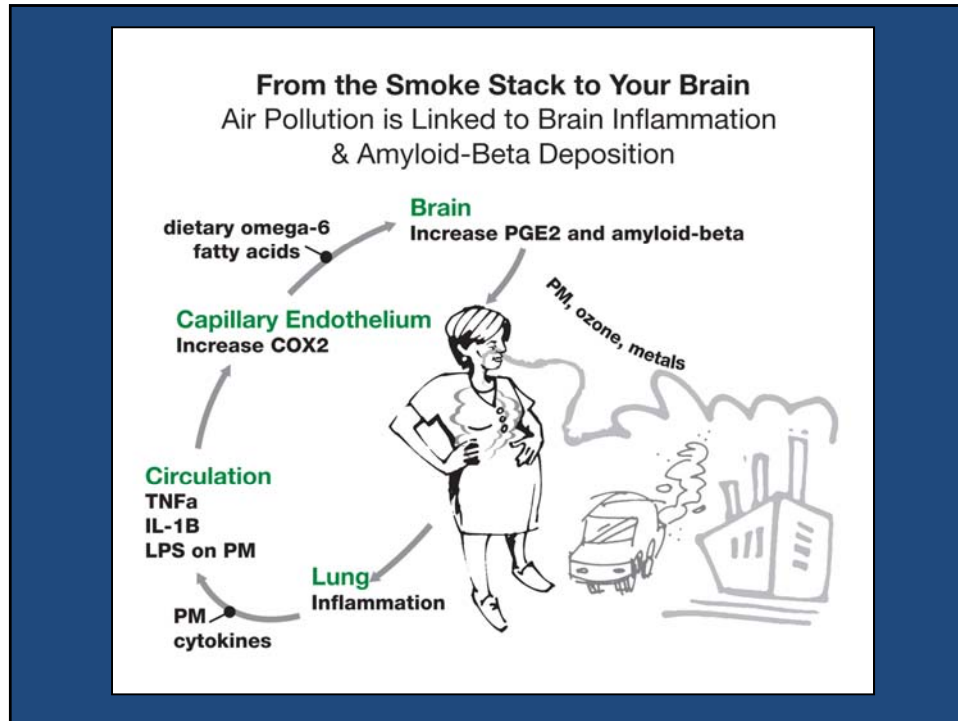- Etc.

Pesticides and Parkinson's disease

– Human studies - 24/31 studies show ↑ risks for PD.
  (OR 1.6-7); positive dose-response where examined
      (Brown 2006)

– Animals - Rotenone & paraquat→damage neurons in
          striatal region of brain
          - Combinations of maneb and paraquat;
          - prenatal exposure "primes" the brain,
            increasing adult susceptibility
                    (Cory-Slechta 2005)

Developmental neurotoxicity of industrial chemicals: the known, unknown-unstudied universe

Lead
Methylmercury
Arsenic
PCBs
Solvents

Pesticides
Manganese
Fluoride
Perchlorate

Brominated
flame retardants

n=5
n=201
n>1000
n>80 000

Chemicals known to be toxic to human neurodevelopment

Chemicals known to be neurotoxic in experiments

Chemicals known to be neurotoxic in human beings

Chemical universe

Grandjean, Lancet, 2006

Air pollution

- Particulates; nitrogen oxides; SO2; hazardous chemicals; metals; CO2
- Particulates > increased risk of respiratory illnesses, premature death from coronary artery disease
- SO2 > asthma
- NOx > ozone; smog precursors; green house gas
- CO2 > green house gas

From the Smoke Stack to Your Brain
Air Pollution is Linked to Brain Inflammation & Amyloid-Beta Deposition

