
Environmental Impacts on Reproductive Health: Foundations of the Science

Association of Reproductive Health
Professionals

www.arhp.org



Expert Medical Advisory Committee

- Kathleen Hill Besinque, PharmD, MSEd, FCSHP
 - Maureen Paul, MD, MPH
 - Barbara Sattler, RN, DrPH, FAAN
 - Ted Schettler, MD, MPH
 - Michael Thomas, MD (co-chair)
 - Tracey Woodruff, PhD, MPH (co-chair)
 - Sandy Worthington, MSN, WHNP-BC, CNM
-

Learning Objectives

At the conclusion of this course, clinicians should be able to:

- Appreciate impact of exposure to harmful environmental chemicals & heavy metals on reproductive health
- Express value of incorporating basic questions about environmental risks into patient history & physical examination

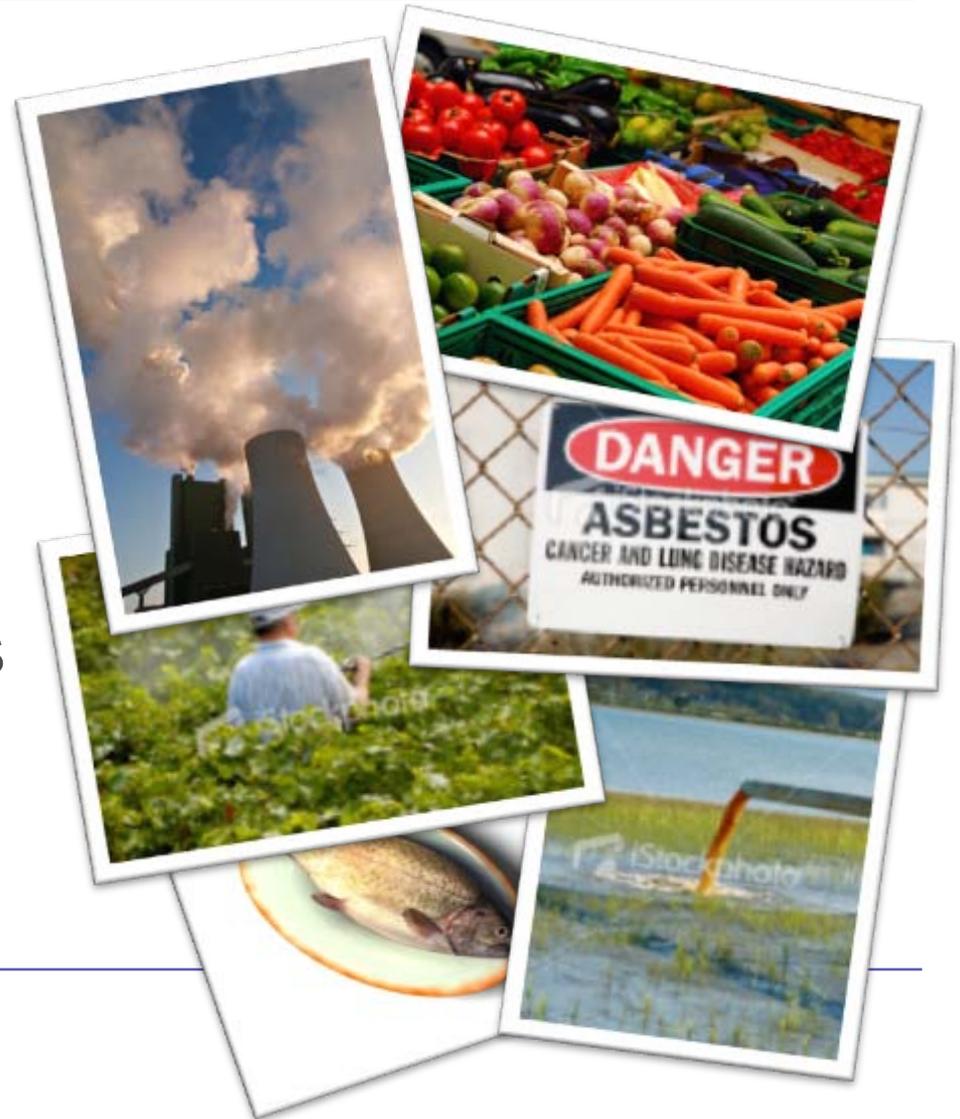
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Learning Objectives (continued)

- Use resources that provide information about environmental exposures in their communities & patient populations
 - Refer patients to relevant resources & further information to learn more about environmental risks
-

Awareness of Environmental Exposures & Impacts Is Growing

- Air pollution
- Water contamination
- Harmful substances in physical structures and workplaces
- Food contamination
- Personal care products



Awareness of Reproductive Effects Is Growing

“...exposures of males and females to foreign substances prior to conception can affect both their ability to conceive and the health of their offspring.”

Davis DL, et al.
JAMA. 1998

Reproductive Trends in Some Geographic Areas Raise Concerns

- Increase in testicular cancer incidence
- Decreasing sperm counts
- Decline in serum testosterone

more...

Reproductive Trends in Some Geographic Areas Raise Concerns (con't)

- Younger age at pubertal development in girls, possibly boys
- Fewer males being born
- Documented increases in certain types of birth defects

Some Reproductive Effects Are Well Known

Exposure	Can Increase the Risk of...	
Tobacco smoke	Miscarriage Infertility Preterm delivery	Low semen quality Low birth weight
Heavy alcohol use	Fetal alcohol syndrome Mental retardation	Behavioral problems Birth defects
Heavy metals (lead, mercury)	Miscarriage Infertility Menstrual irregularities	Abnormal sperm Altered pubertal onset
Toluene (e.g., in paint thinner, solvents)	Fetal solvent syndrome	
DBCP (pesticide)	Low sperm count	Other male reproductive effects

Jones HE, et al. *Obstet Gynecol Clin North Am.* 1998. EPA. 2008. Woodruff TJ, et al. *Fertil Steril.* 2008.

