

“How Toxic Is Toxic?”

Toxicology is defined as the study of the adverse effects of natural and synthetic chemical substances on living organisms. In evaluating the relative toxicity of chemicals, scientists study their mode of action, physical and biological effects, and how they can be detected. All chemicals are toxic at some level. Thus, every chemical will be toxic under some set of exposure conditions. The reverse, however, is also true—every chemical has some set of exposure conditions in which it is not toxic. The risk or hazard posed by a chemical is further 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.

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 LD₅₀ value, which stands for “lethal dose, 50%.” The LD₅₀ 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 LD₅₀ value is expressed in milligrams

of chemical per kilogram of body weight (mg/kg). A typical LD₅₀ statement includes the substance, the route of entry, and the animal species, as follows: Aniline LD₅₀ oral-rat: 250 mg/kg. In plain English, this LD₅₀ 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. LD₅₀ values are commonly determined for the following routes of exposure: ingestion (oral), skin absorption, subcutaneous or intravenous injection, and inhalation.

GHS (Globally Harmonized System of Classification and Labeling of Chemicals) classifies the health hazards due to the acute toxicity of chemicals into four categories:

- Fatal if swallowed: 0–50 mg/kg
- Toxic if swallowed: 0–300 mg/kg
- Harmful if swallowed: 300–2000 mg/kg
- May be harmful if swallowed: > 2000 mg/kg

It should be noted that no LD₅₀ 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 LD₅₀ value, the more toxic the substance. The chart below lists the LD₅₀ values for common chemicals. LD₅₀ values have not been measured for all chemicals—even some known hazardous chemicals, such as lead compounds, do not have published LD₅₀ values.

Substance LD ₅₀	per kilogram
Acetaldehyde.....	661 mg
Acetanilide.....	800 mg
Acetic Acid.....	3310 mg
Acetic Anhydride.....	1780 mg
Acetone.....	5800 mg
Acetyl Salicylic Acid.....	200 mg
Adenine.....	227 mg
Aluminum Chloride.....	3311 mg
Aluminum Nitrate.....	3671 mg
Ammonium Chloride.....	1650 mg
Ammonium Hydroxide.....	350 mg
Ammonium Molybdate.....	333 mg
Ammonium Nitrate.....	2217 mg
Ammonium Persulfate.....	689 mg
Ammonium Sulfate.....	2840 mg
Ammonium Thiocyanate.....	750 mg
n-Amyl Alcohol.....	5.66 mL
Aniline.....	250 mg
Aniline Hydrochloride.....	840 mg
Anthranilic Acid.....	5410 mg
Antimony Trichloride.....	525 mg
Arsenic Trioxide.....	14.6 mg
Barium Acetate.....	921 mg
Barium Carbonate.....	418 mg
Barium Chloride (intraperitoneal mouse).....	51 mg
Barium Nitrate.....	355 mg
Benzaldehyde.....	1300 mg
Benzene.....	930 mg
Benzoic Acid.....	1700 mg
Benzyl Alcohol.....	1230 mg
Bismuth.....	5000 mg
Bismuth Nitrate.....	4042 mg
Boric Acid.....	2660 mg
Brilliant Green.....	313 mg
Bromine.....	2600 mg

Substance LD ₅₀	per kilogram
Bromobenzene.....	2383 mg
Bromoform.....	1147 mg
n-Butyl Alcohol.....	790 mg
sec-Butyl Alcohol.....	2193 mg
tert-Butyl Alcohol.....	2743 mg
Butyric Acid.....	2000 mg
Cadmium.....	2330 mg
Cadmium Chloride.....	88 mg
Cadmium Nitrate.....	300 mg
Caffeine.....	192 mg
Calcium Chloride, dihydrate.....	1000 mg
Calcium Chloride, anhydrous.....	1000 mg
Calcium Fluoride.....	4250 mg
Calcium Hypochlorite.....	850 mg
Calcium Nitrate.....	3900 mg
Camphor (mouse).....	1310 mg
Carbon Disulfide.....	1200 mg
Cesium Chloride.....	2600 mg
Cetyl Alcohol.....	5000 mg
Chloroform.....	695 mg

Never ingest any laboratory chemical, no matter the LD₅₀.

