

Environmental Health Resoures Self Learning Module

Toxicology



**Agency for Toxic Substances
and Disease Registry**
Division of Community
Health Investigations




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- Arrow keys or
- Page Up and Page Down keys.

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Overview and Objectives

This module has been created to provide local health agencies a quick overview of toxicology as well as additional, more detailed resources. While geared to local health departments (LHDs), the materials may be useful for other environmental health professionals.

Objectives:

- Gain familiarity with toxicology **terminology**
- **Raise or enhance understanding** of toxicology and the role of local health agencies in its application
- Use the modules to **enhance understanding of community concerns** about potential exposures to contaminants



Module Organization

This Toxicology resource is organized by:

1. A [printable summary](#) of toxicology basics.
2. A [self-study module](#) that contains more detailed training and resources about toxicology.

Toxicology

Part One: Summary Overview





Toxicology Definition

Toxicology is the **study of the harmful effects of substances on humans or animals**. The word “toxicity” describes the degree to which a substance is poisonous or can cause injury.



Toxicology Terminology

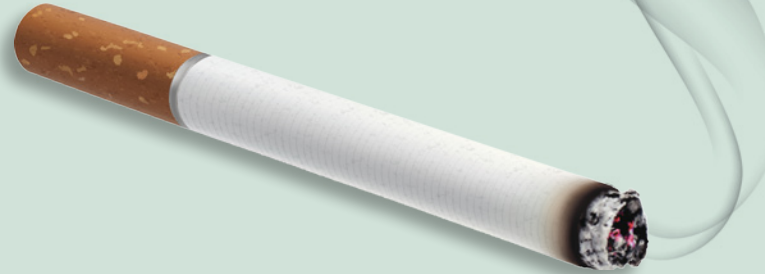
Toxicity

Toxicity depends on a variety of factors:

- dose
- duration
- route of exposure
- shape and structure of the substance itself (the three-dimensional shape of a molecule)
- individual human factors such as differences in health status, sex, and genetics



Dose



The dose is the amount of a substance that enters the body.

- Dose is often measured as a fraction of milligrams (or micrograms) per body weight (e.g. kilogram).
- Time (duration) that you are exposed to a substance is often given as dose per day (e.g. amount/weight per measure of time).

In general, the higher the dose or longer the time someone is exposed, the more an effect is present.



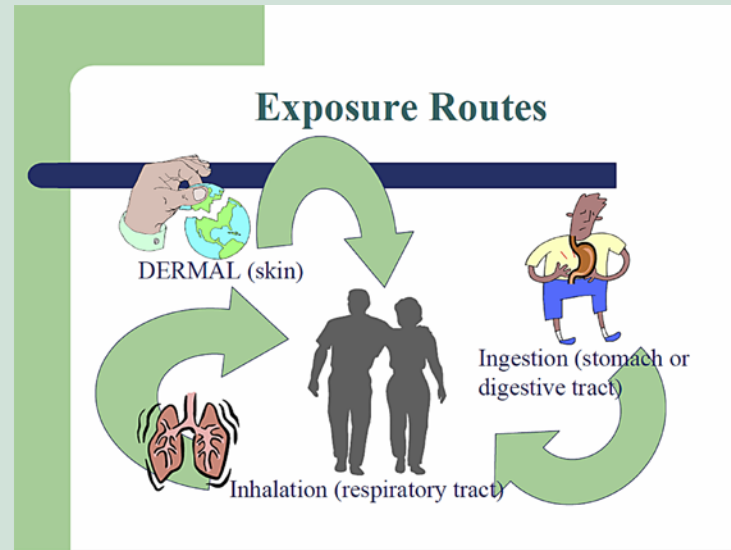
Environmental Exposures

Environmental exposures are often divided into two categories based on the amount of time exposed:

- acute exposure is short-term (e.g., 24 hours)
- chronic exposure is long-term (e.g. weeks, months, or years)

Environmental exposure to substances occurs through [three major routes](#):

- Ingestion (eating)
- Inhalation (breathing)
- Dermal (skin) contact





Exposure Example



Garden. Source: City of Blue Island, 2014.