Environmental Impacts on Reproductive Health: Content Overview

This slide set will review:

- State of the science
 - Windows of susceptibility
 - Patient counseling
 - Further information and resources
-

US Chemical Production and Importation Are High

87K

Approximate no. of
chemicals
registered for
commerce in US

8K

--or one-tenth--have
been tested for
potential health
effects*

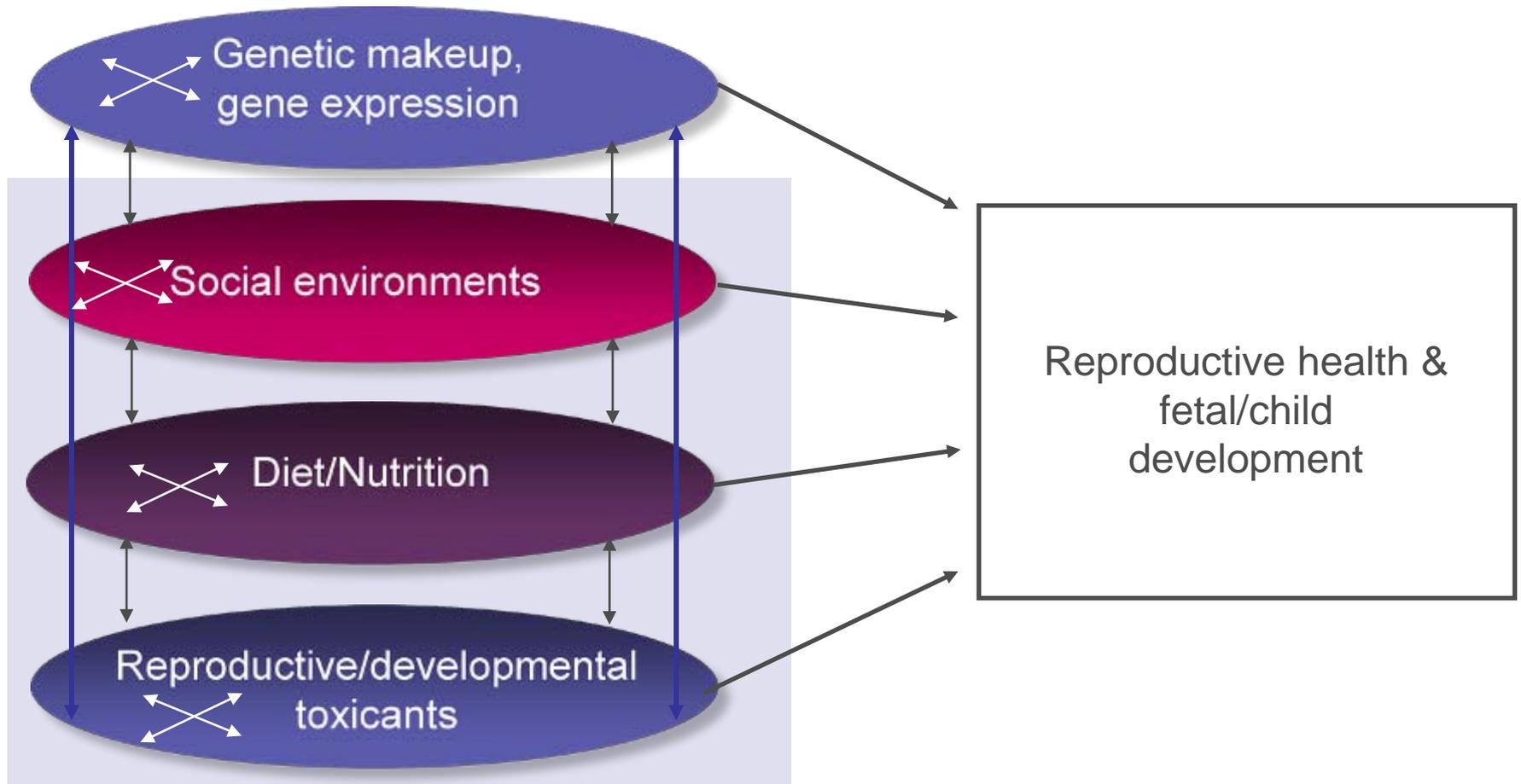
3K

are produced or
imported in annual
quantities of
>1 million pounds

*Among those tested for certain properties, reproductive/environmental effects may not have been assessed.

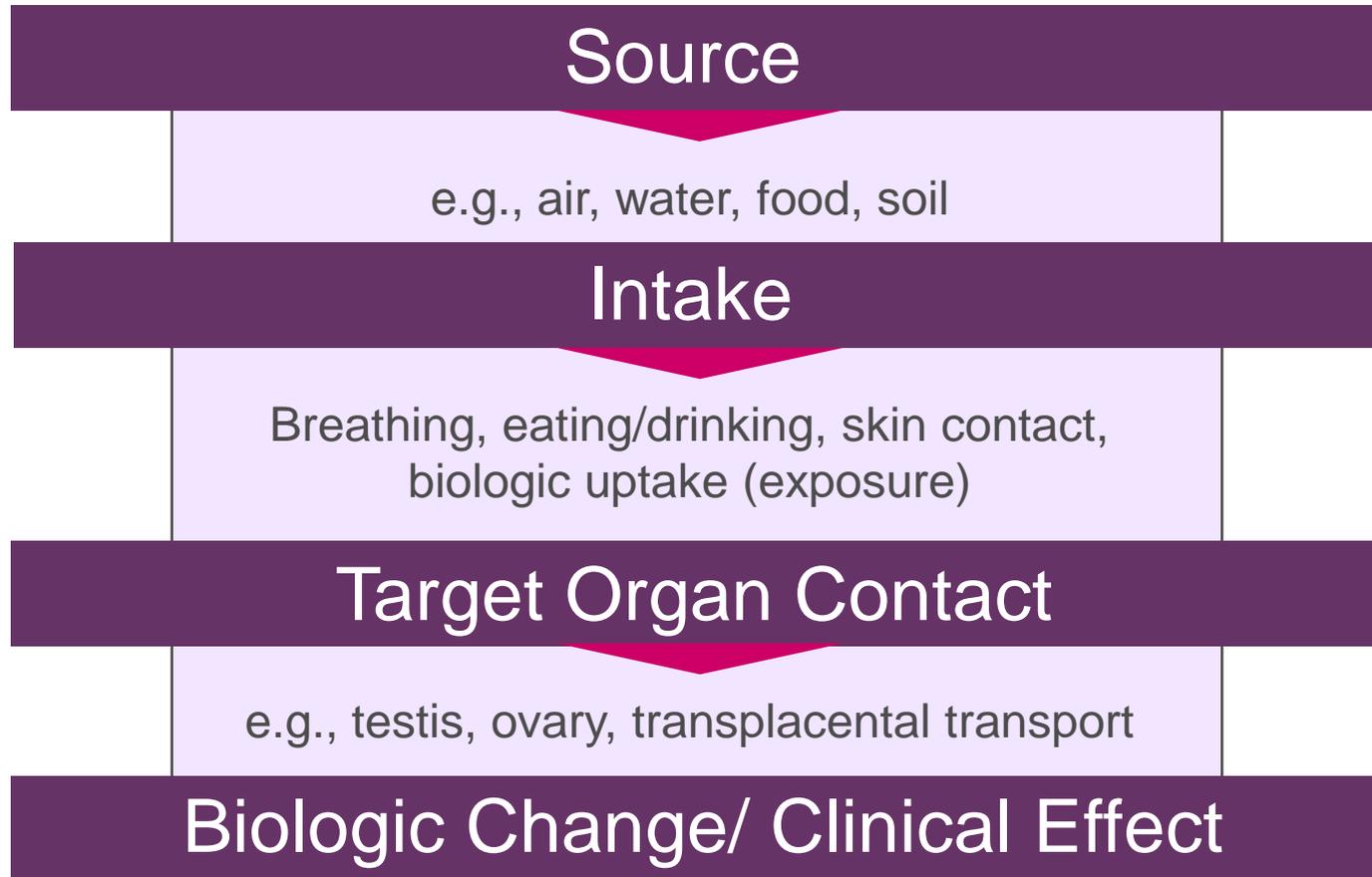
GAO. 2006; EPA. 2008.