Chromium(III) Chloride.....	1790 mg
Chromium(III) Nitrate.....	3250 mg
Chromium Trioxide.....	80 mg
Cinnamaldehyde.....	2220 mg
Citric Acid, anhydrous.....	3000 mg
Cobalt Carbonate.....	640 mg
Cobalt Chloride.....	766 mg
Cobalt Nitrate.....	691 mg
Cobalt Oxide.....	5000 mg
Cobalt Sulfate.....	582 mg
Colchicine (mouse).....	6 mg
Copper(I) Chloride.....	140 mg

Substance LD ₅₀	per kilogram
Copper(I) Oxide.....	470 mg
Copper(II) Acetate.....	710 mg
Copper(II) Carbonate.....	1350 mg
Copper(II) Chloride.....	140 mg
Copper(II) Nitrate.....	940 mg
Copper (II) Sulfate.....	300 mg
Crystal Violet.....	420 mg
Cyclohexanol.....	1400 mg
Cyclohexene.....	1920 mg
2,6-Di-t-Butyl-4-Methyl Phenol.....	890 mg
p-Dichlorobenzene.....	500 mg
2,4-Dichlorophenoxy Acetic Acid.....	375 mg
1,4 Dioxane.....	4200 mg
Diphenylamine.....	1120 mg
Dodecyl Alcohol.....	12800 mg
Dodecyl Sulfate, Sodium Salt.....	1300 mg
Eosin Y.....	2344 mg
Erythrosin B.....	1840 mg
Ethyl Acetate.....	5620 mg
Ethyl Ether.....	1215 mg
Ethylenediamine.....	1200 mg
Ethylenediaminetetraacetic Acid (mouse).....	30 mg
Ethylene Dichloride.....	670 mg
Ethylene Glycol.....	4700 mg
Fast Green FCF.....	2000 mg
Ferrous Ammonium Sulfate.....	3250 mg
Formaldehyde.....	100 mg
Formic Acid.....	1100 mg
Glutaraldehyde.....	134 mg
Glyoxal.....	2960 mg
Hexamethylenediamine.....	750 mg
Hexyl Alcohol.....	720 mg
Hydroquinone.....	302 mg
Hydroxylamine Hydrochloride.....	141 mg

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“How Toxic Is Toxic?”, continued

Substance LD ₅₀	per kilogram
Indigo Carmine.....	2000 mg
Indole-3-Butyric Acid.....	100 mg
Iron(II) Sulfate (mouse).....	1520 mg
Iron(III) Chloride.....	1278 mg
Iron(III) Nitrate.....	3250 mg
Isobutyl Alcohol.....	2460 mg
Isopentyl Alcohol.....	1300 mg
Isopropyl Alcohol.....	5045 mg
Isoraleic Acid.....	1850 mg
Kerosene (rabbit).....	2835 mg
Lactic Acid.....	3543 mg
Lead Acetate.....	4665 mg
Lithium Carbonate.....	525 mg
Lithium Chloride.....	526 mg
Lithium Sulfate (anhydrous salt).....	613 mg
Magnesium Nitrate.....	5440 mg
Malachite Green Oxalate.....	275 mg
Maleic Acid.....	708 mg
Malonic Acid.....	1310 mg
Manganese(II) Chloride.....	1484 mg
Menthol.....	3180 mg
Methyl Alcohol.....	5628 mg
Methyl-t-Butyl Ether.....	4000 mg
Methyl Ethyl Ketone.....	2737 mg
Methyl Isobutyl Ketone.....	2080 mg
Methyl Orange.....	60 mg
Methyl Salicylate.....	887 mg
Methyl Violet 2B.....	413 mg
Methylene Blue.....	1180 mg
Methylene Chloride.....	1600 mg
Naphthalene.....	490 mg
Naphthalene Acetic Acid.....	1000 mg
1-Naphthol.....	1870 mg
Nickel Ammonium Sulfate.....	400 mg
Nickel Chloride.....	105 mg
Nickel Nitrate.....	1620 mg
Nicotine.....	50 mg
o-Nitrobenzaldehyde.....	600 mg
meta-Nitrophenol.....	328 mg
para-Nitrophenol.....	202 mg
1-Octanol (mouse).....	1790 mg
4-(t-Octyl) Phenol.....	3210 mg
Orcinol (guinea pig).....	600 mg
Oxalic Acid.....	375 mg
Pentane.....	400 mg
Peppermint Oil.....	2426 mg
Perchloroethylene.....	2629 mg
1,10-Phenanthroline.....	132 mg
Phenol.....	317 mg
Phenyl Salicylate.....	3000 mg
Phenyl Thiocarbamide (mouse).....	10 mg
Phosphoric Acid.....	1530 mg
Phosphorous Pentoxide (inhalation, LD ₅₀).....	1217 mg/m ³
Phthalic Anhydride.....	4020 mg
Potassium Acetate.....	3250 mg
Potassium Bisulfate.....	2340 mg
Potassium Bromate.....	157 mg
Potassium Bromide.....	3070 mg
Potassium Carbonate.....	1870 mg
Potassium Chlorate.....	400 mg
Potassium Chloride.....	2600 mg

