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Safety Notes

Discussion and Notes

Keep a copy of these safety training notes and a signed attendance sheet to verify regular safety training. Regulatory inspectors will usually request proof of safety training.

The relationship between the dose and toxicity of a chemical is quantified in a dose–response curve. Typical curves are S-shaped.

Another important safety rule is that any food-grade items that have been brought into the lab for an experiment or demonstration are considered laboratory chemicals and should not be eaten or removed from the lab and should be disposed of after use.

Toxicology Primer

Every chemical in the academic laboratory can be toxic under some set of exposure conditions. However, the reverse is also true—every chemical has some set of exposure conditions in which it is not toxic. This fundamental toxicology principle is usually summarized in the saying “the dose makes the poison,” which dates back to the medieval physician and scientist Paracelsus born in 1493.

Modern toxicology is defined as the study of the adverse effects of natural and synthetic chemical substances on living organisms. In evaluating the toxicity of chemicals, scientists study their mode of action, physical and biological effects, and how they can be detected.

The risk or hazard posed by a chemical is determined by the route and duration of exposure. There are three major routes by which a chemical can enter the body: by ingestion, inhalation, and skin absorption. Practicing strict chemical hygiene is thus the most effective way to reduce the hazards and work safely with chemicals. This simple fact underscores the importance of always abiding by these safety rules in the academic science lab:

- Always wear goggles, gloves, and other personal protective equipment.
- Work with volatile substances only in a properly functioning hood or well-ventilated lab.
- Immediately clean up all spills, no matter how minor they may seem at the time.
- Do not eat food, drink beverages or chew gum in the laboratory.

Acute Toxicity

Acute toxicity, which is defined as the immediate effect of a substance as a result of a single dose, can be measured experimentally. Chronic toxicity, resulting from low doses of a chemical repeated over long periods of time, is more difficult to test and is usually evaluated based on epidemiological evidence.

Acute toxicity is determined on the basis of test dosages made on experimental animals under controlled conditions. The most common measure toxicologists use to compare acute toxicity is the LD_{50} value, which stands for “lethal dose, 50%.” The LD_{50} value for a chemical is the amount of chemical that can be expected to cause death in one-half (50%) of a group of a particular animal species. Since the amount required to cause death is related to body weight, the LD_{50} value is expressed in milligrams of chemical per kilogram of body weight (mg/kg). A typical LD_{50} statement includes the substance, the route of entry, and the animal species, as follows: Aniline LD_{50} oral-rat: 250 mg/kg.

In plain English, this LD_{50} statement says that 250 mg of aniline for every kilogram body weight of rat, when administered in a single dose by mouth, will cause the death of 50% of the test animals. LD_{50} values are commonly determined for the following routes of exposure: ingestion (oral), skin absorption, subcutaneous or intravenous injection, and inhalation.

How Toxic Is Toxic?

No LD_{50} data exists for humans. Data from test animals is used to estimate the possible acute toxicity of a chemical on a human being. Toxicity data should therefore be used to evaluate the relative toxicity of various chemicals and which chemicals may require greater precautions when handled. The lower the LD_{50} value, the more toxic the substance. Refer to the Flinn Chemistry Catalog/Reference Manual for LD_{50} values for common chemicals. LD_{50} values have not been measured for all chemicals—even some known hazardous chemicals, such as lead compounds, do not have published LD_{50} values.

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The inhalation hazard of a chemical is determined by mixing the chemical in vapor form with air in a known concentration and the toxicity is expressed as the LC_{50} (lethal concentration) value. Typical LC_{50} units are milligrams of chemical per cubic meter of air (mg/m^3) or parts per million (ppm). The duration of exposure is also reported. Example: LC_{50} (mouse)—5 mg/m^3/2 hr.

In general, chemicals with LD_{50} values less than 300 mg/kg are considered highly toxic, those with LD_{50} values between 300 and 1,000 mg/kg are considered moderately toxic, and those with LD_{50} values between 1,000 and 5,000 mg/kg are considered slightly toxic. Because LD_{50} values depend on body weight, however, many chemicals that may not be harmful to an adult may be toxic to a child.

Online Video Available!

Do you have questions about how to use the basic principles of toxicology to protect yourself and your students? Visit the Flinn website at https://labsafety.flinnsci.com/app/User/MyCourses/ViewUnitContent/10984/90962/104 to view "FAQs—Applying the Principles of Toxicology," one of the video chapters in the online Flinn Scientific Laboratory Safety Course. In this seven-minute video, Ken Runkle, a former chemistry teacher who is now a senior toxicologist at a major state university, answers common questions instructors have about chemical exposure, such as: Am I being exposed to a chemical by inhalation if I can't smell it? How do I assess the relative hazard of a chemical if it doesn't have a published TLV value?

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