Many Complex Factors Interact to Affect the Impact of Exposures



Adapted from Hubbs-Tait et al. *Psychological Science in the Public Interest*. 2005.

Exposure-Effect Continuum



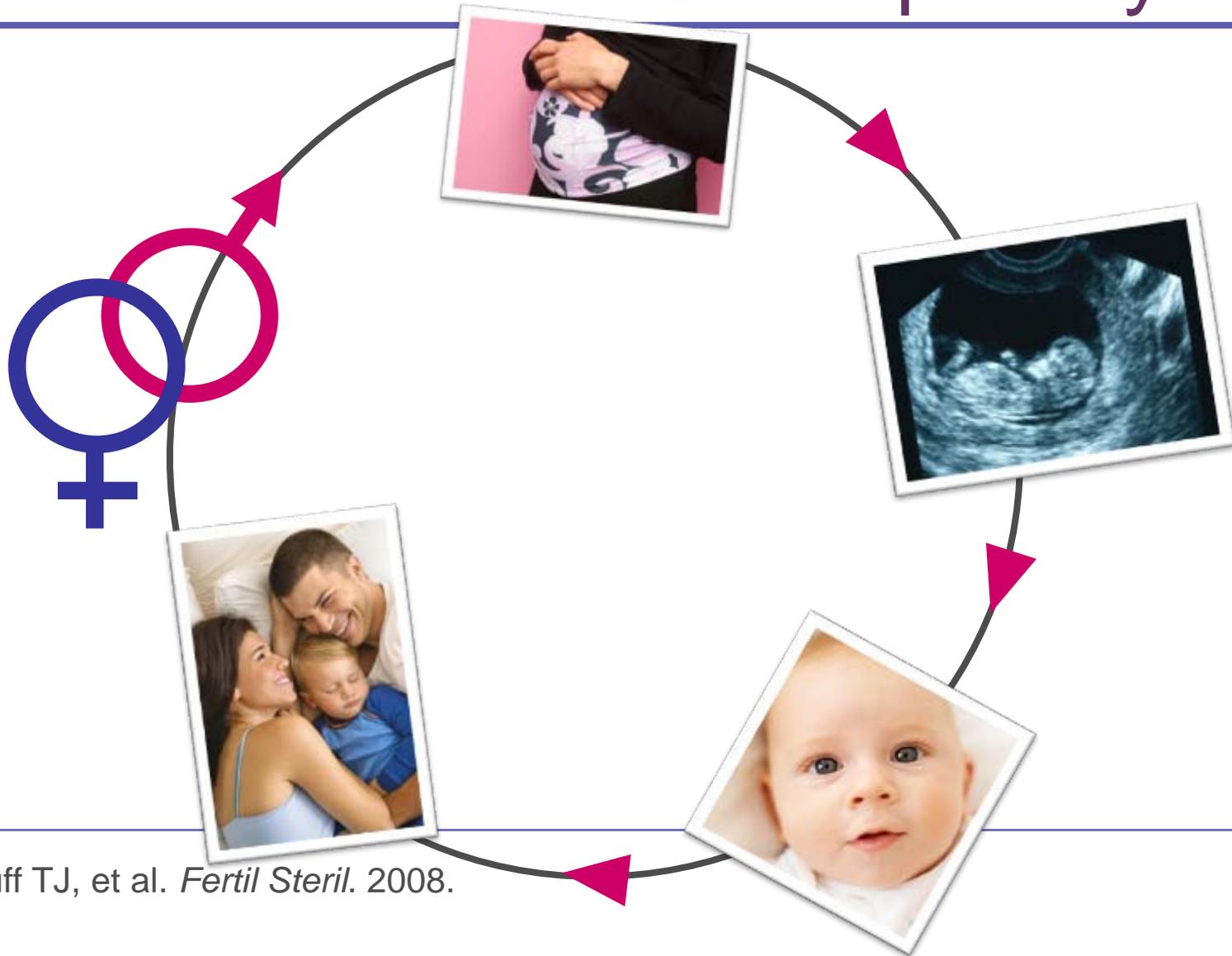
Adapted from CDC. 2009.

Biomonitoring Can Yield Useful Information

- Measures chemical levels in body tissues or fluids
- One way to determine occurrence
- Measures in blood, urine, tissues, breast milk, hair
- Accurate at low levels
- No source information
- Unclear clinical significance