Substance LD ₅₀	per kilogram
Potassium Chromate (mouse).....	180 mg
Potassium Cyanide.....	5 mg
Potassium Dichromate.....	25 mg
Potassium Ferricyanide.....	1600 mg
Potassium Ferrocyanide.....	6400 mg
Potassium Fluoride.....	245 mg
Potassium Hydroxide.....	273 mg
Potassium Iodate.....	531 mg
Potassium Nitrate.....	3750 mg
Potassium Nitrite.....	200 mg
Potassium Permanganate.....	1090 mg
Potassium Persulfate.....	802 mg
Potassium Thiocyanate.....	854 mg
Propionic Acid.....	2600 mg
n-Propyl Alcohol.....	1870 mg
Pyridine.....	891 mg
Pyrogallol (mouse).....	300 mg
Resorcinol.....	301 mg
Rhodamine B (mouse).....	887 mg
Salicylic Acid (mouse).....	480 mg
Sebacoyl Chloride.....	400 mg
Silicon.....	3160 mg
Silver Nitrate.....	1173 mg
Silver Oxide.....	2820 mg
Soda Lime.....	3530 mg
Sodium Acetate.....	3530 mg
Sodium Arsenite.....	41 mg
Sodium Benzoate.....	4070 mg
Sodium Bicarbonate.....	4220 mg
Sodium Bismuthate.....	420 mg
Sodium Bisulfite.....	2000 mg
Sodium Borate.....	2660 mg
Sodium Bromate.....	300 mg
Sodium Bromide.....	3500 mg
Sodium Carbonate.....	4090 mg
Sodium Chlorate.....	1200 mg
Sodium Chloride.....	3000 mg
Sodium Chromate, tetrahydrate.....	52 mg
Sodium Chromate, anhydrous.....	136 mg
Sodium Dichromate.....	52 mg
Sodium Fluoride (mouse).....	57 mg

Substance LD ₅₀	per kilogram
Sodium Hexametaphosphate (mouse).....	4320 mg
Sodium Iodide.....	4340 mg
Sodium Metabisulfite.....	1131 mg
Sodium Metasilicate.....	1153 mg
Sodium Nitrate.....	1267 mg
Sodium Nitrite.....	180 mg
Sodium Oxalate (mouse).....	5094 mg
Sodium Perborate.....	1200 mg
Sodium Salicylate.....	930 mg
Sodium Sulfide (anhydrous salt).....	208 mg
Sodium Sulfite.....	3560 mg
Sodium Thiocyanate.....	764 mg
Streptomycin Sulfate.....	430 mg
Strontium Chloride (anhydrous salt).....	2250 mg
Strontium Nitrate.....	2750 mg
Styrene, Monomer.....	2650 mg
Succinic Acid.....	2260 mg
Sulfamic Acid.....	3160 mg
Sulfanilamide.....	3900 mg
5-Sulfosalicylic Acid.....	2450 mg
Sulfuric Acid.....	2140 mg

**To put toxicity into perspective,
compare the LD₅₀ to that of
sodium chloride (3000 mg).**

Tannic Acid.....	2260 mg
Tetrahydrofuran.....	1650 mg
Thioacetamide.....	301 mg
Thiourea.....	125 mg
Thymol.....	980 mg
Tin(II) Chloride.....	700 mg
Toluene.....	636 mg
Trichloroethylene.....	4920 mg
Triethanolamine.....	4.92 mL
Urethane.....	1809 mg
Xylenes.....	4300 mg
Zinc Acetate.....	794 mg
Zinc Chloride.....	350 mg
Zinc Nitrate.....	1190 mg
Zinc Sulfate.....	1260 mg

Safer Storage

Provide extra safety for the storage of severe poisons. Chemicals that have an LD₅₀ of less than 300 mg/kg may be described as fatal or toxic if swallowed. These should be stored in a separate and secure storage cabinet to protect against theft, vandalism, or fire.

The Flinn/SciMatCo Poison Cabinet is compact and will fit into an existing storage cabinet or shelf.

Severe poisons must be locked up. The Flinn/SciMatCo Poison Cabinet is a “must” safety aid for any high school chemical storage area.

