Basics of Environmental Health
Objectives:

• Be able to identify the major exposure routes and importance for toxicity

• Understand characteristics/issues that influence exposure levels

• Understand the importance of dose-response in environmental health
BASICS OF EXPOSURE
Major Exposure Routes:
Exposure Route & Toxicity:

Depending on exposure route, some chemicals can have very different toxicities. Why?

Tetrodotoxin  Paraquat  Elemental Mercury
Skin (Dermal) Exposure:

Absorption rate of chemicals varies by location of skin. The eyelids and genitalia have the quickest absorption rates. The soles and palms tend to have the slowest absorption.
Absorption of chemicals through the skin is promoted by:

- high lipid solubility
- sweaty, hot skin
- wrapping of skin
- abrasion or injury
- presence of solvents
Ingestion:

Most absorption occurs in the small intestines. The lining of the intestinal tract is only one cell thick and has an extremely large surface area. Absorption can occur throughout, including the mouth and rectum. To limit toxic effects from ingestion, time is essential to limit absorption.
Inhalation:
Adults breathe several cubic meters of air per day, depending on activity level. Fibers and small particles (< 1 micron) can be lodged in the lungs. Other gases can diffuse across the respiratory lining and enter the blood.
Duration of Exposure

The length of time that an organism is exposed to a chemical is critical to determine toxicity.

**Duration** and **frequency** contribute to dose. Both may alter toxic effects.

- **Acute** Exposure = typically involves a single or short exposure
- **Chronic** Exposures = multiple exposures over time (frequency)
Exposure Example: Lead in toys

The concern from lead containing toys is ingestion through hand-to-mouth activity. Problematic toys include antiques or toys manufactured in another country. Lead may be found on the paints of imported toys, as well as the plastics from other toys.

Sunlight, normal aging and detergents can all help release lead from plastic. Over time, paints begin to flake off as well.

Source: US CPSC 2007
Vulnerable Populations

- Young
- Elderly
- Immunocompromised
- Organ Transplant
- Pregnant/breast feeding
- Enzymatic deficiency
- Genetic makeup
- Subsistence
- Socio-economic status
Concerns for women of child-bearing age?

Toxins can cross the placenta and are found in breast milk.

Fetal exposure can effect behavioral, neurological and cognitive function in infants and children.

Many of the most pronounced effects occur in the first trimester and some chemicals have a long half-life.
BASICS OF DOSE & RESPONSE
Dose-Response

A key concept in toxicology is that a quantifiable relationship exists between a chemical concentration and the magnitude of the toxic effect (i.e. the “Dose Makes the Poison”).

In a given population, there will be a range of sensitivities. There will also be an average sensitivity or dose in a population. These averages are important to determine.

*Paracelsus*

* a.k.a Areolus Phillipus Theophrastus Bombastus von Hohenheim
Effects of Amount on Response

A Small Dose of Toxicology
Effects of Size on Response

A Small Dose of Toxicology
Dose Response

Reference Dose (RfD)

No Effect Level

Uncertainty Factors

Dose

Response
Declining “Safe Dose” of Lead

Acceptable Childhood Blood Lead Levels

Agency and Year

Blood Lead (µg/dl)

CDC 1960: 60
CDC 1973: 40
CDC 1975: 30
CDC 1985: 25
WHO 1986: 20
EPA 1986: 15
CDC 1990: 10
CDC 2006?: 2

A Small Dose of Toxicology, modified
Biomonitoring:

One method for assessing human exposure to chemicals is by measuring the chemicals or their metabolites in various biological samples.

Often, the metabolite (breakdown product) of the chemical is detected in samples because the parent compound is changed by the liver or other organ.
Biomonitoring:

- Urine
- Blood
  - fetal cord
  - whole
  - plasma
- Hair (limited)
- Tissue
- Breast milk
- Exhaled air
- Nails (limited)
- Saliva
- Biomarkers
Testing for Chemicals

For biomonitoring tests, urine or blood is the gold standard. The form of the chemical tested is important. For example, total arsenic (inorganic + organic) is usually reported in urine tests. Usually, we are more concerned about inorganic arsenic. However, fish contain lots of organic arsenic. Therefore, one should avoid fish and shellfish for 3 days to get an accurate inorganic test result.