Environmental Exposures and Critical Windows of Susceptibility



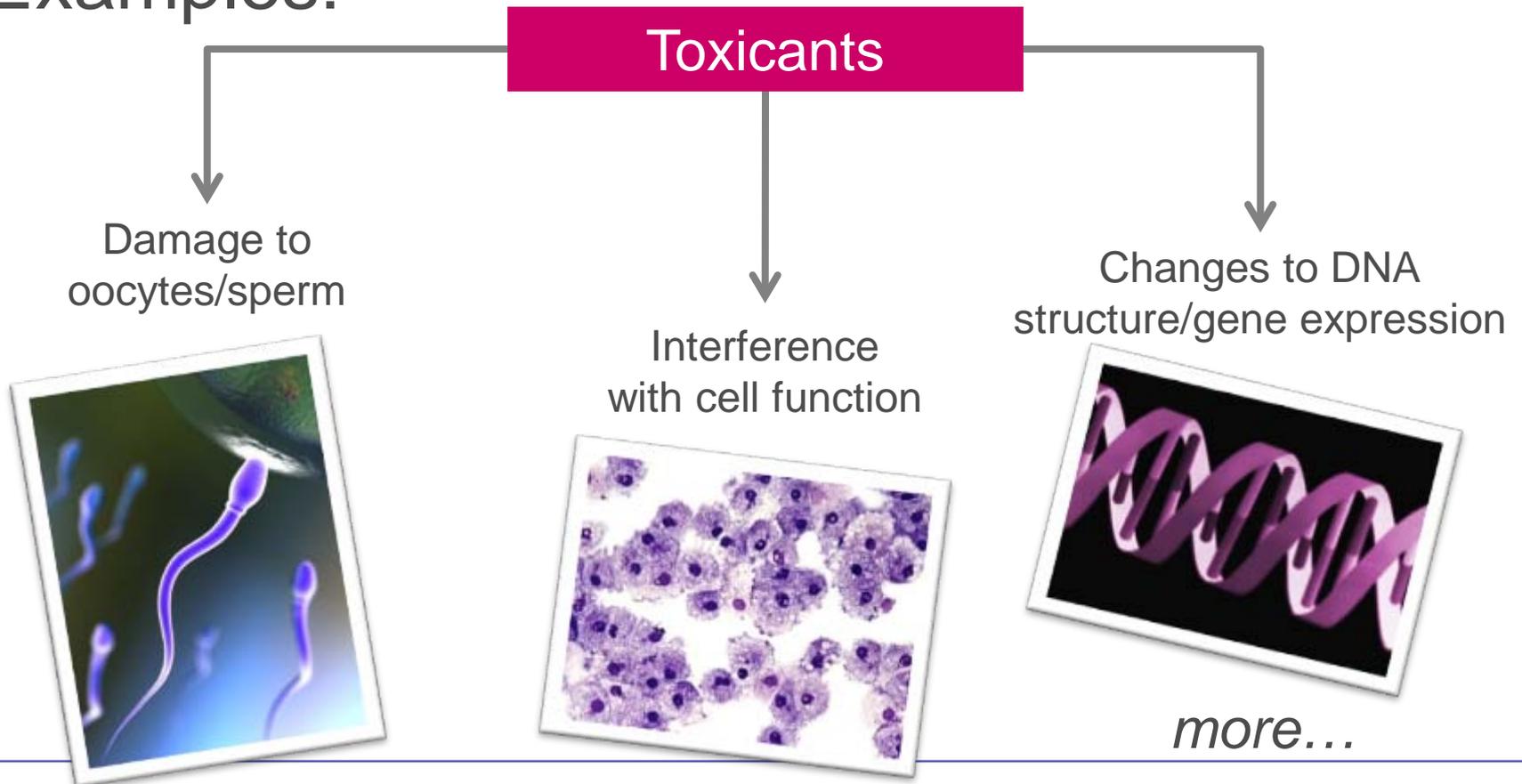
Woodruff TJ, et al. *Fertil Steril.* 2008.

Identified Reproductive Endpoints in Animal and/or Human Studies

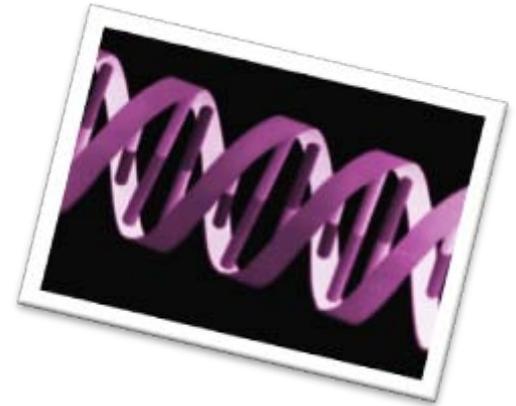
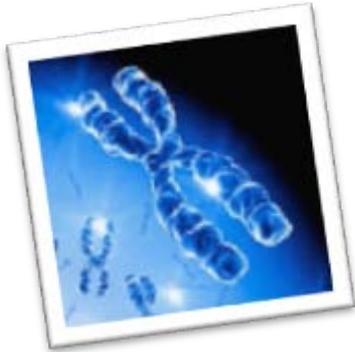
Female	Male
<ul style="list-style-type: none">• Effects on:<ul style="list-style-type: none">▪ Oocyte & follicle development & function▪ Ovary formation, cell organization▪ Uterine development▪ Corpus luteum development & function▪ Pubertal development▪ Menstrual & ovarian function• Increased risk of:<ul style="list-style-type: none">▪ Cervical/vaginal cancer▪ Infertility▪ Miscarriage	<ul style="list-style-type: none">• Effects on:<ul style="list-style-type: none">▪ Sertoli cell differentiation▪ Spermatogonia formation, sperm count▪ Testis, prostate, penis development• Increased risk of testicular germ cell cancer• Low serum testosterone levels

Environmental Effects Have Multiple Mechanisms

Examples:



Exposure May Affect DNA Structure and Gene Expression



1
Structural changes
to DNA sequence

2
Functional changes
to gene expression

more...

Exposure May Affect DNA Structure and Gene Expression

3
Structural changes
to DNA sequence

Chromosomal damage

Example:
Gene mutations

Example:
Birth defects and cancer

4
Functional changes
to gene expression

Modification of
gene expression

Example:
Hormone disruption

Examples:
Altered hormone levels,
altered pubertal development

Epigenetic Effects Result from Changes to Gene Expression

Epigenetic effects:

- Not caused by internal changes in DNA
- May be caused by external environmental factors that modify gene activation
- Can persist into a second generation—or three or more generations

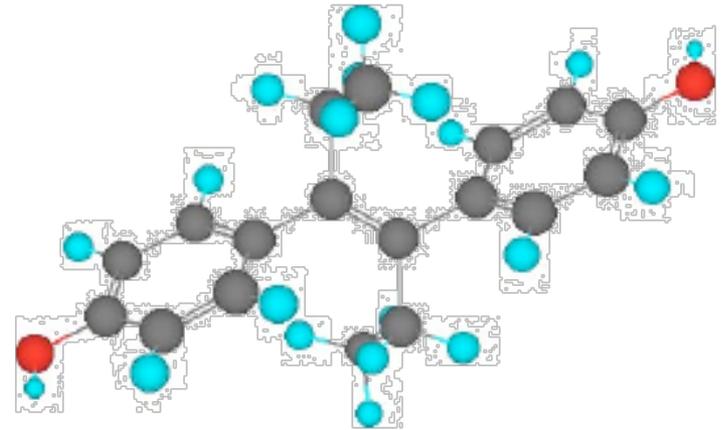
The Barker Hypothesis

“Exposures to adverse insults during critical...windows of development can permanently reprogram normal physiologic responses, and thus give rise to...disorders later in life.”

