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SCHOOL of PUBLIC HEALTH

Introduction to Environmental Health

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Section A

Objectives and Definitions

Course Learning Objectives

- Define the major types, sources, and environmental distribution of environmental agents
- Describe how these agents interact with biological systems, and describe the mechanisms by which they exert adverse effects
- Predict the nature of the agent's adverse effects from its physical, chemical, or infectious properties, and how that may influence environmental or public health

Course Learning Objectives

- Describe and use models for prediction of the magnitude of adverse effects in biological systems
- Identify significant gaps in the current knowledge base concerning health effects of environmental agents, and areas of uncertainty in the risk-assessment process
- Describe current legislation and regulation regarding environmental issues

Definitions: Environment

- The circumstances, objects, or conditions by which one is surrounded

  or

- The complex of climatic, edaphic (soil-based), and biotic factors that act upon an organism or an ecologic community

Public Health Definition of "The Environment"

- All that which is external to the individual host. [It] can be divided into physical, biological, social, and cultural factors, any or all of which can influence health status in populations.
  - Last, J. M. (Ed.). (1995). *A Dictionary of Epidemiology* (3rd ed.). New York: Oxford University Press.

Definitions: Health

- The condition of being sound in body, mind, or spirit
- A flourishing condition or well-being—not just the absence of disease

or

Definitions: Health

- A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity
  - WHO. (1948).

Definitions: Disease

- Trouble or a condition of the living animal or plant body or one of its parts that impairs the performance of a vital function

Definitions: Safe

- ***Free*** from harm or risk
- ***Secure*** from threat of danger, harm, or loss
- ***Zero*** risk

Definitions: Risk

- Possibility of loss or injury, peril
- The chance of loss; the degree of probability of such loss

What Is Environmental Health Sciences?

- NIEHS charter: "The study of those factors in the environment that affect human health"
  - Factors ("pollutants" or "toxicants") in air, water, soil, or food
  - Transferred to humans by inhalation, ingestion, or absorption
  - Production of adverse health effects

Contributors to the "Environment"

- Chemical
  - Air pollutants, toxic wastes, pesticides, VOCs
- Biologic
  - Disease organisms present in food and water
  - Insect and animal allergens
- Physical
  - Noise, ionizing and non-ionizing radiation
- Socioeconomic
  - Access to safe and sufficient health care

WHO Definition of Environmental Health

- Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations.

Facets of Environmental Health

- Environmental epidemiology
  - Associations between exposure to environmental agents and subsequent development of disease
- Environmental toxicology
  - Causal mechanisms between exposure and subsequent development of disease
- Environmental engineering
  - Factors that govern and reduce exposure
- Preventive medicine
  - Factors that govern and reduce disease development
- Law
  - Development of appropriate legislation to protect public health

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Section B

Environmental Health Issues

Question

- Do you think that environmental issues are among the top three public health issues in this country?

The "Right" First Question

- What criteria do you use to identify an important public health issue?

Traditional Public Health Approach

1. Define the problem
2. Identify and characterize the parameters governing the problem
3. Design appropriate PH interventions
4. Implement and evaluate the interventions

Another Possible Approach

1. Define the health parameters of importance
2. Identify the problems most impacting the health parameters
3. Identify and characterize the parameters governing the problem
4. Design appropriate PH interventions
5. Implement and evaluate the interventions

Measure of Disease Burden and NIH Funding

- Source: (1999). NEJM, 340, 1181.

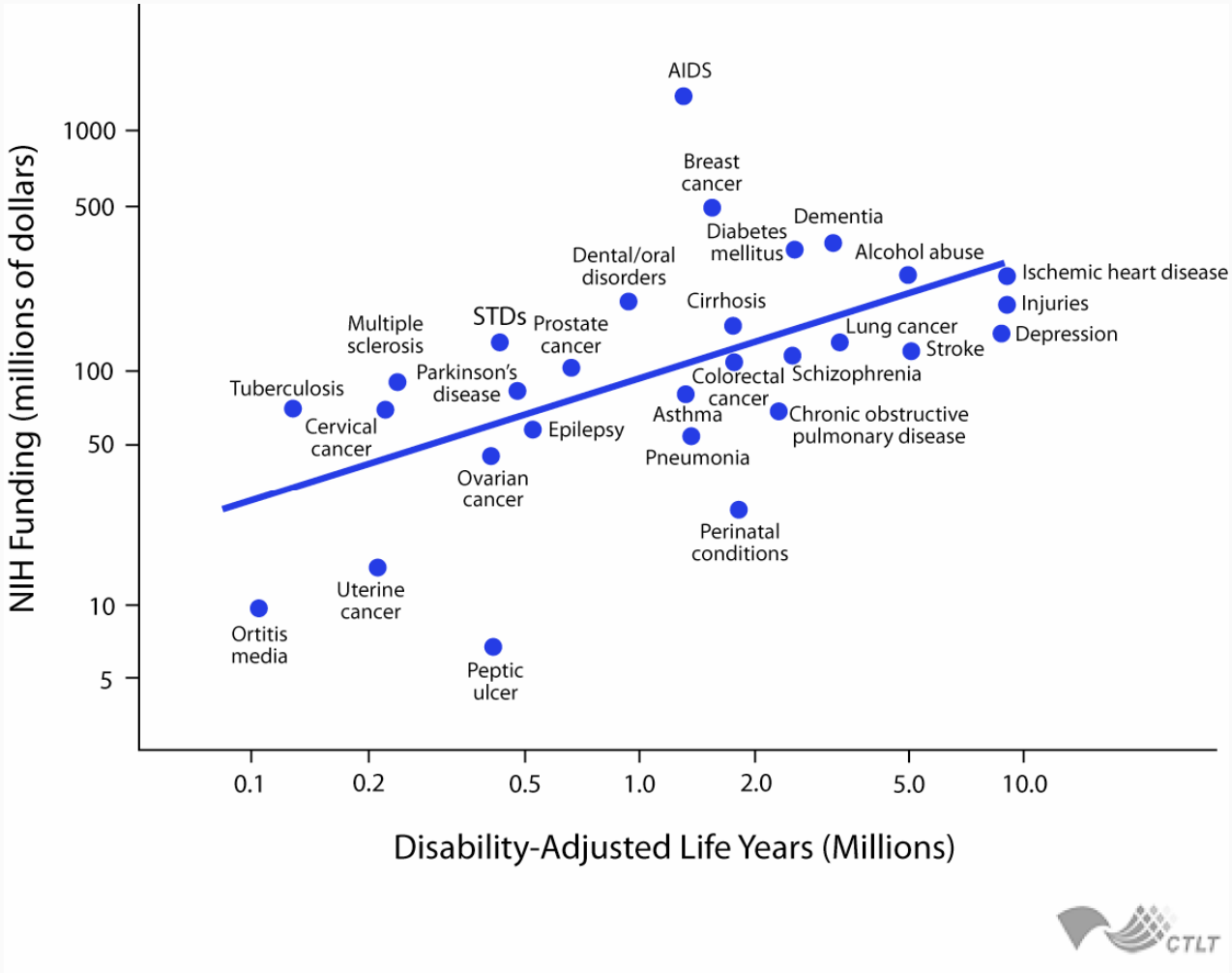
Measure (Year Assessed)	Units	Correlation Coefficient (r)	P Value
Incidence (1990)	No. of new cases per year	-0.05	0.82
Prevalence (1990)	No. of existing cases	0.25	0.23
Hospital days (1994)	Days in acute care hospitals	0.24	0.21
Mortality (1994)	Deaths per year	0.40	0.03
Years of life lost (1994)	Years	0.42	0.02
Disability-adjusted life-years (1990)*	Years	0.62	< 0.001

*Loss of one year of healthy life to disease

Source: Adapted from (1999). NEJM, 340, 1181

Disability-Adjusted Life-Years and NIH Funding

- Relationship between NIH disease-specific research funding and disability-adjusted life-years



Source: Adapted from (1999). NEJM, 340, 1181.

Should You Care about EHS?

- Acute environmental catastrophes (high-level exposures)
- Chronic (low-level) exposures
- Indirect effects of global environmental changes

The Wake-up Calls: Environmental Catastrophes

- Minamata disease (1953–1961)
  - Methyl mercury poisoning
- Seveso, Italy (1976)
  - Leak of toxic gas (TCDD)
- Bhopal (1984)
  - 16.5 tons of toxic pesticide released