When a person gardens, they have dermal contact with the dirt and substances in the dirt. If the substances stick to their skin, they will be exposed for the entire time they are gardening until they wash their hands and remove anything they have touched. They also may inadvertently inhale or ingest substances on their hands or under their fingernails. They should be careful to not eat until they have washed their hands. A person can lower their chance of dermal exposure by wearing gloves.



Exposure Factors Handbook

We know that we don't all react the same way when exposed to different substances. In particular, we have learned that exposure to the same substances may be more harmful to children and the elderly than other adults.

EPA developed a handbook called the [Exposure Factors Handbook](#) that can be used by public health and environmental health professionals as they consider the risks of exposure to adults and children in different life and development stages.





Exposure Factors Handbook: Children

EPA developed a [Child Specific Exposure Factors Handbook](#) to specifically determine children's exposure risk.





Dose Response

Dose Response: Dose-response is a relationship between exposure and health effects that can be established by measuring the effect (response) relative to an increasing dose. Usually the larger the dose (amount/weight), the greater the effect (response).

Even substances we use all the time, like salt, can be a poison if the dose is high enough. This is the meaning behind the statement “the dose makes the poison.”



NOAEL

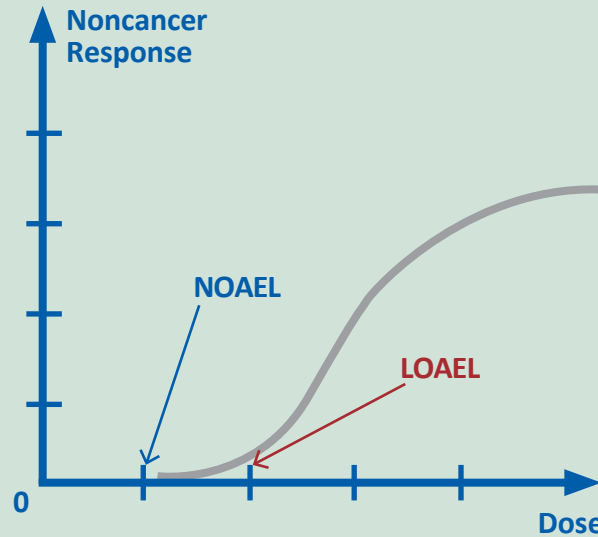
The no observed adverse effect level (NOAEL) is dose below which the harmful (adverse) effects of a substance are not seen in a population.

LOAEL

The lowest observed adverse effect level (LOAEL) is the lowest tested dose of a substance that has been reported to cause adverse health effects. However, for substances causing cancer (carcinogens), there is no safe level of exposure, because any exposure could result in cancer.



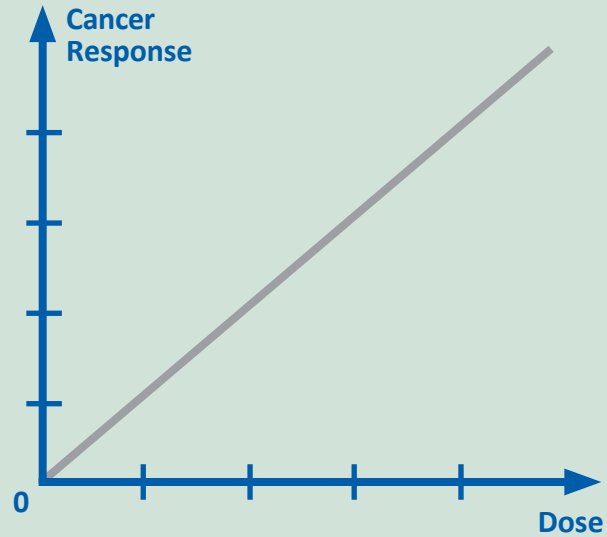
Dose-response Relationship for Non-cancer Effects



The dose-response relationship (the response occurring with increasing dose) varies with pollutant, individual sensitivity, and type of health effect.



Dose-response Relationship for Cancer



The **relationship between dose and response is a straight line**—as the exposure (dose) increases, there is an increase in cancer response.



