

4 INFORMATION AND TRAINING

All laboratory personnel must receive information regarding this manual and lab safety training prior to working with hazardous chemicals. Principal Investigators shall direct laboratory personnel to the AU Risk Management and Safety website <https://cws.auburn.edu/rms/> to access manuals, policies, procedures and other safety information.

4.1 Laboratory Safety Training

Training sessions arranged by RMS are held regularly and are announced in the AU Daily and/or on the RMS website. Most training is also available on the web at cws.auburn.edu/OHS.

Contact RMS Environmental Programs at 334-844-4870 for information on [Hazardous Materials Shipping and Receiving](#).

Additional lab specific safety training should be provided by the supervisor. All laboratory personnel must receive this training prior to beginning work with hazardous chemicals or for non-routine tasks presenting new /unique hazards for which an individual has not been trained in.

4.2 Chemical Safety Information Resources

There are numerous sources of chemical safety information. These sources include:

- The labels found on the containers of hazardous chemicals
- The substance's Safety Data Sheets (SDS)
- Special health and safety reference literature available at the library or on the web (i.e. Prudent Practices in the Laboratory, Merck Index, Laboratory Health and Safety Handbook, NIOSH Pocket Guide, Lab Safety Institute, etc.)
- Other reference literature recommended by RMS
- [PubChem](#) database maintained by the National Center for Biotechnology Information (NCBI), a component of the National Library Medicine, which is part of the National Institutes of Health (NIH).
- In addition, your supervisor and RMS are available to provide safety information.

4.3 Safety Data Sheets

A Safety Data Sheet (SDS) is a detailed informational document prepared by the manufacturer or importer of a hazardous chemical which describes the physical and chemical properties of the product. Information included in a Safety Data Sheet aids in the selection of safety products, helps individuals understand the potential health and physical hazards of the chemical, and describes how to respond effectively to exposure situations. It should be noted that the health and safety guidance in the Safety Data Sheet is often very generic and addresses worst case situations. It is not always helpful in selecting appropriate safeguards in the laboratory. If you have safety questions regarding a particular chemical contact RMS or your supervisor.

Safety Data Sheets for most chemicals are readily available on-line. If you do not have web access and want to review a hard copy form of an SDS, RMS can provide you with one upon request free-of-charge. Your laboratory supervisor may also have SDSs available for the materials commonly used in your laboratory. You can also contact the chemical manufacturer and receive SDSs directly from the supplier.

The format of a Safety Data Sheet may vary, but there is specific information that must be included in each sheet.

All SDSs must contain the following information:

- Identity of the product, using the name used on the original label
- The chemical and common names of the hazardous ingredients, if in >0.1% concentration
- Physical and chemical characteristics of the product
- Physical and health hazards of the product, specifying carcinogens at >0.1% concentration
- Primary routes of entry
- Exposure limits, if any
- Safe handling and use information
- Engineering and personal protective equipment control recommendations
- Emergency and first aid procedures
- Date of the SDS revision
- Name and contact information of the chemical manufacturer, importer, or other responsible party preparing or distributing the SDS

Many manufacturers are using the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS) as a tool to assist with communicating health, physical, and environmental hazards of chemicals.

4.4 Chemical Toxicology

4.4.1 Chemical Toxicology Overview

Toxicology is the study of the nature and action of poisons.

Toxicity is the ability of a chemical substance or compound to produce injury once it reaches a susceptible site in, or on, the body.

A material's **hazard potential** is the probability that injury will occur after consideration of the conditions under which the substance is used.

4.4.2 Dose-Response Relationships

The potential toxicity (harmful action) inherent in a substance is exhibited only when that substance comes in contact with a living biological system. The potential toxic effect increases as the exposure increases. All chemicals will exhibit a toxic effect given a large enough dose. The toxic potency of a chemical is thus ultimately defined by the dose (the amount) of the chemical that will produce a specific response in a specific biological system.



4.4.3 Routes of Entry into the Body

There are three main routes by which hazardous chemicals enter the body:

- Absorption through the respiratory tract via inhalation.
- Absorption through the skin via dermal contact.
- Absorption through the digestive tract via ingestion. (Ingestion can occur through eating or smoking with contaminated hands or in contaminated work areas.)

Most exposure standards. Such as the Threshold Limit Values (TLVs) by the American Conference of Government and Industrial Hygienists (ACGIH) and Permissible Exposure Limits (PELs) by the Occupational Safety and Health Administration (OSHA), are based on the inhalation route of exposure. The limits are expressed in terms of parts per million (ppm) or milligrams per cubic meter (mg/m³) in concentration in air. If a significant route of exposure for a substance is through skin contact, the SDS, PEL, and/or TLV will have a “skin” notation. Examples of substances where skin absorption may be a significant factor include pesticides, carbon disulfide, carbon tetrachloride, dioxane, mercury, thallium compounds, xylene, and hydrogen cyanide. It is important to not exceed PEL and TLV limits. These limits are often found in chemical SDS sheets.

4.4.4 Types of Effects

Acute poisoning is characterized by sudden and severe exposure and rapid absorption of the substance. Normally, a single large exposure is involved. Adverse health effects are often reversible. Examples: carbon monoxide or cyanide poisoning.

Chronic poisoning is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Health effects are often irreversible. Examples: lead or mercury poisoning.

Local Effect refers to an adverse health effect that takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples: strong acids or alkalis.