The Wake-up Calls: Environmental Catastrophes

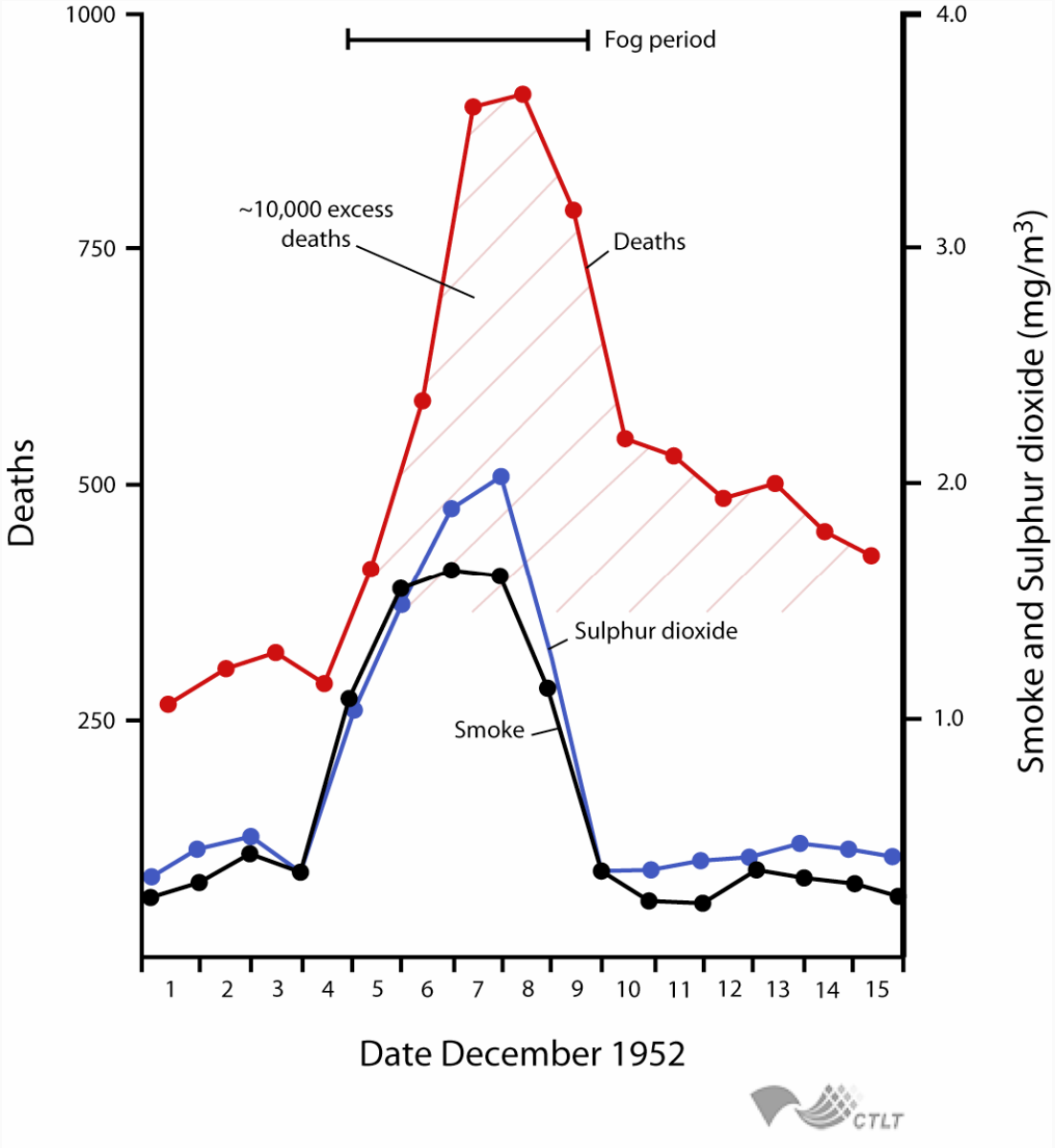
- Chernobyl (1986)
  - Nuclear reactor accident
- Milwaukee incident (1993)
  - Cryptosporidium in drinking water

Major Air Pollution Episodes

Date	Place	Xs Deaths
Dec. 1882	London, England	1,000
Dec. 1930	Meuse Valley, Belgium	63
Oct. 1948	Donora, Penn.	20
Dec. 1952	London, England	4,000
Dec. 1962	Osaka, Japan	60
Jan. 1963	New York City	200–405
Nov. 1983	New York City	250

Excess deaths refers to the additional number of fatalities counted above the number expected under otherwise normal conditions.

The London "Killer" Smog of 1952

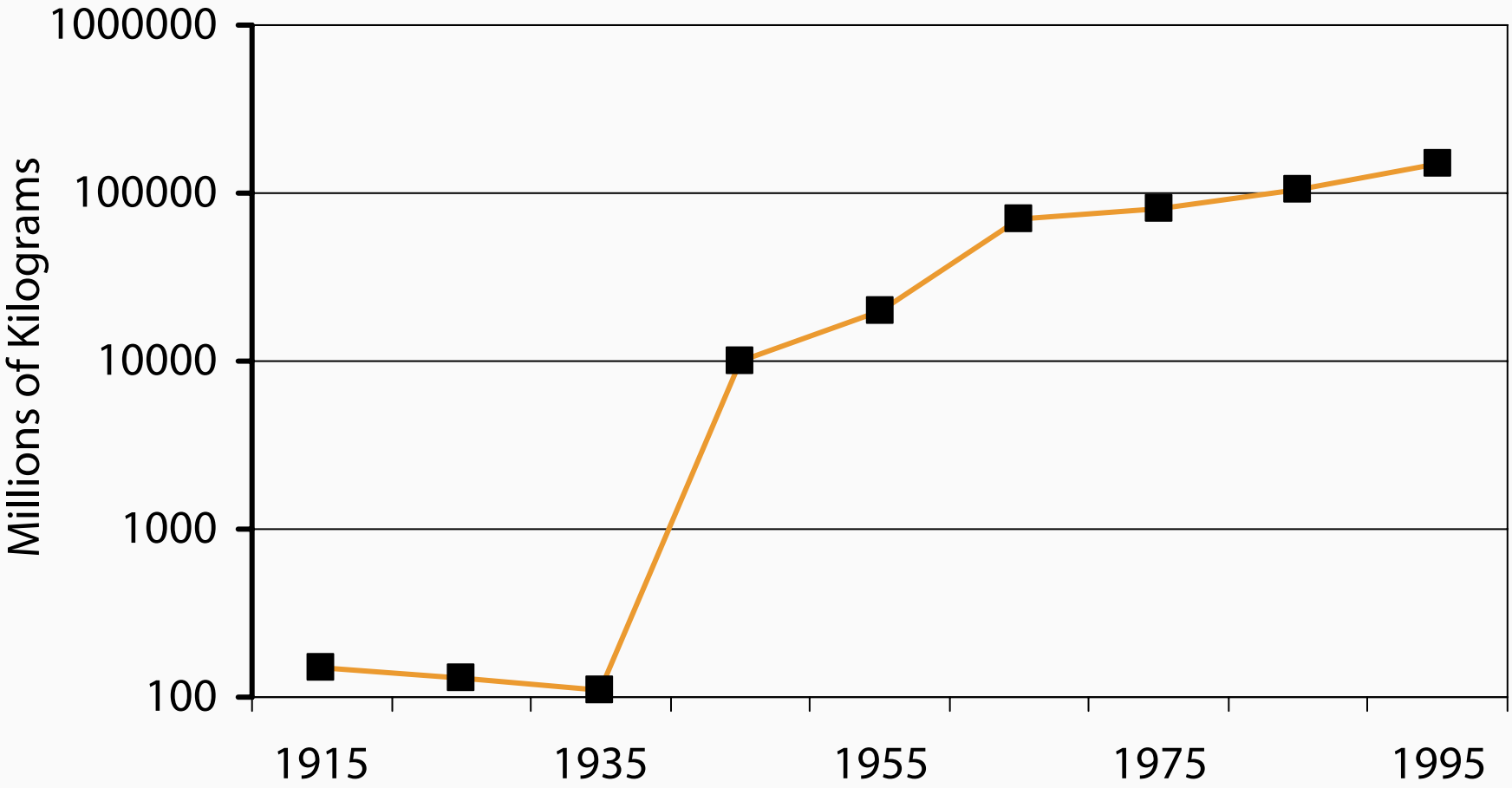


Source: Adapted from Turco, R. P.

Chemicals in the Environment

- Roughly 70,000 different synthetic chemicals are on the global market; many others are emitted as by-products of their production, use, or disposal
- Production of synthetic organic chemicals (e.g., dyes, plastics, solvents) has increased from less than 0.15 billion kilograms (1935) to more than 150 billion kilograms (1995)