# Climate change and public health

- More heat-related illness
- Greater risk of infectious disease
- Worsening air quality
- Threatened quality and quantity of water
- Rising sea levels; community displacement
- More extreme weather events
- Threatened food supplies; food safety
- Environmental refugees; security concerns
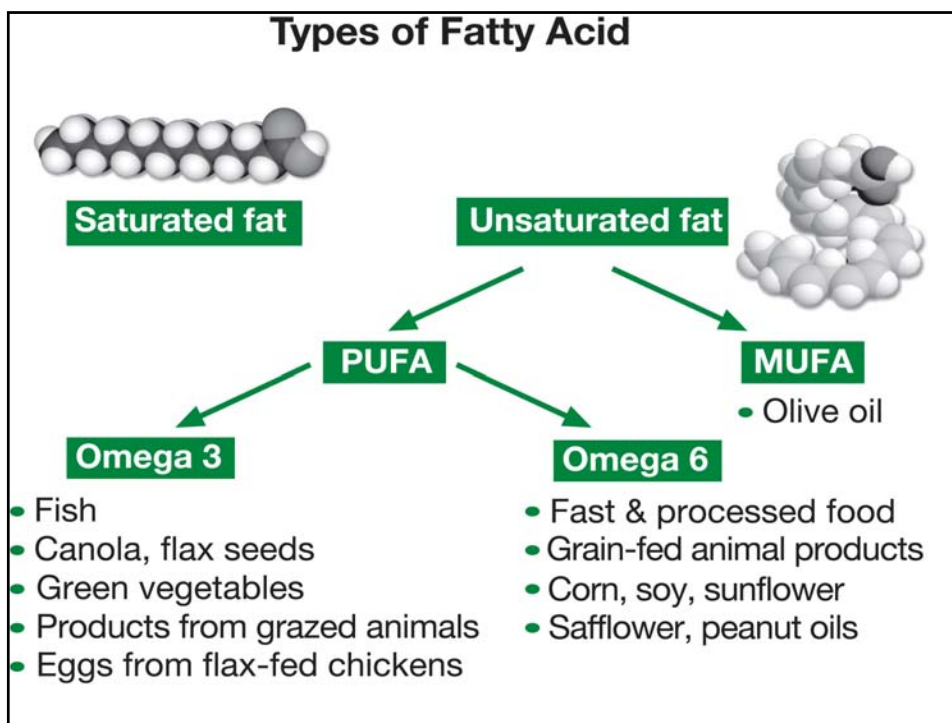- Stressed ecosystems; loss of services

Food environment

High glycemic carbohydrates increase the risk of diabetes, CHD, obesity

High glycemic carbohydrates break down quickly during digestion, rapidly releasing glucose (sugar) into the bloodstream.

INSULINEMIC RESPONSE

Low glycemic food

High glycemic food
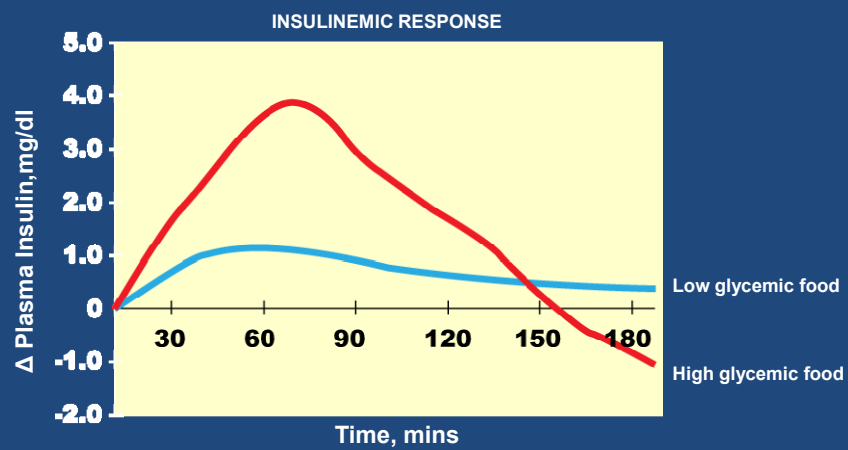
Properties of Fatty Acids

	Omega-3	Omega-6	Saturated
Food System	Perishable Short shelf life Increased in pasture- fed animals	Durable Processed foods Long shelf life	Increased in factory farmed animals
Immune Properties	Anti-inflammatory	Inflammatory & Anti-inflammatory	Inflammatory
Evolutionary Context	Recent marked decline	Recent marked increase	Recent marked increase

Influence of nutritional factors on chronic diseases

- Increase risks
  - saturated and trans fats
  - high glycemic carbohydrates
  - lack of fruits/vegetables/omega 3s
  - Large excess omega 6s vs. omega 3s

- Reduce risks
  - fruits, vegetables
  - omega 3s (fish, pasture-fed animals, walnuts, flax)
  - low glycemic carbohydrates
  - Mediterranean diet

Benefits of Mediterranean-Type Diet on Chronic Disease Risk

Clinical intervention studies
- 70% ↓ heart attacks, cardiac death & total mortality DeLogeril 94
- 60% ↓ cardiac events in CVD patients* Ornish 98
- ~50% ↓ metabolic syndrome Esposito 04
- 39% ↓ in CRP Esposito 04
- ↓insulin resistance Esposito 04
- ↓ weight Esposito 04