Woodruff TJ, et al.
Fertil Steril. 2008

DES: An Example of Delayed Effects

- Given to pregnant women from 1930s to 1970s to prevent miscarriage
- Linked to health effects in offspring
- Increased cancer risk; reproductive abnormalities



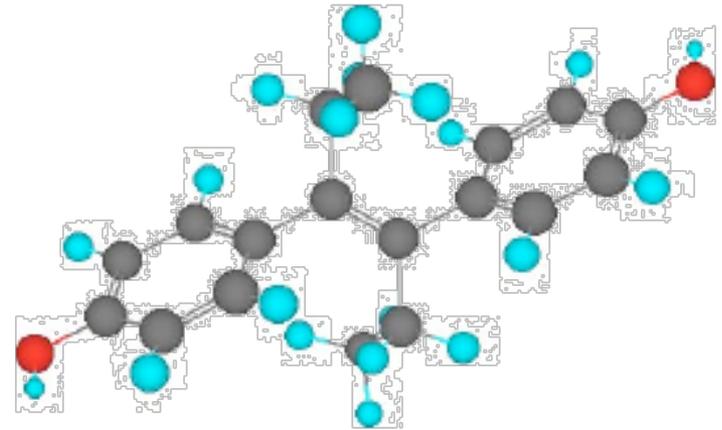
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DES: An Example of Delayed Effects

(continued)

Examples of delayed effects in offspring:

- High-risk pregnancy; miscarriage
- Increased vaginal, cervical, breast cancer
- Increased infertility
- Structural defects in reproductive organs



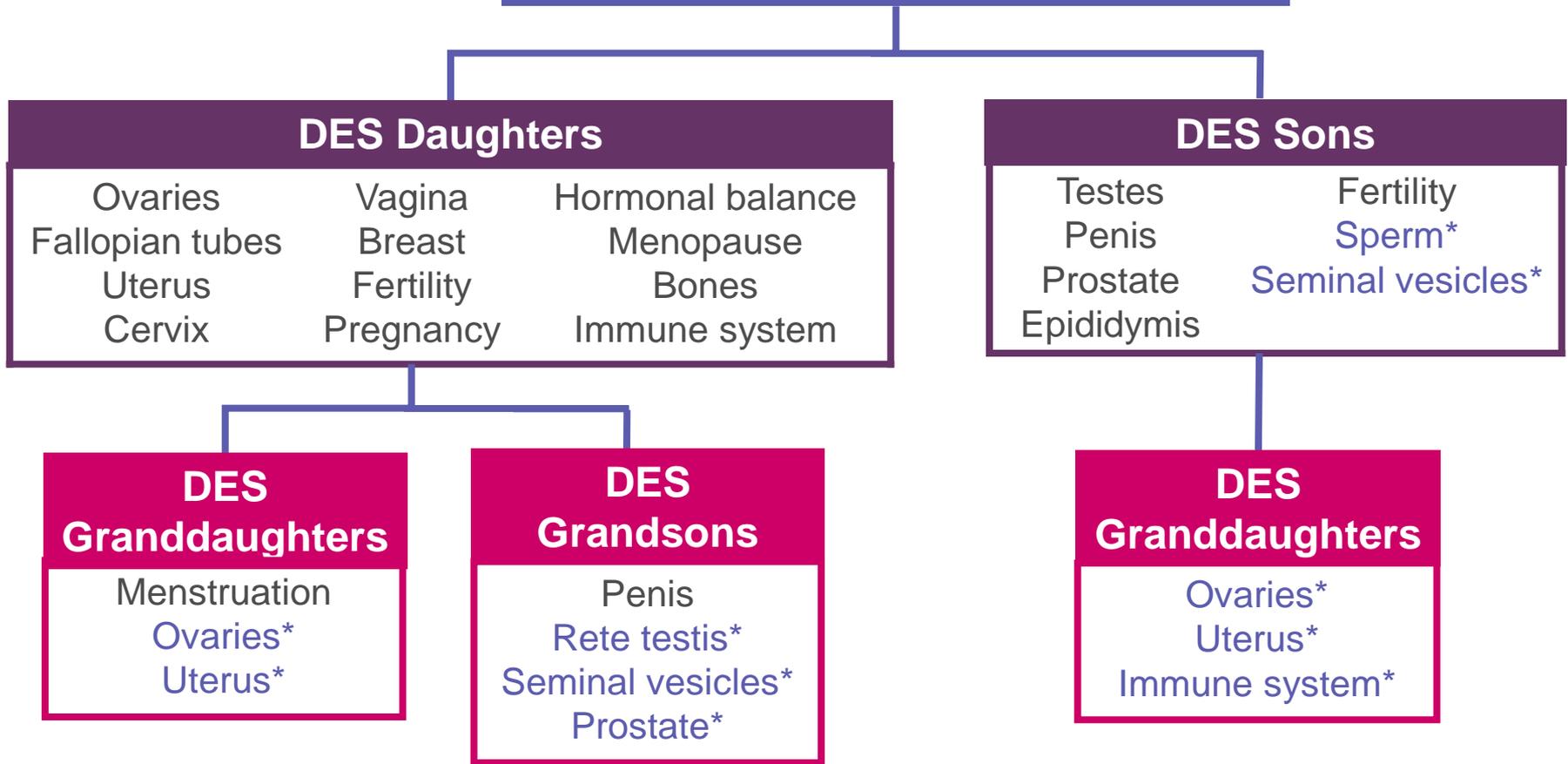
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DES: An Example of Delayed Effects

(continued)

* = Effects in animals

Women who took DES while pregnant



Adapted from Schwartz JM, Woodruff TJ. *Shaping Our Legacy*. 2008.

Endocrine-Disrupting Chemicals

- Certain pesticides, industrial chemicals & byproducts, ingredients in plastics manufacture
 - Interfere with hormonal levels or functions, including estrogen, testosterone, prolactin, LH, FSH, thyroid, etc.
 - Demonstrated by rigorous animal studies & epidemiological observations

Lessons Learned from EDCs: PCBs

Name	Polychlorinated biphenyls (PCBs)
Uses	Coolants and lubricants in electrical equipment before 1977
Route of Exposure	Mainly food contamination; body burden levels had been decreasing but recently have leveled off

more...

EDC Lessons Learned: PCBs (continued)

Examples of potential effects:

- Altered neurodevelopment as a result of in utero exposure
- Endometriosis
- Reduced fertility
- Decreased semen quality
- Miscarriage
- Altered pubertal development
- Reproductive tract malformations

Conventional Assumptions Are Being Questioned

Most environmental effects studies (reproductive health) based on assumptions:

Assumption:

Environmental research indicates:

Doses below a certain threshold are safe.

Effects of very low doses have been underestimated.

High-dose testing predicts low-dose results.

High-level tests do not necessarily predict low-level impacts.

Effects increase with dose in a linear fashion.

Some effects are seen only at low levels.