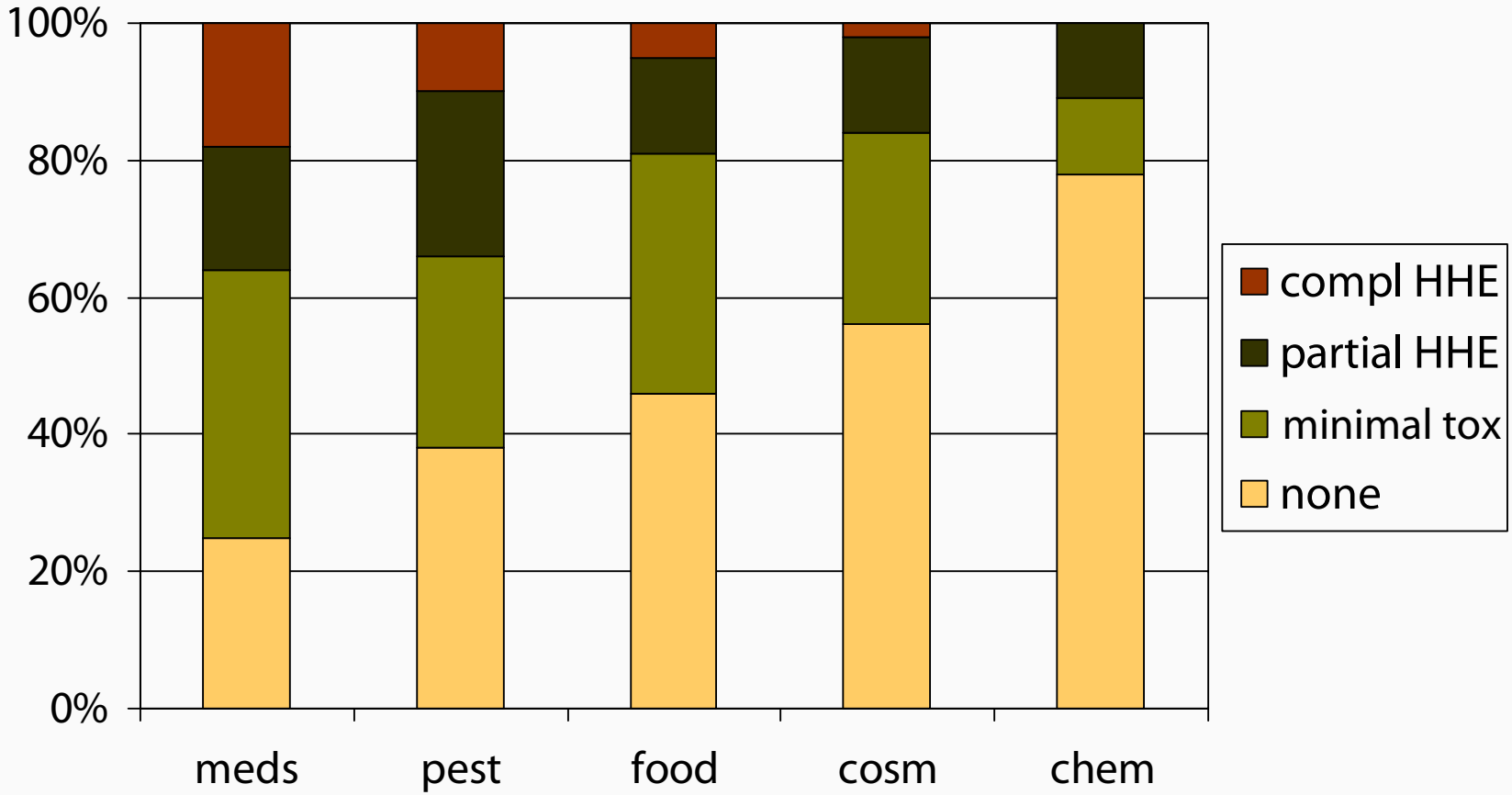
World Production of Synthetic Organic Chemicals



Data from Mitchell, J.D.

Substance-Specific Toxicity and Health Information

- Substance-specific toxicity and health information (NRC/NAS, 1984)



HHE = health hazard evaluation; meds = medications; pests = pesticides; food = food additives; cosm = cosmetics; chem = commercial chemicals

Why Don't We Know More about These Chemicals?

- Number of chemicals (1984—NRC/NAS)
  - Pesticides 3,350
  - Drugs 1,815
  - Cosmetics 3,410
  - Food additives 8,627

Why Don't We Know More about These Chemicals?

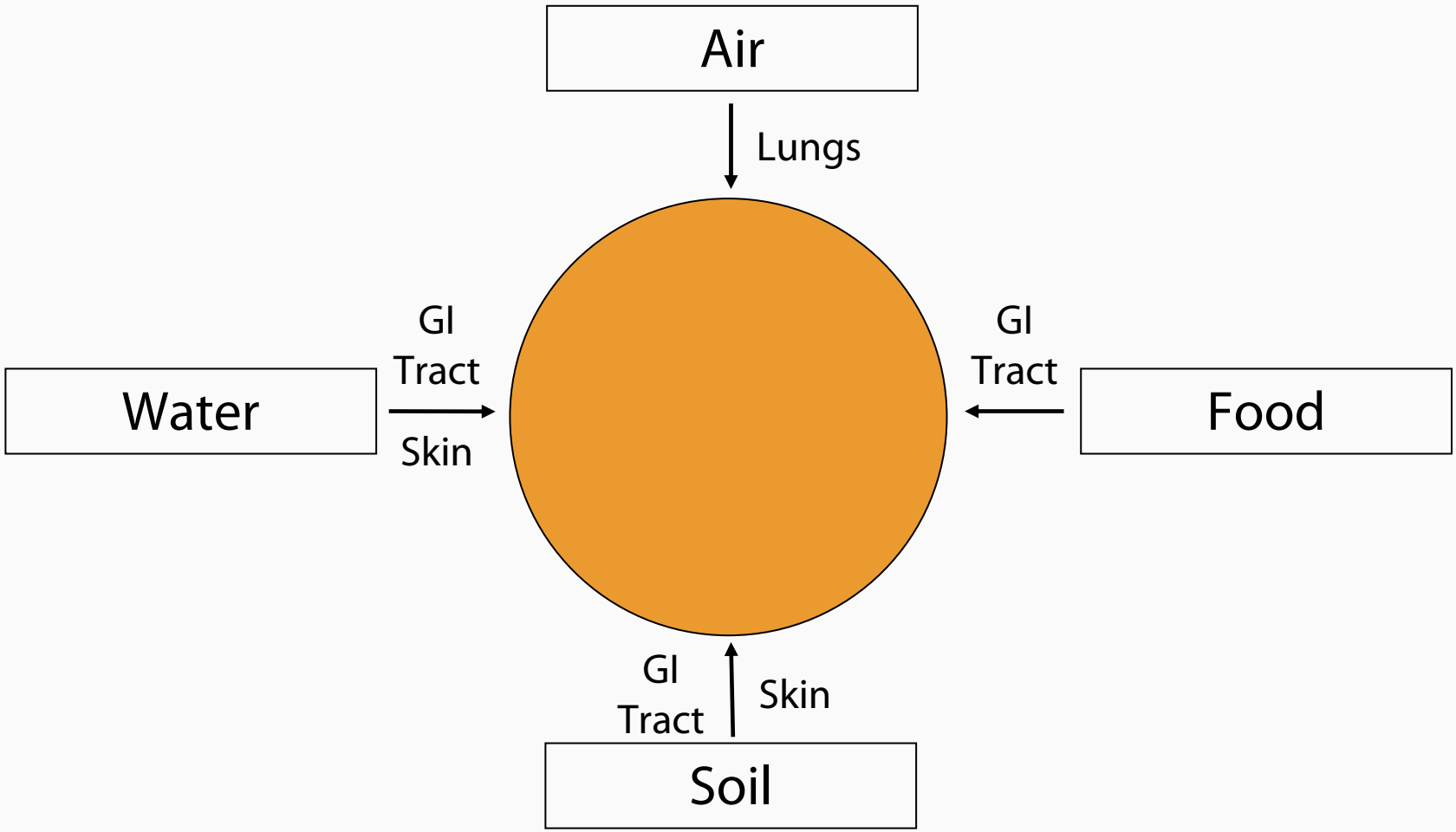
- Chemicals in commerce (1984)
  - >1 million lbs/yr 12,860
  - <1 million lbs/yr 13,911
  - Production unknown 21,752

Why Don't We Know More about These Chemicals?

- Each year ~1,000 new chemicals come on line
- It costs ~ $ 2 million to do a cancer toxicology screen on each chemical (NTP guidelines)
- The cancer toxicology screen takes ~2 years

