

There is some risk involved in almost all of our activities even though the levels of risk vary greatly. Some activities such as hang gliding, mountain climbing and whitewater sports have recognized high risks. Although we may decide to accept the inherent risk of these activities because we enjoy those particular sports, any sane person will think about the dangers involved with a given activity and decide whether or not the risk is acceptable.

Most items that are purchased carry a warning label about some risk involving the product. These labels state that the activity or substance may be hazardous to your health. They do not say you will be harmed by the activity or substance. These warnings are references to the statistical probability of an event. The studies that are conducted to provide these probabilities are risk assessment studies.

Risk assessment can be defined as the process of assigning probabilities to the adverse effects of human activities or natural catastrophes. The elimination of all environmental effects of human activity may well be impossible to achieve. The annual risk of dying from certain behaviors is shown in the following table.

Hazard	Annual Risk (Probability of Dying)
cigarette smoking	3.6 out of 1000
all cancers	2.8 out of 1000
motor vehicle accident	0.24 out of 1000
police killed in action	0.22 out of 1000
air pollution in the eastern U.S.	0.20 out of 1000
home accidents	0.11 out of 1000

An activity such as smoking has well-documented risks and the law requires that each package of cigarettes carry a warning label. Regardless of how the warning label is worded, smoking remains the leading cause of preventable death in the United States and second-hand smoke is the third leading cause of preventable death.

One risk study shows the loss of life expectancy (LLE) in days for various activities or environments. Bottles of diet soda carry a warning that aspartame should not be consumed by persons that suffer from phenylketonuria because these people lack an enzyme that will metabolize phenylalanine. Should the rest of us worry about consuming aspartame? Obesity will put us at much greater risk than ingesting limited amounts of aspartame assuming that we do not suffer from phenylketonuria.

Risk	LLEs-days
Living in poverty (poor diet, poor health care, sanitation and violent neighborhoods)	3,500
Smoking	1,500
Being 20% overweight	1,000
Driving a motor vehicle	200
Drinking alcohol (alcoholics have a LLE = 4,000)	130
Swimming (drowning)	40
Riding bicycles	6
Living near a nuclear power plant	0.5

If the risk involves a substance in our air, food, or water, exposure and toxicity are both factors that need to be addressed in a risk assessment. The toxicity of a substance can only be determined by human population studies, animal studies, or bacterial studies. These toxicities are given as LD₅₀ toxicity figures.

Poison is a general term for any toxic substance. **Toxins** are poisons of biological origin. A substance is considered to be toxic if it interferes with an organisms normal metabolic processes. Toxic substances enter the body by inhalation, ingestion and dermal contact.

LD₅₀ toxicity figures are based on animal studies. This figure is equal to the amount of a substance that will cause 50% of the test

animals to die. The LD₅₀ values given in the following table were based on studies using mice and rats.

Compound	Number of Grams/ kilogram of body weight
sugar (sucrose)	29.7
ethanol (grain alcohol)	14
vinegar (acetic acid)	3.3
sodium chloride	3
Malathion (insecticide)	1.2
aspirin	1
caffeine	0.13 (one cup of coffee = 0.15g)
DDT (insecticide)	0.1
arsenic	0.048
strychnine	0.002
nicotine	0.001
potassium cyanide	0.00015
aflatoxin-B	0.000009
dioxin	0.000001 (about the size of a grain of salt)
botulinum toxin	0.00000001

Aflatoxins are present in molds that can grow on grains and peanuts in storage. Clostridium botulinum bacteria grows naturally in the soil and most poison cases come from ingestion of improperly canned food, usually home canning. These toxins bind irreversibly to nerve endings preventing the synthesis of acetylcholine which is necessary for nerve transport. Impulses are not sent to the respiratory muscles, resulting in suffocation.

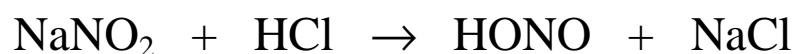
Population studies are conducted by collecting statistical data over a period of time to determine the percentage of people affected by the substance in question. A large sample size over a period of several years must be considered in order for the results to be statistically significant.

Animal studies are used in order to obtain results in a shorter period of time. Animals are observed for harmful effects after they have been given a measured amount of the substance. There is an ethical question involved in using animals for research and there is a question whether their response to a substance will be valid for humans. The animals are usually given large doses of the substance to accelerate the effect and there is also a question whether that large dose changes the significance of the data.

Bacteria reproduce and mature very quickly allowing studies to be conducted over short periods of time at little expense. Again, there is the serious question as to whether bacteria respond to a substance in a manner that can be related to human response.

Carcinogens are chemical compounds that cause cancer. Some known carcinogens are aflatoxins, asbestos, benzene, nitrosoamines and vinyl chloride.

Nitrous acid is formed in the stomach by the action of hydrochloric acid on sodium nitrite (found as a preservative in meats).



Nitrous acid reacts with compounds called secondary amines to form nitrosoamines which are proven carcinogens. Secondary amines are ubiquitous in the biochemical compounds that make up our food.

Mutagens are chemical compounds that alter genes and cause developmental abnormalities. Some known mutagens are aflatoxin, benzo(α)pyrene, nitrous acid and ozone.

Teratogens are chemical compounds that can cause birth defects in the embryo. Some known teratogens are mercury, polychlorinated

biphenyls PCBs and thalidamide (once used as a tranquilizer and sleeping pill in Europe).

Mercury vapor is very toxic if inhaled. It passes into the bloodstream and is transported to the brain. Symptoms include depression, insomnia, irritability and psychotic behavior. Organic mercury salts are very toxic and can be produced by bacterial action on inorganic mercury salts that settle to the bottom of lakes and streams. The organic mercury salts once formed are concentrated by bioaccumulation.

Most of the subtle risks we are exposed to involve our food supply or our environment. As the population of the world increases, there will be a corresponding increase in the need for energy, food and shelter. Food growth and preservation will become increasingly important and bring with them the cost of increased exposure to pesticides. Fertilizer runoff will cause environmental problems in our lakes and streams. Increased demand for energy production will bring increased risks of air pollution and radioactive waste if a nuclear fusion power plant is not developed in time.

The population of the world is increasing at a geometrical rate. The population in 1850 was approximately one billion. The population in 1930 was approximately 2 billion, only 80 years later. The population in 1975 was approximately 4 billion, a doubling in only 45 years. Population growth is expected to double again by the year 2020. This magnitude of growth will only exacerbate the global problems facing the world today. Knowledge of Chemistry can and will solve many of the problems facing humanity but drastic changes in human behavior are needed to solve the rest.