Most Environmental Health Science Is Based on Animal Studies

- Most evidence for environmental health (EH) effects derived from animal studies
- Effects found effects “real-life” doses



Many Factors Complicate the Environmental Health Picture

- “Safe” levels often based on limited endpoints, political/economic considerations can influence the choice
- Epidemiological studies limited capacity to identify causal relationships
- Many factors contribute to complexity of this area
- Clinical relevance not always clear in the individual

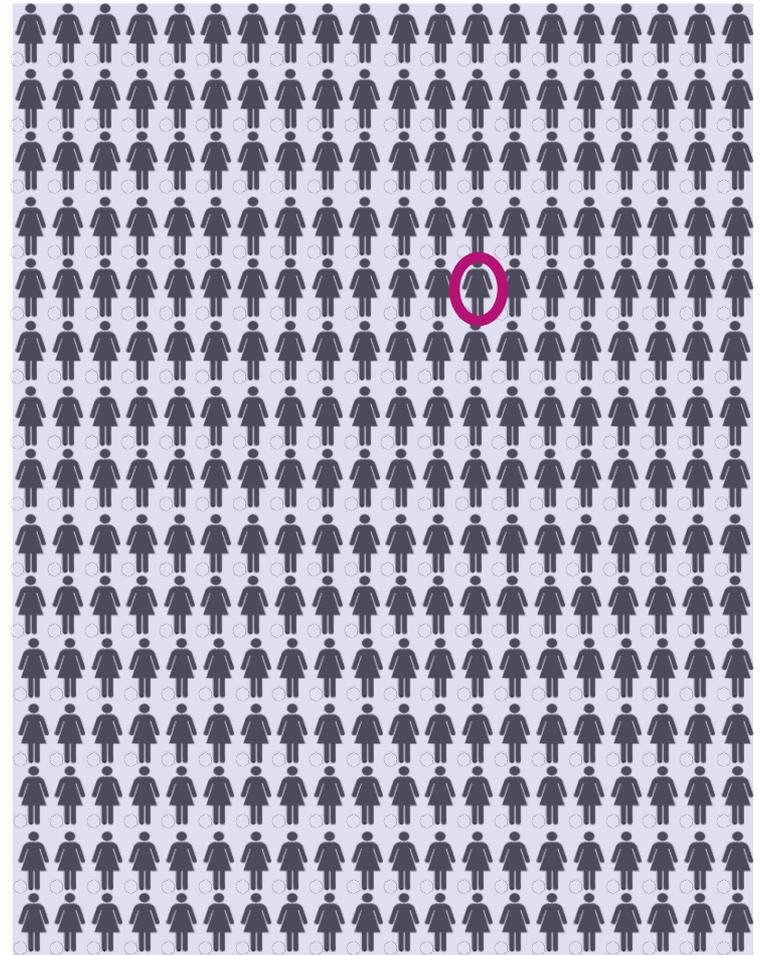
The Precautionary Principle

“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically.”

SEHN. 2008.

Translating Population-Wide Risks into Individual Risks

- Clinicians work with individuals, not populations
- Elevated population-wide risks may be extremely small for an individual

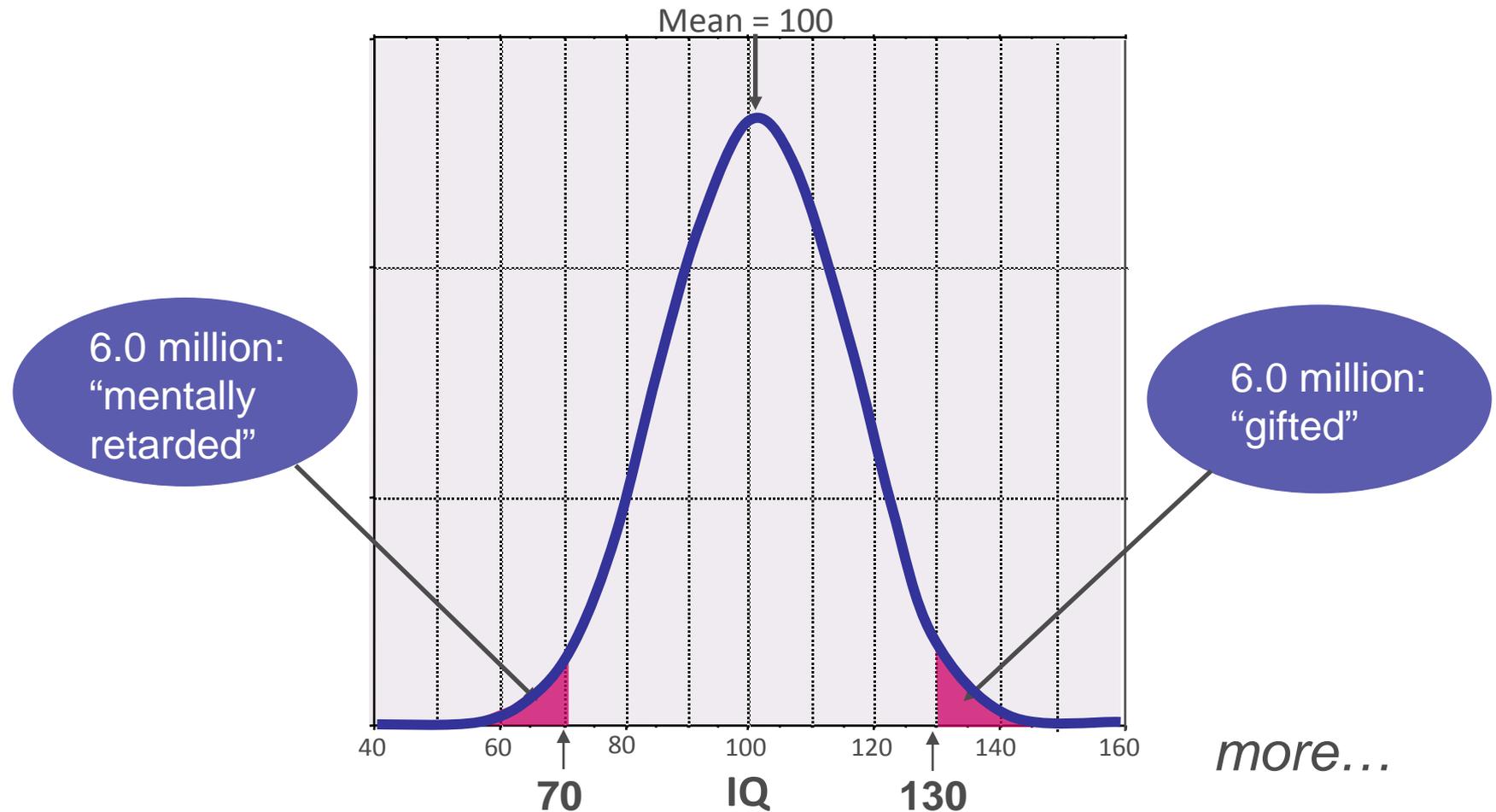


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Translating Population-Wide Risks into Individual Risks (continued)