Prospective observation studies
- 80% ↓ diabetes Martinez-Gonzalez 08
- ~31% ↓ all-cause & cardiovascular mortality, 22% ↓ cancer mortality*calculated from Sofi 08* ↓ 73% Alzheimer's mortality Scarmeas 07
- 25-30% ↓ Parkinson's disease Gao 07
- 78% ↓ childhood asthma maternal diet Chatzi 08

*10% low fat, vegetarian diet + exercise, stress reduction; social support

Socioeconomic, Psychosocial Stressors

- Lower socioeconomic status → risk of impaired neurodevelopment, cardiovascular disease, diabetes, obesity, metabolic syndrome, Alzheimer's disease, many kinds of cancer, asthma.

- Due to: Combinations of increased exposures to hazards, increased susceptibility, decreased capacity to cope and recover.

- Elevated levels of inflammatory cytokines, glucocorticoids, sympathetic activity
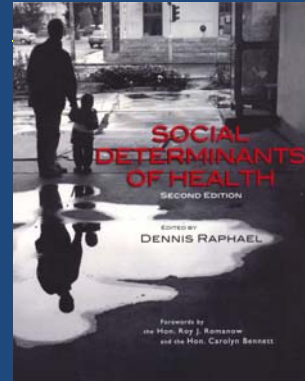
Effects of the Built Environment on Health

- Neighborhoods that lack social cohesion, sidewalks, or safety
  - Limited exercise
  - Increased risk of depression and obesity
  - Increased impact of other stressors (e.g. lead)

- Health effects of indoor and outdoor air contaminants

The challenges inherent in putting it all together

- Cumulative risk of chemical and non-chemical stressors

Science and Decisions:
Advancing Risk Assessment—2009

The framework for risk assessment of chemicals should be modified to account for uncertainty and variability in responses to exposures attributable to age, ethnic group, and socioeconomic status, as well as other attributes that affect individuals and make them a part of a vulnerable group.