Case Study



Source: <http://www.nap.edu/read/4795/chapter/14> 

A rural Wisconsin family with six children experienced health problems including unusually sensitive skin (sensory hyperesthesias), muscle cramps, recurrent pink eye (pruritic conjunctivitis), earaches and middle ear infection (otitis media), and inflammation of the sinus tissue, bronchial tubes, and walls of the lungs (sinusitis, bronchitis, and pneumonitis). The

six children displayed recurrent “measleslike” rashes. They also experienced reddened thickened skin on the soles of the feet. The babies, who crawled on the floor, developed a rash on the legs, diaper and stomach area, hands, arms, and face, which later came off as scale-like flakes (desquamated). At home the children went barefoot.

The parents reported that they would “black out” for up to two hours, leaving them disoriented. The two youngest children had multiple grand mal seizures



before their first birthday. The fourth youngest child required a tracheostomy and slept under oxygen at night. The family also experienced hair loss (alopecia) that peaked every March and April and significantly declined by November.

Toxicologists from the state health agency discovered that for the past four years the father had been burning scraps of plywood from a construction site he had previously worked at in the family's wood burning stove. This means that the family had been exposed for four years. The plywood contained a CCA solution of 47% chromium oxide (C), 34% arsenic pentoxide (A), and 19% copper oxide (C). Arsenic is used as a pesticide in wood treatment.

Toxicologists collected and analyzed hair and fingernail samples from the family and ashes from the wood-burning stove in the kitchen. Arsenic levels of 12 to 87 ppm (parts per million) were found in the mother and father. Ashes from the wood-burning stove contained over 1000 ppm of arsenic as well as other materials consistent with CCA-treated wood. From the family's symptoms and the home analysis, toxicologists suspected arsenic poisoning.

Toxicologists could not determine the **dose** of chromium, copper and arsenic for each family member since exposure was **chronic** (long term). In **acute** poisoning arsenic can be detected in blood and urine, however the family



had **chronic exposure**. This means that the chemicals of concern had already reached their **target organs**. To determine if there is chronic arsenic exposure, hair and fingernails are used. In the youngest child, who was crawling in the kitchen in their first year, 2,998 ppm of arsenic was measured in the fingernails.

The family stopped burning CCA-treated wood as soon as arsenic poisoning was discovered as the source of the family's symptoms. Cleanup operations immediately followed. Resettlement attempts were made but due to lack of funds, the family had not been able to relocate. Efforts continued toward cleaning the house, whose walls and surrounding soil contained arsenic content. The fourth child's tracheostomy was closed. All symptoms among the family members lessened considerably, but their health continued to be monitored.



End of summary overview.

If you need assistance in understanding concepts in this resource, please contact your State Health Department, your [ATSDR Regional Office](#), or send an email to atsdr.landreuse@cdc.gov.

For a hard copy of the summary overview, print pages 5–20.

For further toxicology learning and training materials please explore the resources in the SELF STUDY Module, Part Two: Self Study Toxicology Materials.

Proceed to the [self-study module](#) on Toxicology.

Toxicology

Part Two: **Self-study Materials**





Toxicology Tutors (Tox Tutors)



In the [Tox Tutors](#), created by the US Health and Human Services, you can learn about the history and explore an introduction to the basic principles of toxicology in the module entitled [Introduction to Toxicology and Dose-Response](#).

The Tox Tutors will introduce you to:

- **Basic Principles** provides a detailed explanation of dose-response, effects and types of toxicity, chemical interactions, and how toxicity is tested
- **Toxicokinetics** examines how toxins are absorbed, distributed, metabolized and eliminated from the body
- **Cellular Toxicity** looks at toxicity on an organ, tissue, and (much more specifically) the cellular level.
- **Cells and Tissues: Injury and Repair** provides further reference on the effect toxins can have on a cellular level



Tox Tutors Using Healthy People 2020 to Improve Population Health



Environmental Health: Issues and Impact

These modules are designed for continuing education, students, and health practitioners to provide an introduction to environmental health. Using Healthy People 2020 as a guide, this module looks at vulnerable populations, environmental hazards, mitigation strategies, and case studies.



Toxicology Mobile App



Learn about environmental health and toxicology by playing the National Library of Medicines' (NLM) game called [ToxInvaders](#). This app is available for free at the [Apple Store](#).