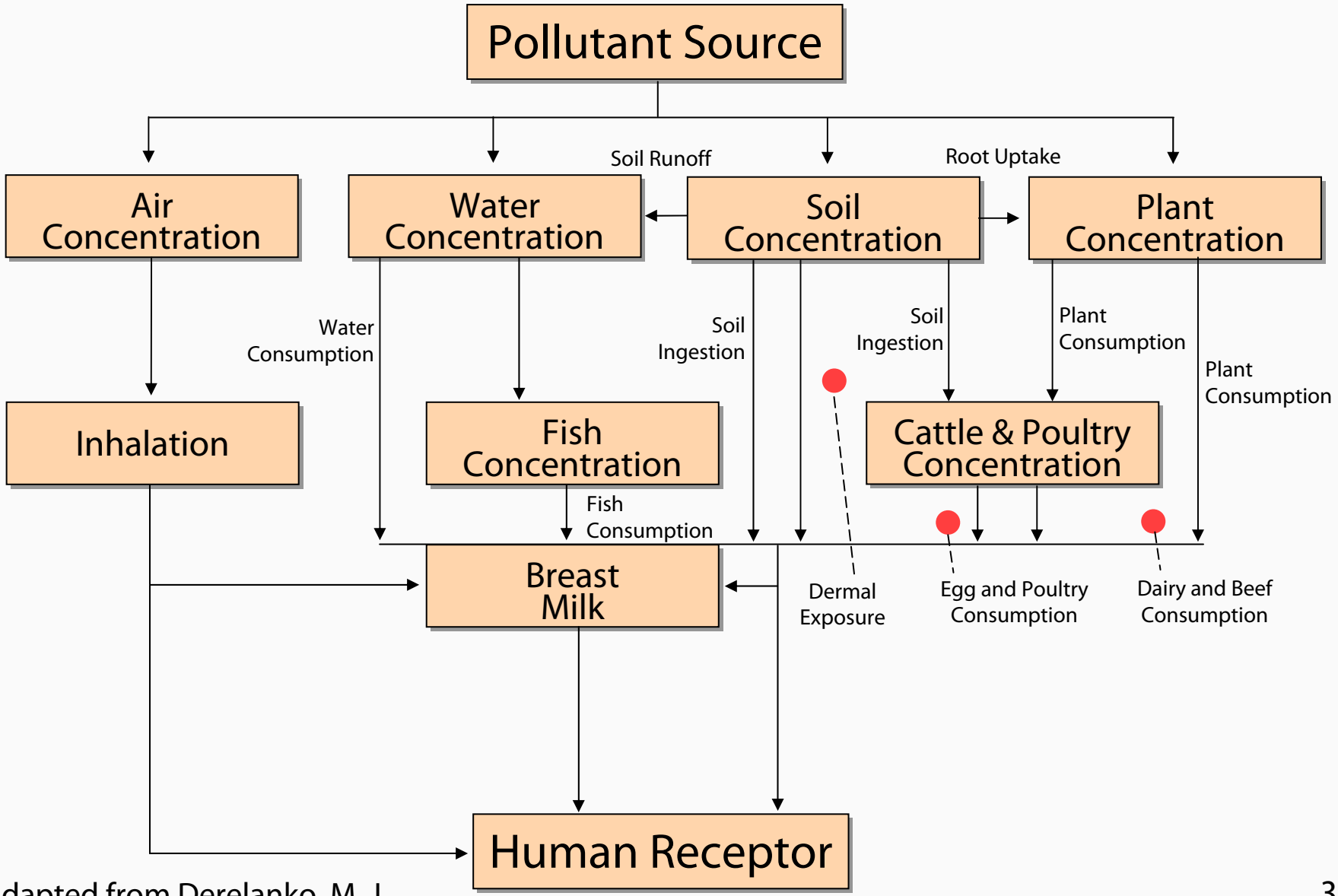
Routes of Exposure

- Routes of exposure through gaseous, liquid, and solid media



Adapted from Moeller, D.W.

Pollutant Source Pathways



Adapted from Derelanko, M. J.

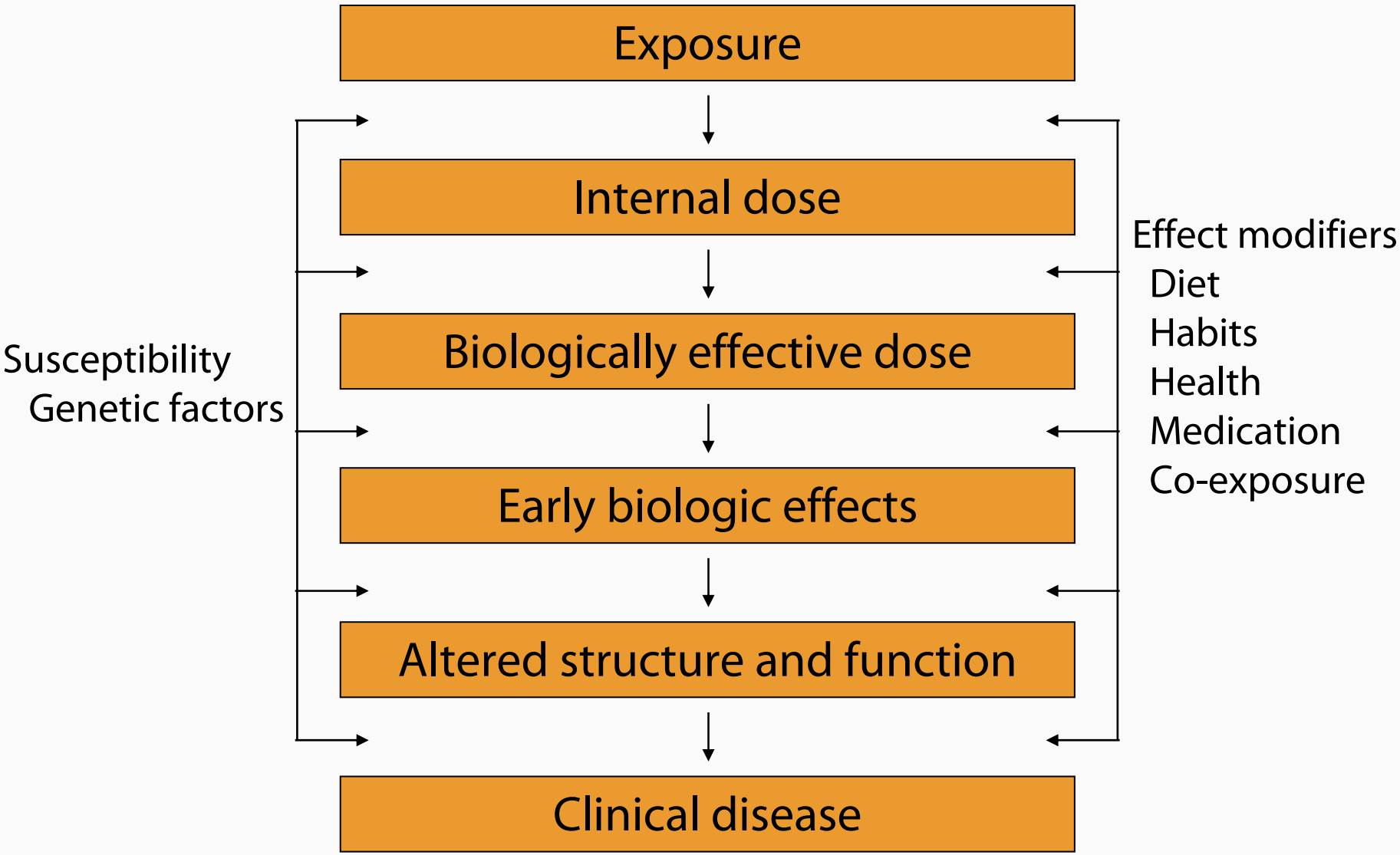
Environmental Pathways for Selected Toxic Agents

Agent	Disease	Source	Pathway
L. pneumophila	Legionnaire's disease	Soil, cooling towers	Air, building ventilation systems
Salmonella	Acute diarrhea	Human or animal feces	Water, meat, eggs
Dioxin	Chloracne, soft tissue tumors	Herbicides, paper mills, incinerators	Air, water, food
Pesticides	Nervous system tox.	Agriculture	Food, water
Asbestos	Asbestosis, lung cancer	Insulation, auto brakes	Air, water

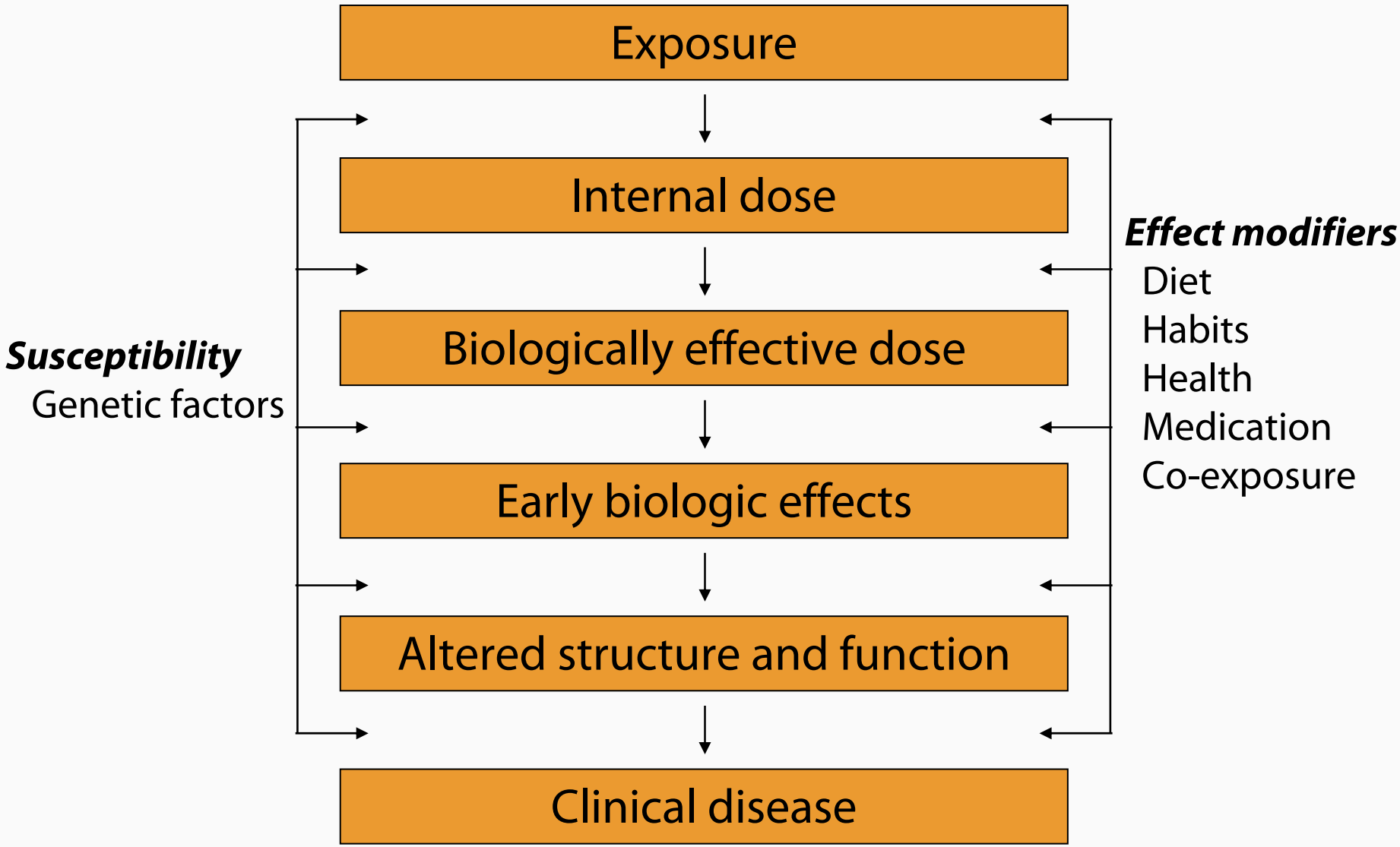
Agents and Vectors

- Agents
  - Chemical, biological, and physical
- Vectors
  - Water, air, soil, and food
- Routes of entry
  - Inhalation, ingestion, absorption