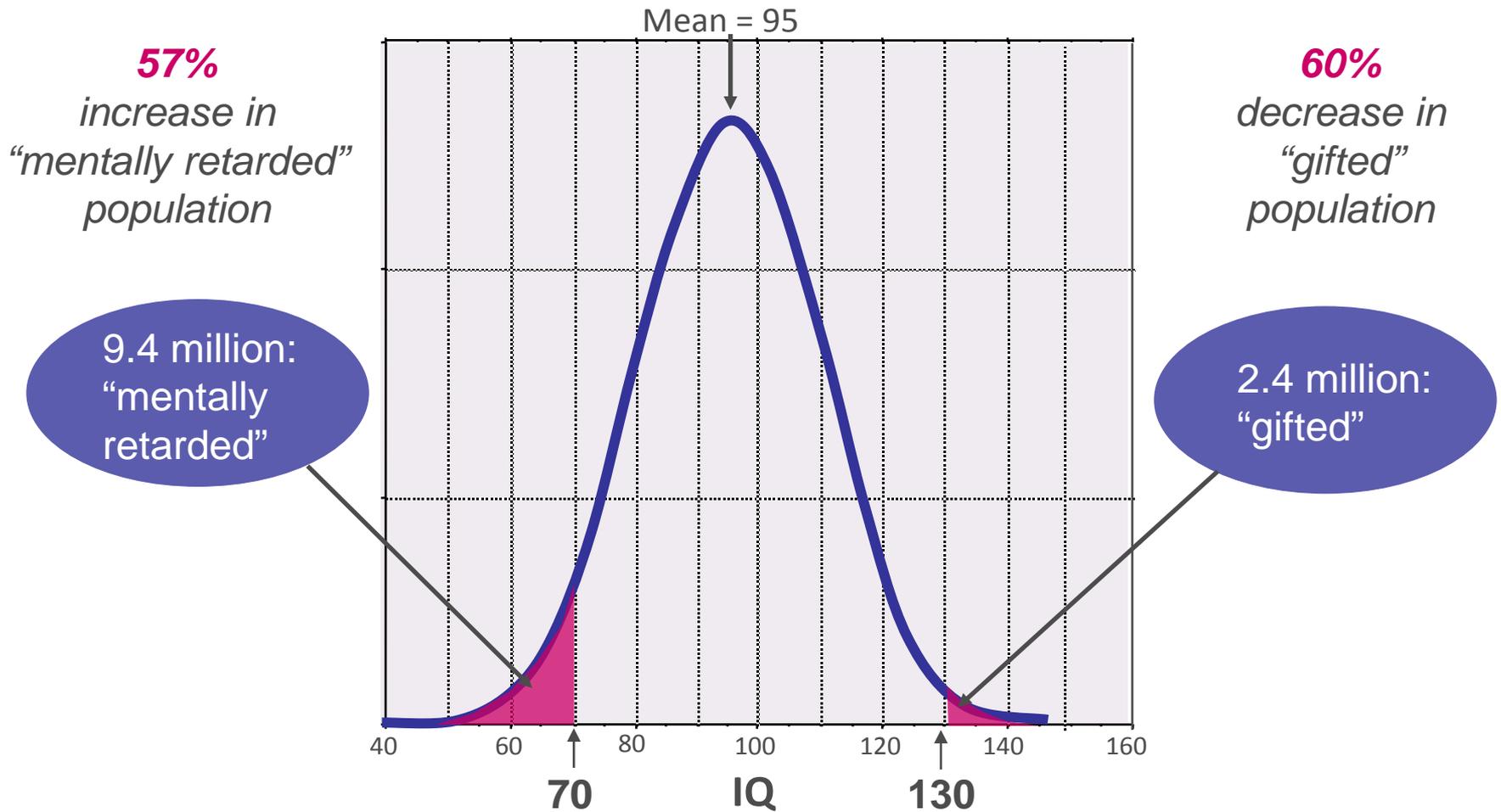
- Modest increases in risk can result in major public health concerns if exposed population is large
- A large increase in risk will be increasingly important in individuals, even if not many people are exposed
- Two times a rare event = still a very rare event

Small Effects Can Have Large Significance



Adapted from Weiss B. *Neurotoxicology*. 1997.

Small Effects Can Have Large Significance (continued)



Adapted from Weiss B. *Neurotoxicology*. 1997.

“So What Do I Do?”

- Science for environmental exposures and reproductive health is:
 - Primarily based on animal studies
 - Warrants guidance to limit/avoid exposure
- Approach patients on case-by-case basis
- Exposure is unavoidable, but specific changes can make a difference

Patient Counseling: Focus on Windows of Susceptibility

- For male and female adolescents
- For male and female patients who experience unintended pregnancy
- For women and men during pregnancy planning
- For pregnant women
- For male and female patients with newborns and children

Environmental Health History Should Be Routine

The Environmental Health History

HOW?

Incorporate into reproductive health history

WHEN?

Vulnerable Stages:

- Early childhood
- Puberty
- Adolescence
- Preconception planning (men & women)
- Pregnancy

WHY?

Identify and reduce or eliminate potentially harmful exposures

Guide patients in making decisions

One Tool for Conducting an Environmental History: CH₂OPS



Community



Home/**H**obbies



Occupation/
School



Personal



Socioeconomic

Adapted from Schettler T. 2009.

CH₂OPS: Community



Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

Community: Guidance for Patients

Learn about/inform patients about community organizations & resources, such as:

- Dry cleaners that avoid toxic solvents
- Salon products without toluene, phthalates, and other toxic chemicals
- Grocery stores that carry organic products

Resource Tip:

- Download the [What We Can Do: Community Efforts to Protect Our Health](#) Tool Kit from the [Women's Health and the Environment](#) Web site

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

CH₂OPS: Home/Hobbies

- Pesticides
- Adhesives
- Furniture products
- Cleaners
- Detergents
- Gardening products
(e.g., pesticides, plant food)



more...

CH₂OPS: Home/Hobbies, cont.

Exposure to:

- Carbon monoxide
- Metals
- Solvents

Fishing:

- Be aware of fish advisories for mercury



more...