Systemic effect refers to an adverse health effect that takes place at a location distant from the body's initial point of contact and presupposes absorption has taken place. Examples: arsenic affects the blood, nervous system, liver, kidneys and skin; benzene affects bone marrow.

Cumulative poisons are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Example: heavy metals. Physical Classifications

Gas applies to a substance which is in the gaseous state at room temperature and pressure.

Vapor is the gaseous phase of a material which is ordinarily a solid or a liquid at room temperature and pressure.

When considering the toxicity of gases and vapors, the solubility of the substance is a key factor. Highly soluble materials, like ammonia, irritate the upper respiratory tract. On the other hand, relatively insoluble materials, like nitrogen dioxide, penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body and be cumulative poisons.

An aerosol is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its airborne concentration. For a proper assessment of the toxic hazard, the size of the aerosol's particles must be determined. A particle's size will determine if a particle will be deposited within the respiratory system and the location of deposition. Particles above 10 micrometers tend to deposit in the nose and other areas of the upper respiratory tract. Below 10 micrometers particles enter and are deposited in the lung. Very small particles (<0.2 micrometers) are generally not deposited but exhaled.

4.4.5 *Physiological Classifications*

Irritants are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from exposure to concentrations far below those needed to cause corrosion. Irritants can also cause changes in the mechanics of respiration and lung function. Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

A primary irritant exerts no systemic toxic action either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. A secondary irritant's effect on mucous membranes is overshadowed by a systemic effect resulting from absorption.

Asphyxiants have the ability to deprive tissue of oxygen.

Simple asphyxiants are inert gases that displace oxygen. Examples: Nitrogen, Helium, Carbon dioxide.

Chemical asphyxiants reduce the body's ability to absorb, transport, or utilize inhaled oxygen. They are often active at very low concentrations. Examples: Carbon monoxide, Cyanides.

Primary anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples: Halogenated hydrocarbons, Alcohols.

Hepatotoxic agents cause damage to the liver. Examples: Carbon tetrachloride, Tetrachloroethane, Nitrosamines.

Nephrotoxic agents damage the kidneys. Examples: Halogenated hydrocarbons, Uranium compounds.

Neurotoxic agents damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples: Tetraethyl lead and carbon disulfide

Some toxic agents act on the blood or hematopoietic system. The blood cells can be affected directly or the bone marrow (which produces the blood cells) can be damaged. Examples: Nitrites, Aniline, Toluidine, Nitrobenzene, Benzene.

There are toxic agents that produce damage of the pulmonary tissue (lungs) but not by immediate irritant action. Fibrotic changes can be caused by free silica and asbestos. Other dusts can cause a restrictive disease called pneumoconiosis. Examples: Coal dust, Cotton dust, Wood dust.

A **carcinogen** is an agent that can initiate or increase the proliferation of malignant neoplastic cells or the development of malignant or potentially malignant tumors.

A chemical is considered a carcinogen or potential carcinogen if it is listed in any of the following publications:

- National Toxicology Program, Annual Report on Carcinogens (latest edition)
 - Listed under the category of “known to be carcinogens”
- International Agency for Research on Cancer, Monographs (latest edition)
 - listed as Group 1, Group 2A or Group 2B
- Regulated by OSHA as a carcinogen under 29 CFR 1910 Subpart Z, Toxic and Hazardous Substances

Known human carcinogens include:

Asbestos	Vinyl chloride
4-nitrobiphenyl	Inorganic arsenic
Alpha-naphthylamine	Ethylene oxide
Methyl chloromethyl ether	1,2-Dibromo-3-chloropropane (DBCP)
3,3'-Dichlorobenzidine	N-nitrosodimethylamine
Bis-chloromethyl ether	Coal tar pitch volatiles

A **mutagen** causes heritable changes (mutations) in the genetic material (DNA) of exposed cells. If germ cells are involved, the effect may be inherited and become part of the genetic pool passed onto future generations.

A **teratogen** (embryotoxic or fetotoxic agent) is an agent which interferes with normal embryonic development without causing a lethal effect to the fetus or damage to the mother. Effects are not inherited. Examples: Lead, Thalidomide.

A **sensitizer** is a chemical which can cause an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (allergic dermatitis) or as serious as anaphylactic shock. Examples: Epoxy compounds, Toluene diisocyanate, Nickel compounds, Chromium compounds, Poison ivy, Formaldehyde, d-Limonene.

4.4.6 Occupational Health Standards

TLV: The threshold limit value is a recommended occupational exposure guideline published by the American Conference of Governmental Industrial Hygienists. TLVs are expressed as parts of vapor or gas per million parts of air by volume (ppm) or as approximate milligrams of particulate per cubic meter of air (mg/M³). The TLV is the average concentration of a chemical that most people can be exposed to for a working lifetime with no ill effects. The TLV is an advisory guideline. If applicable, a ceiling concentration (C) that should not be exceeded, or a skin absorption notation (S) will be indicated with the TLV.

PEL: The permissible exposure limit is a legal standard issued by OSHA. Unless specified, the PEL is a time weighted average (TWA).

TWA: Most exposure standards are based on time weighted averages. The TWA is the average exposure over an eight (8) hour workday. Some substances have short term exposure limits (STELs). These levels are time weighted over a 15-minute period, and exposures should not exceed the STEL in any 15-minute period over the course of an 8-hour workday.

Some substances have Ceiling (C) limits. Ceiling limits are concentrations that should never be exceeded.