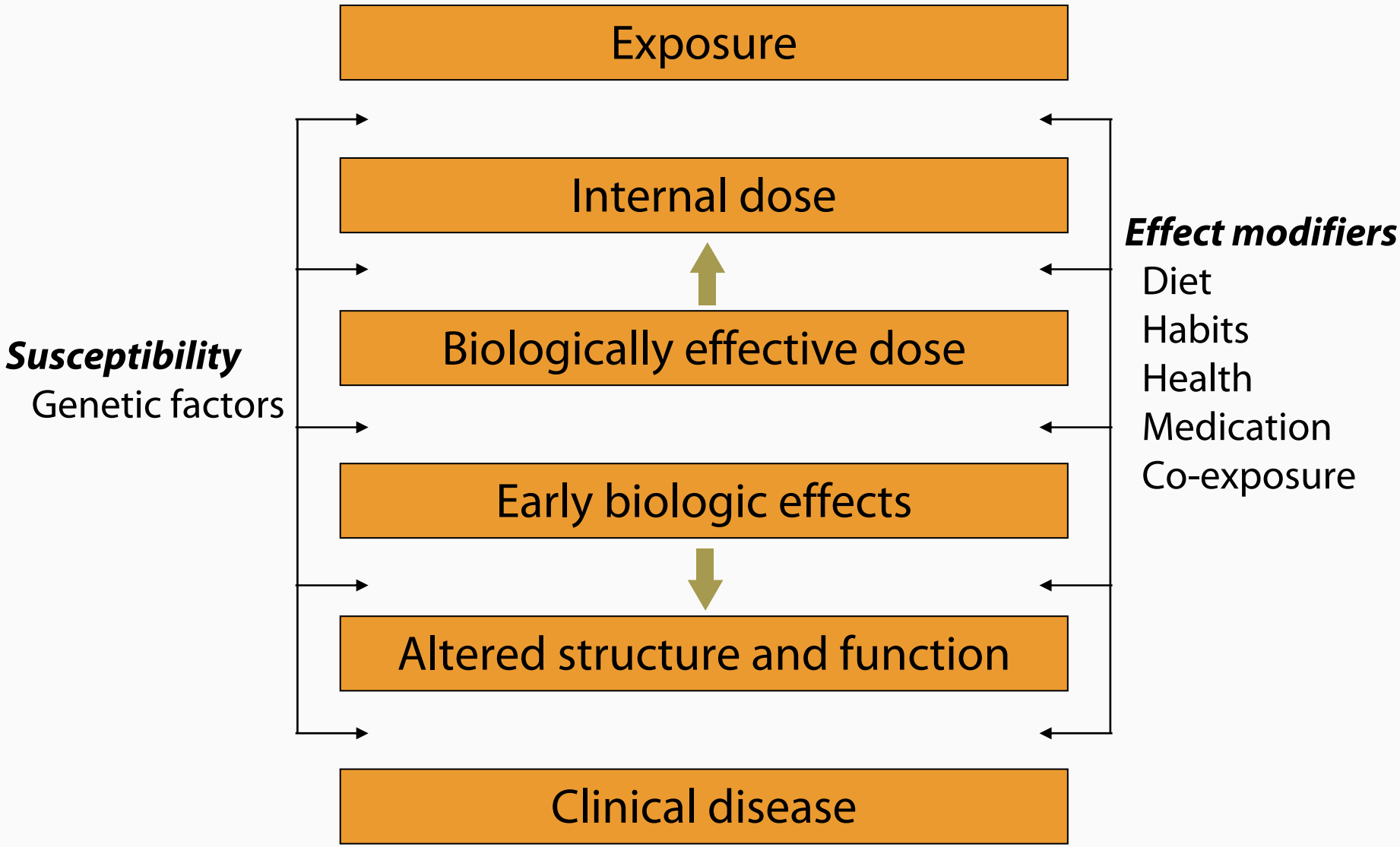
The Toxicological Paradigm



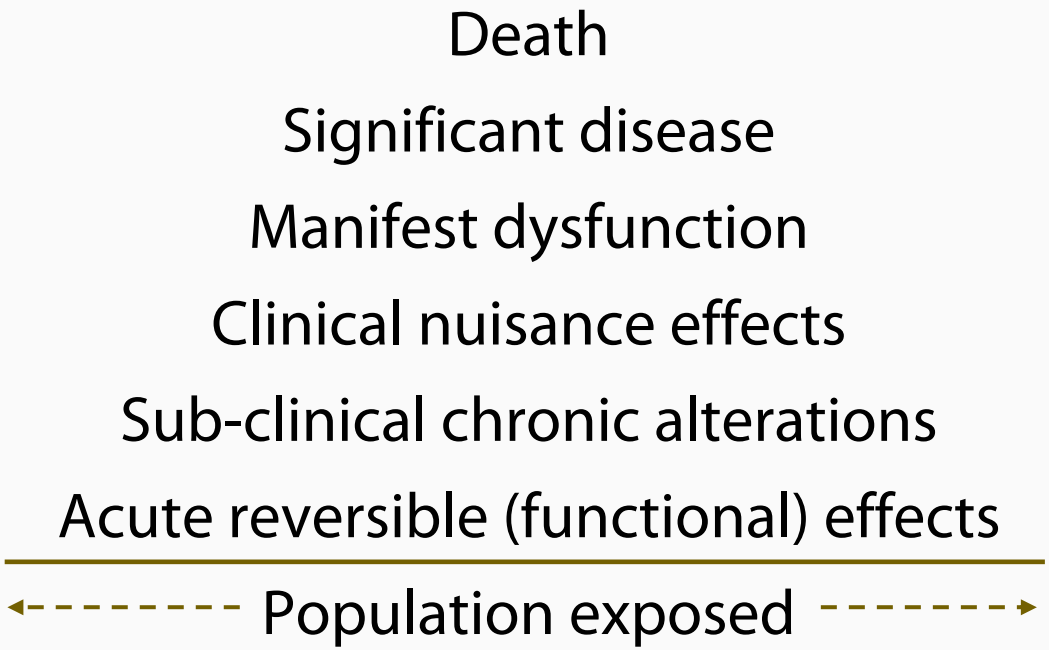
The Toxicological Paradigm



The Toxicological Paradigm



Severity of Adverse Health Effects



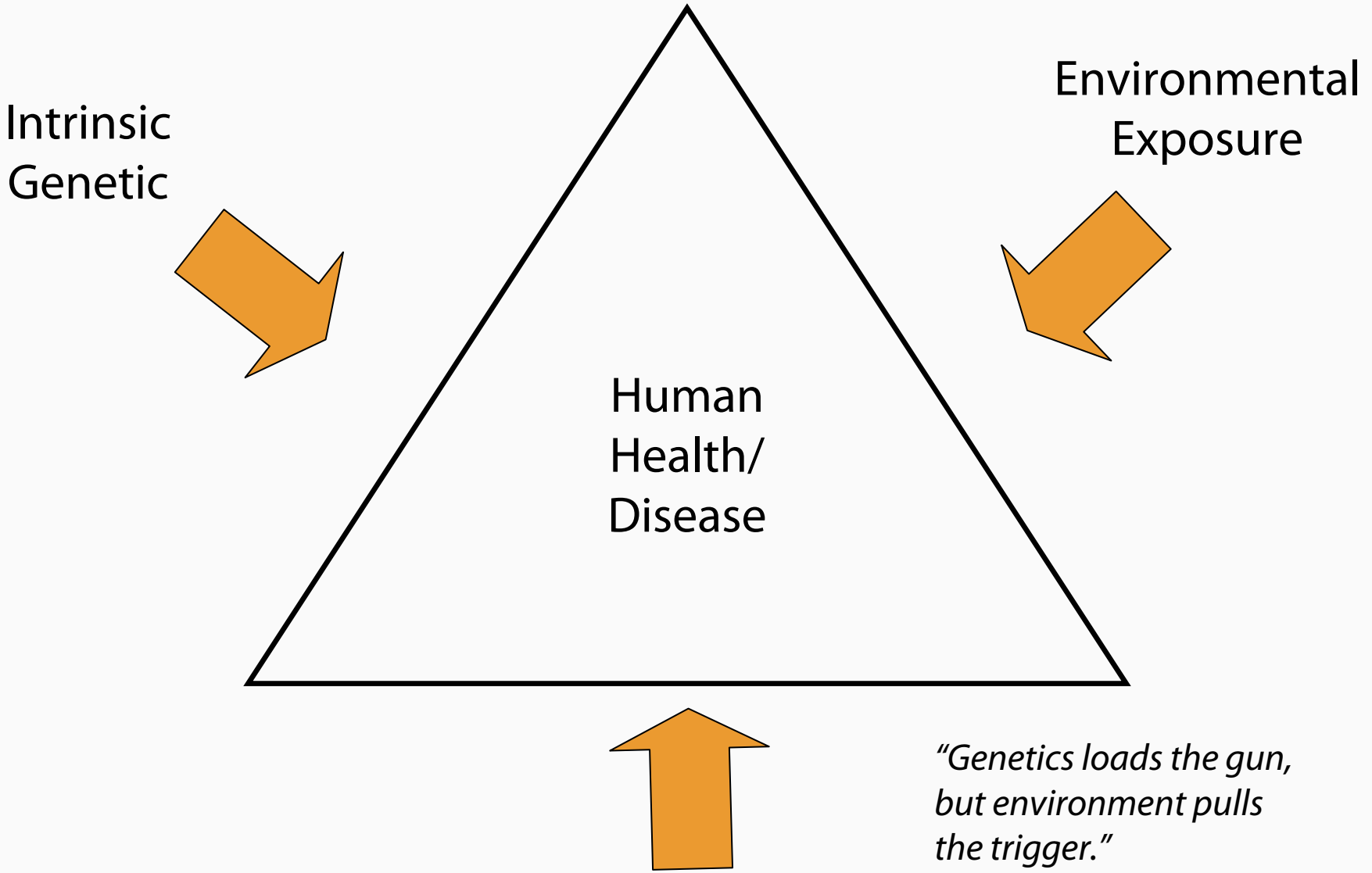
Health Effects

- Adverse vs. beneficial
- Acute vs. delayed onset
- Clinical vs. subclinical manifestations
- Transient (reversible) vs. chronic (irreversible)