ATSDR Toxicology Training Modules

For an overview of the basics of toxicology and risk assessment go to ATSDR's training modules, [Toxicology Curriculum for Communities Trainer's Manual](#). Here you can explore modules pertaining to an [Introduction to Toxicology](#), [Routes of Exposure](#), [Risk Assessment](#), and a [Survey of Toxic Substances](#).



ATSDR Toxicological Profiles

ATSDR Agency for Toxic Substances & Disease Registry

Toxic Substances Portal - Lead

Toxicological Profile for Lead
August 2007
CAS# 7439-92-1
PDF Version, 6.2 MB

Toxicological Profile Information
The ATSDR toxicological profile succinctly characterizes the toxicologic and adverse health effects information for the hazardous substance described here. Each peer-reviewed profile identifies and reviews the key literature that describes a hazardous substance's toxicologic properties. Other pertinent literature is also presented, but is described in less detail than the key studies. The complete list of topics covered (chapter titles) is shown at the left and in more detail further down this page.

The focus of the profile is on health and toxicologic information. Therefore, each profile begins with a **Public Health Statement** that summarizes in nontechnical language, a substance's relevant properties.

A useful two page information sheet, the **ToxFAQs™**, is also available.

Toxicological Profile Access
In order to access the ATSDR toxicological profiles' PDF files below, you must have **Adobe Acrobat Reader**.

You may download that program for free from this link to **Adobe** and then use it to access (open) the files below that are labeled as PDF files.

Complete Profile, 6.2 MB
The table of contents and list of individual PDF files are given below.

Preface, 1.3 MB

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 - Potential for Human Exposure
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 - Glossary
 - Appendices
- Reference
- Disclaimer
- Where can I get more information?

Contact Us:
Agency for Toxic Substances and Disease Registry
4770 Buford Hwy NE
Atlanta, GA 30341
800-CDC-1080
(800-232-4636)
TTY: (888) 232-4343
New Hours of Operation
9am-5pm ET/Monday-Friday
Closed holidays
[Contact CDC-INFO](#)

ATSDR's [Toxicological Profiles](#) are an online database which provides the best science and latest research on toxic substances and how they may affect human health. Included in this database is information on the characteristics, exposure risks, associated health effects, and relevant CDC and ATSDR health studies and assessments.



TOXNET

NIH U.S. National Library of Medicine TOXNET TOXICOLOGY DATA NETWORK

Welcome to TOXNET
Your resource for searching databases on toxicology, hazardous chemicals, environmental health, and toxic releases

SEARCH TOXNET Search all or select specific databases

BROWSE ADVANCED SEARCH

e.g. benzene, endocrine disruptor ALL DATABASES Search

TOXNET Databases

MOST VISITED BY TOXNET USERS

- HSOB**
Hazardous Substances Data Bank. Peer-reviewed toxicology data for over 5,000 hazardous chemicals
- TOXLINE**
4 million references to literature on biochemical, pharmacological, physiological, and toxicological effects of drugs and other chemicals
- ChemIDplus**
Dictionary of over 400,000 chemicals (names, synonyms, and structures)

BREASTFEEDING & DRUGS

- LactMed**
Drugs and Lactation Database. Drugs and other chemicals to which breastfeeding mothers may be exposed

DEVELOPMENTAL TOXICOLOGY LITERATURE

- DART**
Developmental and Reproductive Toxicology Database. References to developmental and reproductive toxicology literature

CHEMICAL RELEASES & MAPPING

- TOXMAP**
TOXMAP: Environmental Health Maps provides searchable, interactive maps of EPA TRI and Superfund data, plus US Census and NCI health data
- TRI**
Toxic Release Inventory. Annual environmental releases of over 600 toxic chemicals by U.S. facilities

Did you know

- There is a guide to choosing a database
- Which Resource Should I Use can help you pick the right resource for your search.
- There is training for using TOXNET databases

Visit [Learn to Use TOXNET](#) for a training schedule and TOXNET workbook.

[More FAQs](#)

Necessary resources for assessing toxicity of chemicals can be found in the many [TOXNET](#) databases. These databases contain information on toxicology, hazardous chemicals, environmental health, and toxic releases.



If you need assistance in understanding concepts in this resource, please contact your State Health Department, your [ATSDR Regional Office](#), or send an email to atsdr.landreuse@cdc.gov.