Environmental Threats to Healthy Aging

Environment Drives Chronic Disease
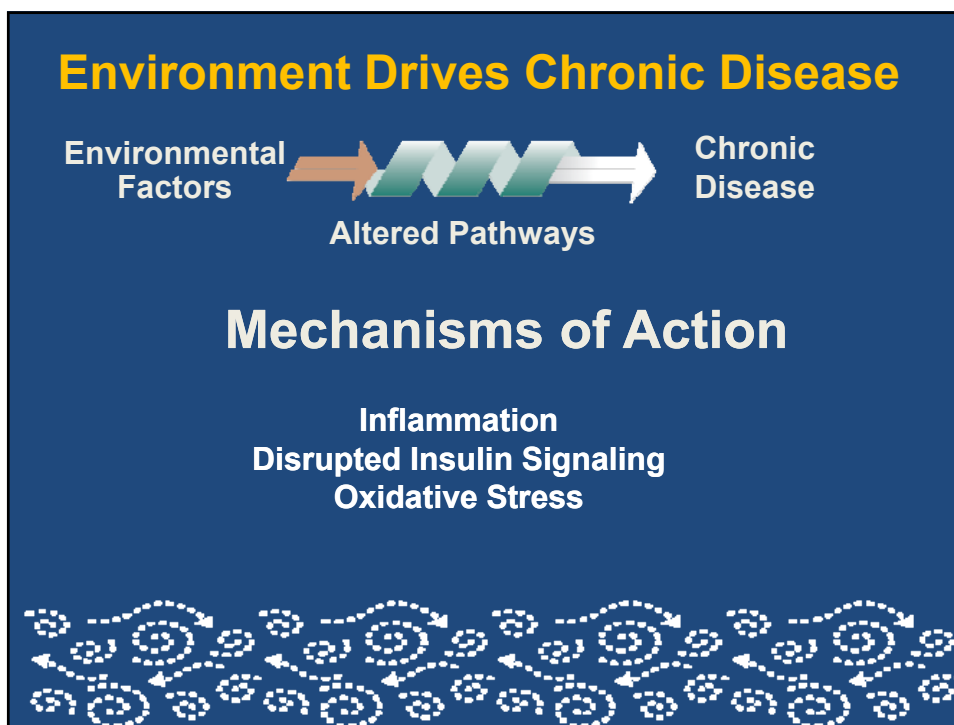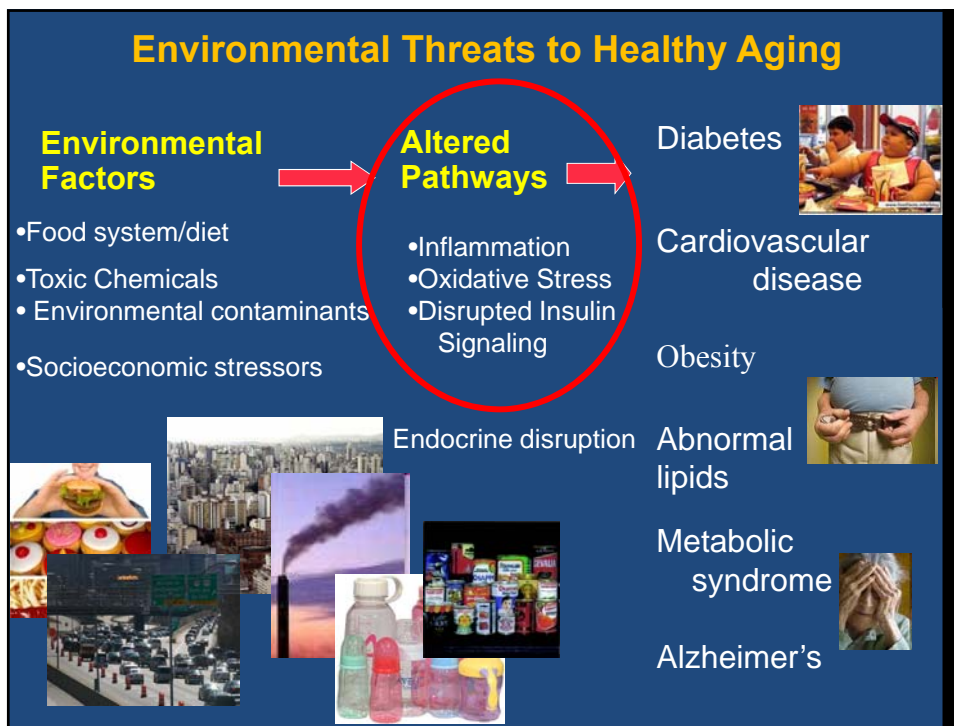
Inflammation

- Inflammation is a dimension of diabetes, metabolic syndrome , obesity, CVD, some neurodegenerative disorders, and other chronic illnesses.

- Numerous inflammatory markers involved

Sources of oxidative stress

- Food
- Tobacco smoke
- Industrial pollutants
- Ozone, particulate air pollution
- Pesticides
- Organic solvents
- Some pharmaceuticals

Insulin Signaling = Normal Metabolism

Insulin signaling

- ↓ blood sugar
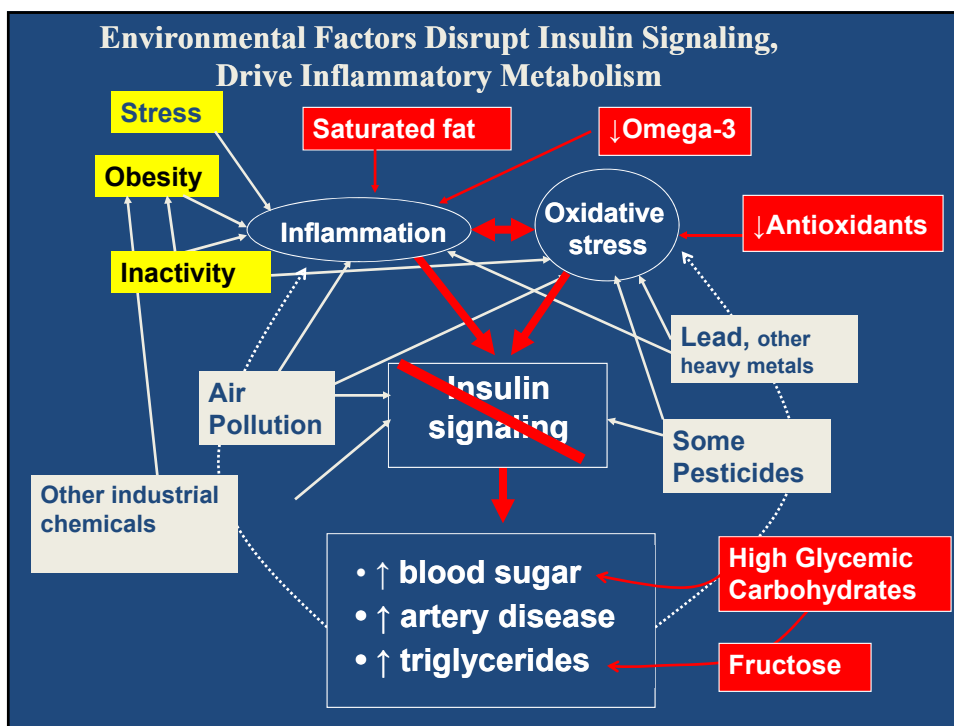- ↑ artery compliance
- ↓ triglycerides