Examples of Manifestations

- Lung disease
- Reproductive effects
- Teratogenic effects
- Neurologic effects
- Immunosuppression and hypersensitivity
- Cancer

Environment Pulls the Trigger



"Genetics loads the gun, but environment pulls the trigger."

— Judith Stern
UC Davis

Vulnerable Groups

- Low socioeconomic status
- Women
- Children
- Elderly
- Ethnic minorities
- Disabled
- Indigenous peoples
- All of whom are often more vulnerable because of—
  - Genetics
  - They are not empowered to change their environment

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Section C

Problem Solving

Problem-Solving Paradigm: Six Steps

1. Define the problem
2. Measure its magnitude
3. Understand key determinants

Risk assessment

4. Develop intervention/ prevention strategies
5. Set policy/priorities
6. Implement and evaluate

Risk management

Selecting Priorities

- ***Risk assessment***
  - The determination of the probability that an adverse effect will result from a defined exposure
    1. Hazard identification
    2. Exposure assessment
    3. Dose-response assessment
    4. Risk characterization
  - Pure “science” activities

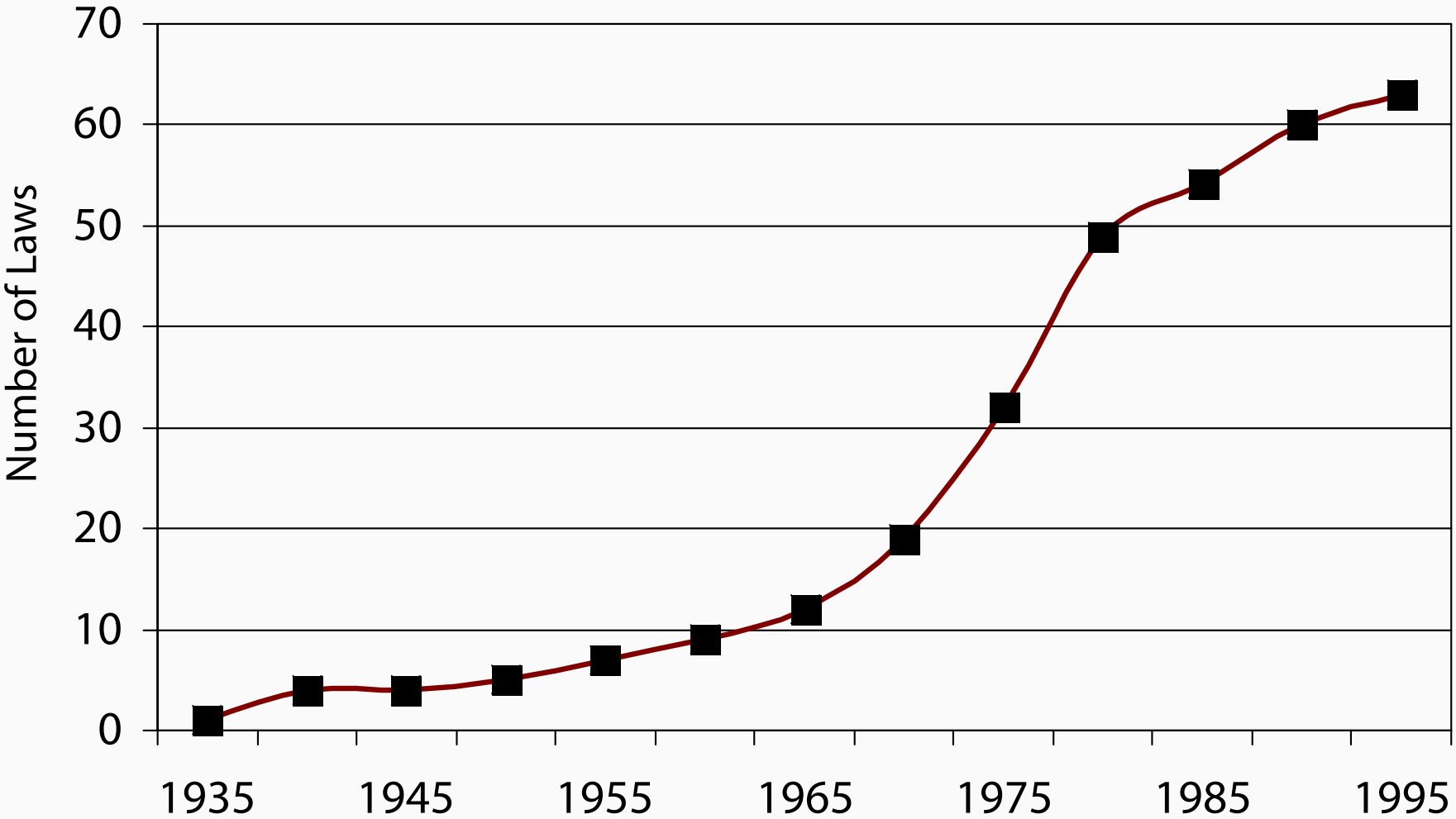
- ***Risk management***
  - The process of weighing policy alternatives and selecting the most appropriate regulatory actions based on the results of risk assessment and social, economic, and political concerns

Commonplace Risks Calculated

- Commonplace risks calculated as number of deaths per 100,000 per year

Activity or Exposure	Risk/Year
Motorcycling	2,000
Smoking (all causes)	1,000
Hand gliding	80
Driving	24
Fires	2.8
4 TBS peanut butter per day (aflatoxin)	0.8
Being struck by lightning	0.05
Being hit by a meteor	0.000006

Major Environmental Legislation



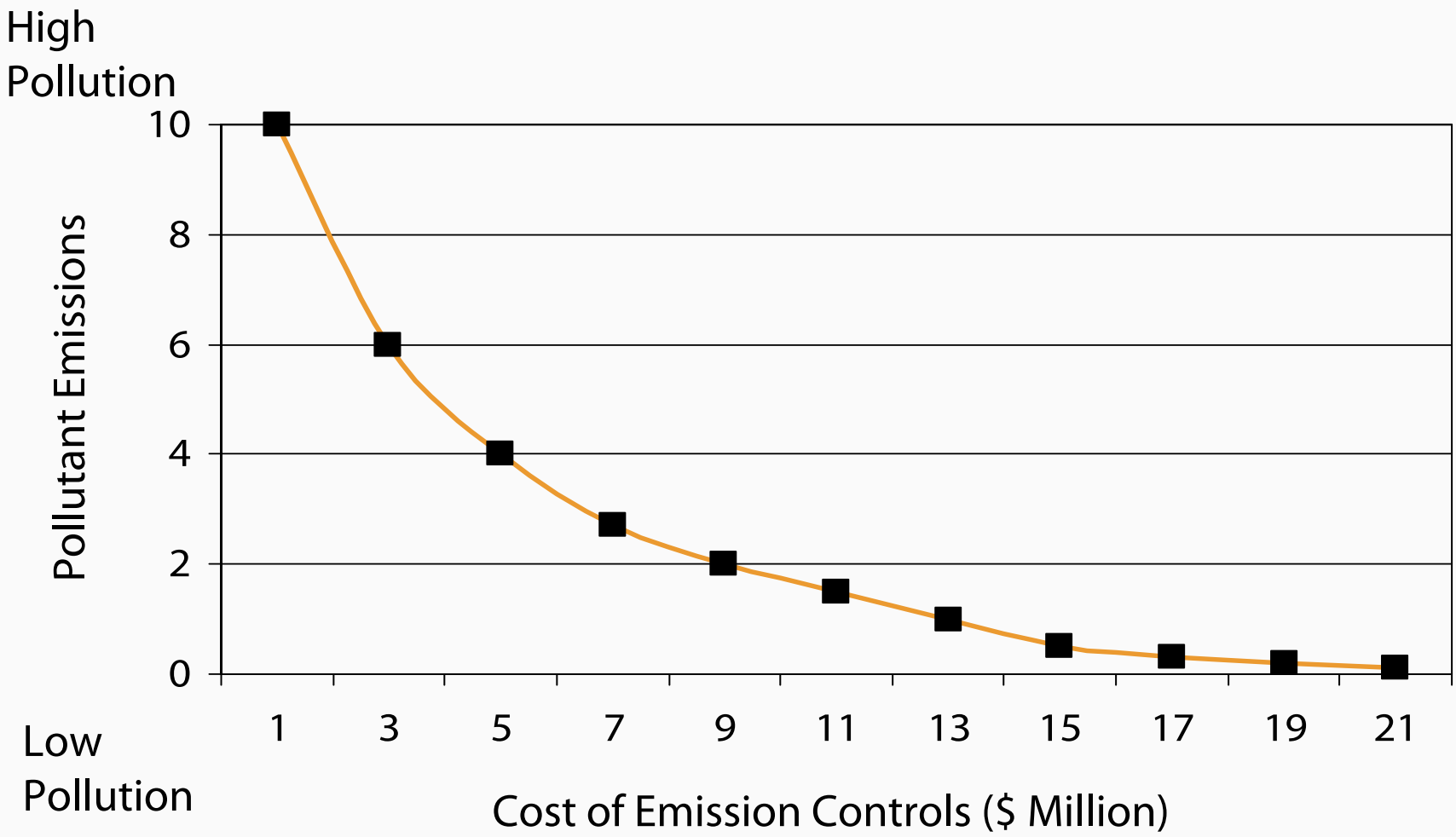
The Cost of Cleanup

- The closer we get to the goal of zero emissions of a pollutant, the more costly it becomes to eliminate each unit of pollution