Home: Guidance for Patients

- Check for lead paint and pipes; manage dust
- Avoid vinyl products, such as shower curtain liners
- Avoid certain types of plastics for food:
 - **No. 3:** Polyvinyl chloride (PVC)
 - **No. 6:** Styrene (Styrofoam)
 - **No. 7:** Polycarbonate (bisphenol A [BPA])
- Where possible, avoid food stored in plastic containers or plastic wrap *more...*

Home: Guidance for Patients (continued)

- Use glass, ceramic, or food-safe metal containers
- Avoid using pesticides in homes, lawns, gardens, or on pets
- Wash fruits and vegetables; buy organic

Resource Tips:

Extensive resources are available to eliminate the use of pesticides or to use less toxic products. Some examples include:

- Visit www.beyondpesticides.org
- Visit the Pesticide Action Network (PAN): www.pesticideinfo.org
- Download the [Shopper's Guide to Pesticides](#) wallet card from the Environmental Working Group

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

Home: Guidance for Patients (continued)

- Read labels on cleaning products
- Avoid using ammonia or chlorine
- Use inexpensive, nontoxic products such as vinegar and baking soda



Resource Tip:

- Find [nontoxic cleaning recipes](#) on the Women's Voices for the Earth Web site or www.care2.com

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

Home: Guidance for Patients (continued)

Limit fish with high levels of mercury

Albacore tuna

King mackerel

Shark

Tilefish

Swordfish



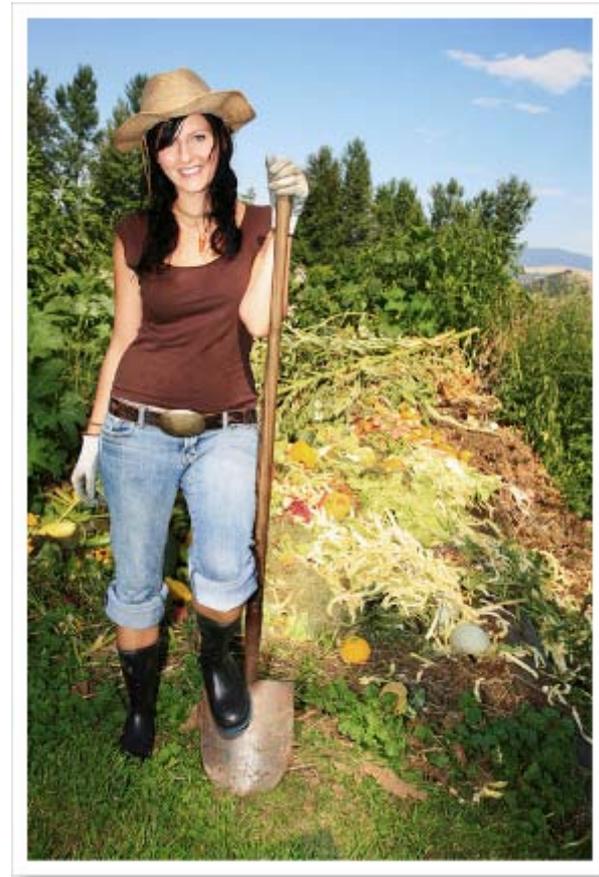
Resource Tips:

- Learn about [on-local fish advisories](#) from the EPA
- Download a [regional fish seafood-watch pocket guide](#) from Seafood WATCH

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009; US Food and Drug Association. 2009.

Hobbies: Guidance for Patients

- Understand mercury present in recreationally caught fish
- Use glue and solvents in well-ventilated spaces
- Garden with organic products



Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

CH₂OPS: Occupation/School

- Chemicals
- Radiation
- Biological agents
- Pesticides in schools



Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

Occupation: Guidance for Patients

- Use protective gear with toxic substances or radiation
- With chemicals, wash exposed skin; change work clothes; clean exposed clothes separately
- Understand chemicals used at work
- Take extra care if pregnant (or planning pregnancy)

Resource Tip:

- Learn more from the CDC report, ["The Effects of Workplace Hazards on Female Reproductive Health"](#)

Occupation (Schools): Guidance for Patients

Advise patients:

- Practice non-pesticide insect management; inform parents if pesticides used
- Use fresh fruit & vegetables; avoid junk foods in cafeterias
- Avoid pressure-treated woods (arsenic) in playground equipment

Resource Tip:

- Visit the [Healthy Schools Network](#) Web site and EPA's [Healthy School Environments](#) Web site to learn more about creating a healthier school environment

CH₂OPS: Personal

- Dietary history
- Alcohol use
- Tobacco use
- Prescription & non-prescription medications
- Substance abuse
- Insect repellants
- Cosmetics; personal care products



Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

Personal: Guidance for Patients

Advise patients:

- Use fewer, simpler products
- Don't trust "dermatologist-tested," "natural," "organic"
- Avoid tobacco use; exposure to 2nd-hand smoke
- Use alcohol in moderation
- Learn about skin products that are safe for children

Resource Tips:

- Check the safety of your own personal care products at the [Skin Deep Cosmetic Safety Database](#) and the [Campaign for Safe Cosmetics](#)
- Download the [Safety Guide to Children's Personal Care Products](#) from the Environmental Working Group
- Visit www.HealthyToys.org to find toy rankings and a safer toy shopping list

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

CH₂OPS: Socioeconomic

- Living in higher levels of air pollution
- Exposure to lead, asbestos
- Limited access to nutritious food
- Vulnerability to other factors



Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.

Socioeconomic: Guidance for Patients

Advice for patients:

- Know tenant & citizen rights
- Work with community organizations, government agencies to ensure risk awareness & knowledge

Resource Tip:

- Visit the [Alliance for Healthy Homes](#) Web site for tools and tips on reducing environmental hazards in homes and communities

An Important Take-Home Message

Identifying and reducing exposures to potentially harmful toxicants *now*, when couples plan (or not) a pregnancy, increases the likelihood of a successful outcome.

ARHP Resources on Environmental and Reproductive Health

Learn more at the ARHP Web site:

- Click on Environmental and Reproductive Health topic area
 - www.arhp.org/topics/enviro-repro-health
 - Fact Sheet: *Environmental and Reproductive Health Resources for Health Care Providers*
 - Patient handout: *Health Matters: The Connection Between Your Health and the Environment*
-

Clinical Resources on Environmental and Reproductive Health

- Critical Windows of Development (www.endocrinedisruption.com): Online tool from The Endocrine Disruption Exchange (TEDX)
- ReproTox (www.reprotox.org): Summaries on the effects of >5,000 agents and exposures on pregnancy, reproduction, and development
- TOXNET (<http://toxnet.nlm.nih.gov/>): Databases on toxicology, hazardous chemicals, environmental health, and toxic releases

more...

Clinical Resources on Environmental and Reproductive Health (continued)

- American College of Occupational and Environmental Medicine (www.acoem.org)
 - Collaborative on Health and Environment (CHE) database (<http://database.healthandenvironment.org/>)
 - EnviRN (www.envirn.umaryland.edu)
 - Local environmental health specialists
 - Occupational and environmental health departments in universities
-

Summary

- Environmental exposures affecting world's health and welfare
- Critical windows of susceptibility
 - Preconception to the postnatal periods
 - Childhood
 - Adolescence
 - Adulthood

more...

Summary (continued)

Clinicians can help by offering guidance, counseling, and resources:

- Incorporate an environmental/occupational history as part of patient health history
 - Be aware of risks in your community
 - Work with community groups to reduce exposure levels
 - Provide education and information sources
-