Disrupted Insulin Signaling = Inflammatory Metabolism

Inflammation ↔ **Oxidative stress**

Insulin signaling

- ↑ blood sugar
- ↑ artery stiffness
- ↑ triglycerides

Environmental Factors Disrupt Insulin Signaling, Drive Inflammatory Metabolism

- Stress
- Obesity
- Inactivity
- Saturated fat
- ↓Omega-3
- ↓Antioxidants

Inflammation ↔ Oxidative stress

Air Pollution

Insulin signaling

Lead, other heavy metals

Some Pesticides

Other industrial chemicals

- • ↑ blood sugar
- • ↑ artery disease
- • ↑ triglycerides

High Glycemic Carbohydrates

Fructose

Solutions
for
Healthy People & A Healthy Planet

Responses

- Research agenda (Children's Health Study; innovative study design and data analysis)
- Personal
- Community
- Sectoral: health care; agriculture, material/product manufacturing, education, etc.
- Improved risk assessments and regulations
- Cross-cutting solutions

Major Illnesses Are Preventable
Personal Actions to Reduce Risks

Personal Level – "Approaches to Healthy Living"

◆ **Eat healthy – whole, fresh, unprocessed, primarily plant based foods; not too much**
◆ **Avoid toxicants whenever possible**

◆ **Exercise**

◆ **Be socially engaged**

Clinicians: Environmental history CH2OPS

- Community
- Home/hobbies
- Occupation (school for children)
- Personal
- Socioeconomic

Diet, exercise, toxic exposures..home, hobbies, work, school, community; personal habits, etc

Food, agriculture

- **Current system:**
  - Subsidies poorly aligned with health goals;
  - Not sustainable: depends on cheap energy, abundant water, climate stability
  - contributes significantly to environmental degradation
    - air and water pollution; marine dead zones
    - Greenhouse gases > climate change

Food, agriculture

- **Sustainable, nutritious food production** ;
  - Reduced use of pesticides; synthetic fertilizers
  - Healthier food
  - Improved food access
- **Opportunities for health care**
  - Local purchasing > local economic support
  - Modeling behavior for other sectors
  - Farm bill: reform in ways that more closely align subsidies and goals with health-based dietary guidance

Chemicals, products

- Institutional preferential purchasing
  - Request product chemistry data from suppliers
  - Prioritize chemicals of high concern for phase out
  - Create contractual obligations with suppliers
    - Avoid chemicals of high concern; safer alternatives
  - Develop goals and metrics to measure progress
  - Communicate rationale to employees, patients, community

Chemicals, products

- Support reform of 1976 Toxic Substances Control Act (TSCA; Federal statute)

  "--the most egregious example of ineffective regulation of environmental chemicals"
  --the President's Cancer Panel

- H.R. 5820   The Toxic Chemicals Safety Act

The built environment

- Transportation
  - Mass transit linked to sidewalks and bike paths (increased exercise, less air pollution, GHG)
- Parks, recreation, safe neighborhoods
- Health care: Green building; transportation policies; reduced energy consumption
- Support energy policy reform
  - Climate change, air pollution

Conclusion

- Causes of prevalent diseases and causes of environmental degradation have much in common
- Common drivers; common solutions
- Many opportunities to intervene can help to solve multiple problems
- What is our responsibility for primary prevention? The level of our commitment?

Acknowledgements; resources

- "Environmental Threats to Healthy Aging"
  Jill Stein, Maria Valenti, Ben Rohrer
- Science and Environmental Health Network
  www.sehn.org
- Health Care Without Harm
  www.noharm.org
- Collaborative on Health and Environment
  www.healthandenvironment.org