The Cost of Cleanup

- Reason
  - First control method is usually the most effective and easiest to implement, and produces the largest benefit at the lowest cost
  - Continued progress requires using more and more expensive methods that remove smaller amounts of pollutant
  - At some point, costs outweigh benefits

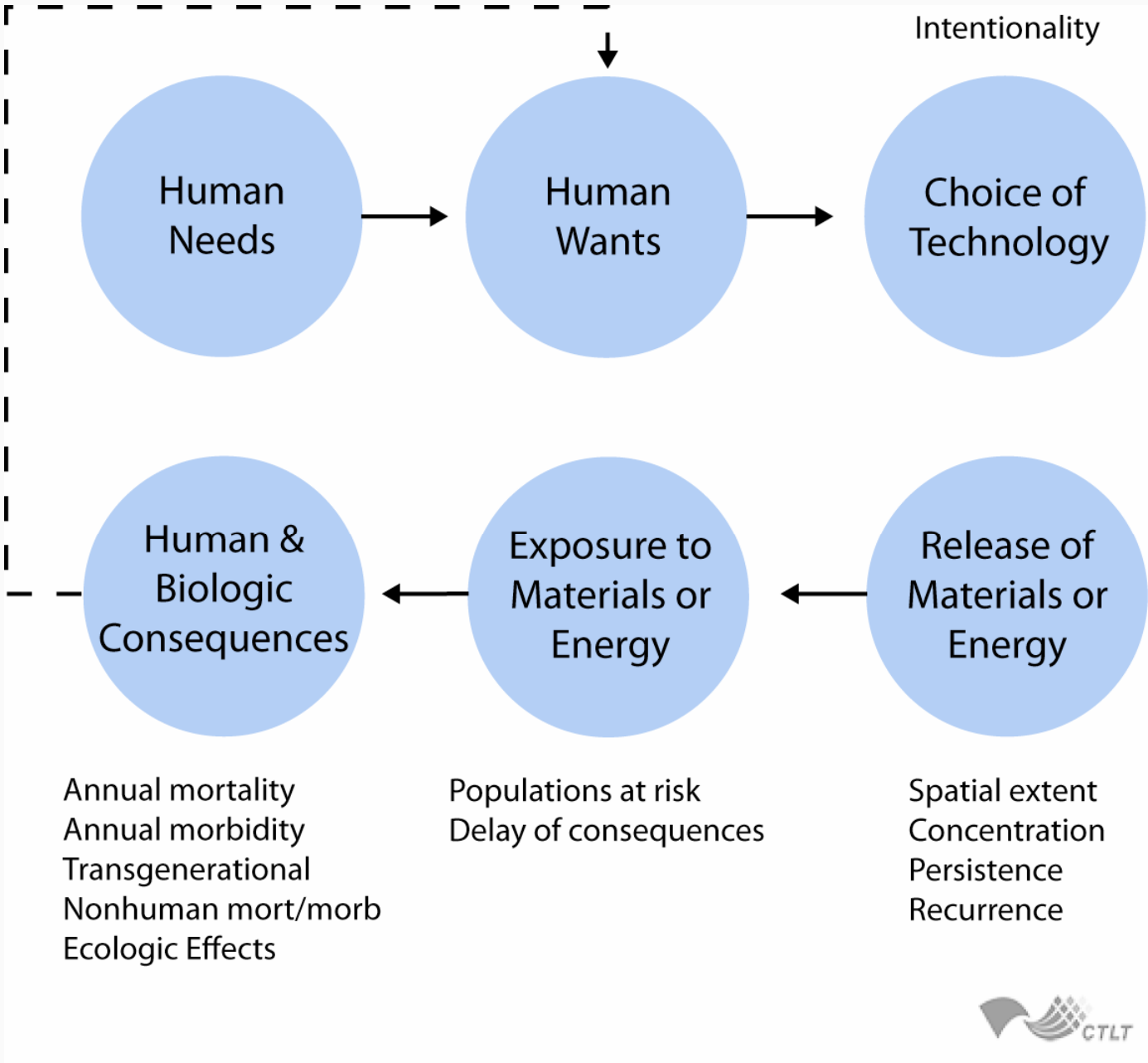
The Law of Diminishing Returns



Societal Determinants

- Human ***needs*** and ***wants*** drive choices that produce environmental impacts which, in turn, may result in adverse health consequences

Societal Determinants Flowchart



Factors

- Factors influencing environmental health problems and solutions
  - Objective (technical/scientific)
  - Subjective (non-scientific)

Examples of Technical/Scientific ("Objective") Factors

- Sources of agents
- Measurement of environmental change
- Toxicological process
- Biological susceptibility
- Engineering approaches
- Human needs

Examples of Non-Scientific ("Subjective") Factors

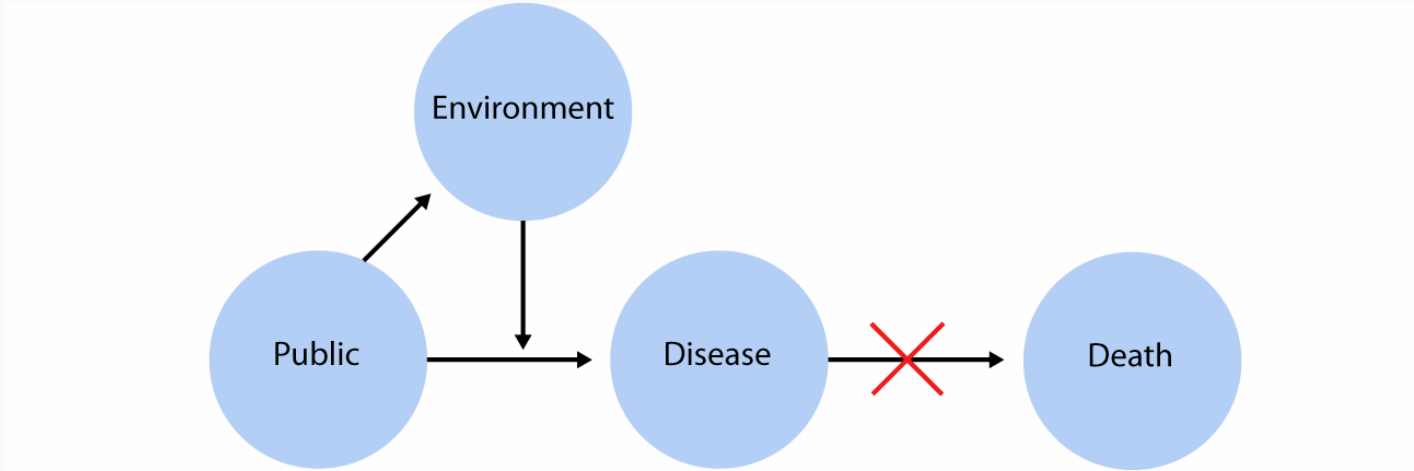
- Human wants
- Religious beliefs ("world view"; e.g., humankind vs. other species and the planet)
- Political systems
- Economic systems
- Societal values
- Population dichotomies (e.g., rich vs. poor; developed vs. developing countries)

Basic Requirements for a Healthy Environment

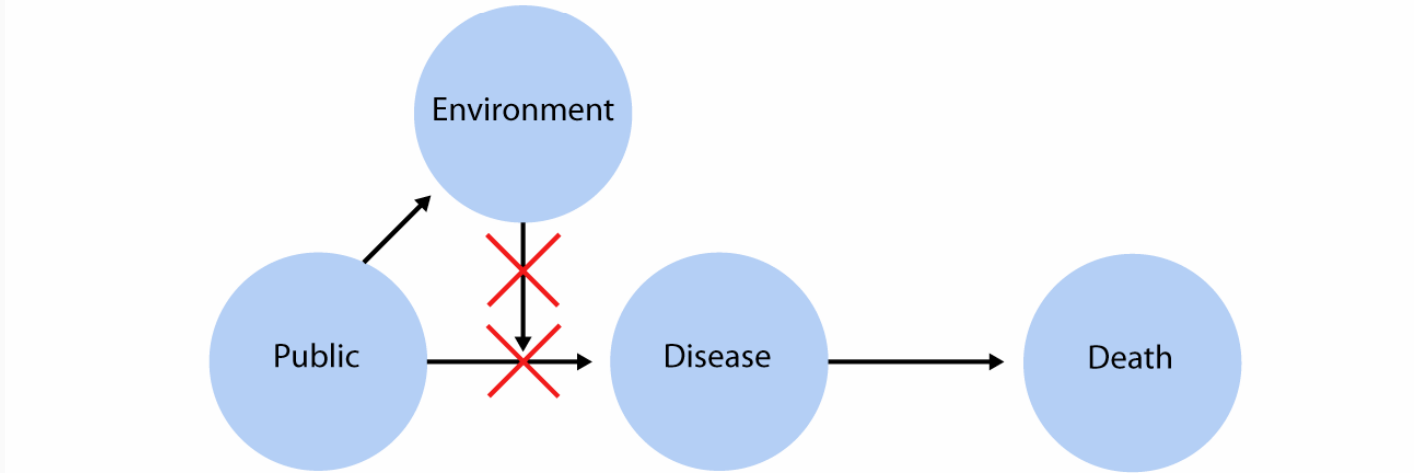
- Clean air
- Safe and sufficient water
- Safe and adequate food
- Safe and peaceful settlements
- Stable global environment

Source: Yassi et al. (2001). UNEP.

