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

**Major Exposure Routes:**

- **Paraquat**
- **Elemental Mercury**
- **Tetrodotoxin**

**Exposure Route & Toxicity:**
Depending on exposure route, some chemicals can have very different toxicities. Why?

- **High Absorption Rates:**
  - Scalp/forehead
  - Eyes/eyelids

- **Medium Absorption Rates:**
  - Arms/legs/back
  - Palms

- **Low Absorption Rates:**
  - Genitalia
  - Soles

**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

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.

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)

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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

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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 affect behavioral, neurological, and cognitive functions 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*
Effects of Amount on Response

Effects of Size on Response

Dose Response
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
  - Plasma
  - 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.

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