Improving Human Health and Environment: 3 Models

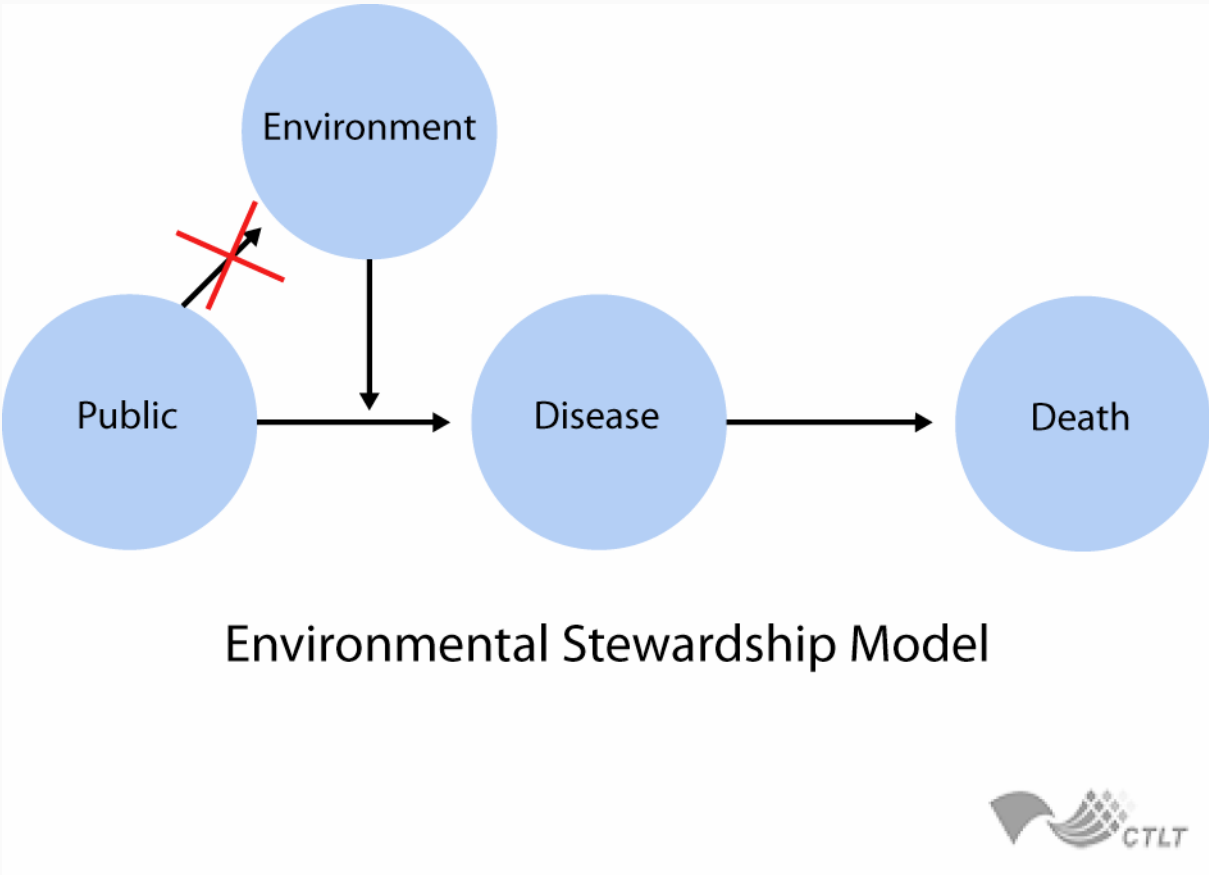


Clinical Intervention Model



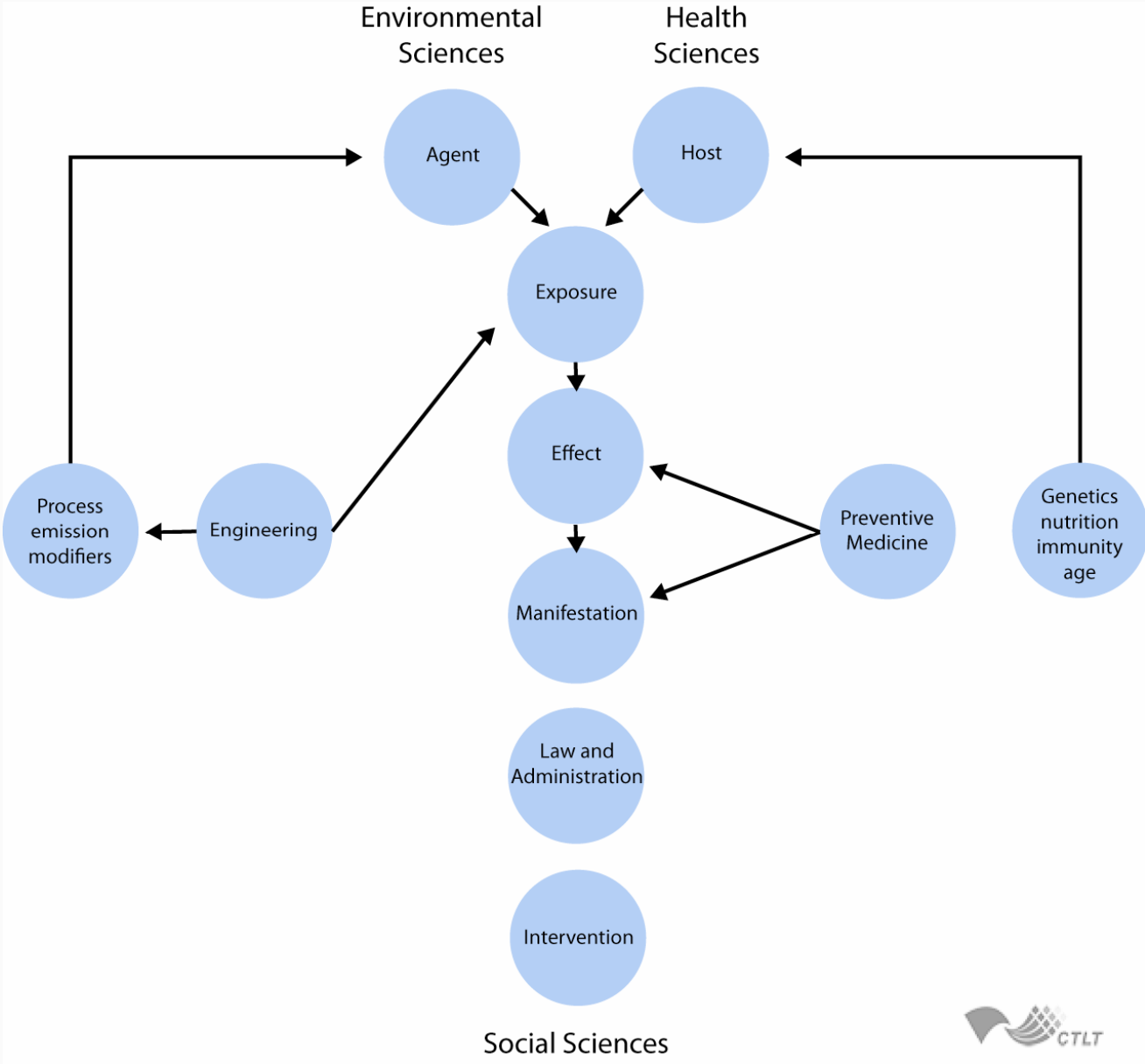
Public Health Intervention Model

Improving Human Health and Environment: 3 Models



Source: Adapted from Moeller, D. W.

Environmental Health Sciences



Key Points

- EHS is the study of those factors in the environment that affect human health
- These factors represent chemical, biological, or physical agents contained in air, water, soil, or food, and are transported to humans via inhalation, ingestion, or skin absorption
- Adverse health effects may be acute or delayed in onset, clinical or subclinical, and reversible or irreversible

Key Points

- Environmental health sciences includes
  - Environmental epidemiology and toxicology as the basis of environmental health risk assessment
  - Environmental engineering and regulation/risk communication as the basis of environmental health risk management