Topic 4 - How Much Is Too Much?

How Much Is That?

Water is a vital source of life for all living organisms. When this is affected by pollution, all living things connected in the web of life are affected. A pollutant is any material, or form of energy that can cause harm to living organisms. Pollution is any alteration to the environment that produces a condition which threatens living organisms. To determine if something is a pollutant or pollution we must determine how much of it is present.

'Percent' of weight, or volume, means how much there is in a weight or volume sample of 100. Concentrations of chemicals are usually measured in …

parts per million (ppm) $\text{ppm} = \frac{\text{grams of solute}}{\text{grams of solution}} \times 10^6$

or **milligrams per Litre** (mg/L) $\text{ppm} = \frac{\text{mg of solute}}{\text{L solution}}$

One part per million means that one unit of an element or chemical can be found in one million units of solution. Investigating Parts per million Some substances are measured in ppb (parts per billion) or even ppt (parts per trillion). To visualize ppt - one part per trillion would be equal to: 1 meter in 1,013,543 kilometers, 1 second in 32,000 years, or 1 cent in $10 billion.

The Danger Is In the Dose

When chemicals that can do harm to living organisms remain in the environment, a toxin is created. Several toxins mixed together can have a cumulative effect and become very toxic. A toxic substance is poisonous. Toxicity is the ability of a chemical to cause harm to an organism. Acute toxicity occurs when serious symptoms occur after expose to the toxic substance. Chronic toxicity occurs when the toxic substance accumulated as a result of many exposures over time. Some insects have become pesticide-resistant and so, new pesticides have to be developed. Heavy metals are toxic agents and have a density of 5g/cm^3 or more. Examples include: mercury, copper, lead, zinc, cadmium and nickel. These metals occur naturally and are also processed into a wide variety of products. Heavy metals can be toxic to a wide range of organisms, so concentrations are constantly monitored. Heavy metals can enter the water supply by the action of acid rain and improper solid waste disposal (which can leach heavy metals into the groundwater). Heavy metals are especially toxic to children causing abnormal development, brain damage, or even death.

Lethal Dose 50

Scientists measure toxins in LD50 amounts.

LD stands for 'Lethal Dose"
50 represents 50% of the subject group that will die,
if they are given the specified dose, all at once.

Substance	LD_{50} (g/kg)	Substance	LD_{50} (g/kg)
Strychnine	0.005	Iron(II) sulfate	1.5
Arsenic trioxide	0.015	Chloroform	3.2
DDT	0.115	Ethyl alcohol	10.6
Aspirin	1.1	Sodium cyclamate	17

Table - http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/L/LD50.html

The classic LD50 test is controversial and many countries have restricted, regulated, or outlawed it. http://iacuc.cwru.edu/policy/nihpolicies/iracld50.htm Experiments to determine LD50 are rarely performed anymore because they provide very little toxicological information compared to the data that can be gained from more modern techniques. However, LD50 values are available for most chemicals from past studies. Some organizations tell it like it is, so that people can see how cruel a practice it really is to the animals involved in the test.
http://www.animalliberation.org.au/toxtest.html What do you think would happen if we didn't know the LD50 of certain chemicals (Table 3.4, p. 218) that we consume? The most lethal poison known comes from a bacterium, *Clostridium botulinum*, which is commonly found in foods we consume. It can be destroyed by high temperatures and acidity.

An Acceptable Risk?

Government agencies and legislators are often pressured to fast track drugs or substances which could potentially help many people, by relieving discomfort or pain. Testing programs follow strict guidelines to prevent fatal doses being consumed, of a medication, or substance, that is intended to be helpful. Most of our fatal-dose information for humans comes from accidental-exposure case studies (Why would anyone want to volunteer to be a test subject in a lethal dose test?).

Thalidomide Issue

Thalidomide was originally developed as a sleeping pill.
Its use in the 1950s and 1960s by pregnant women, to treat morning sickness, http://cerhr.niehs.nih.gov/genpub/topics/thalidomide2-ccae.html resulted in thousands of birth defects.
http://www.thalidomide.ca/en/

A close inspection of these effects resulted in finding out that rats could take a dose of 4000 ppm, whereas pregnant women would have her fetus affected with a dose as small as 0.5 ppm if taken at the wrong time during development of the fetus.

The Evaluation of Risk

Rachel Carson's *Silent Spring* woke up a nation to the effects chemicals were having on living organisms in our environment. With all the publicity on the human use and abuse of toxic chemicals, we often overlook that these chemicals are for the most part, naturally occurring, and not made by humans. There are other toxins that plants and animals have that are helpful to their survival.

For every molecule of human-made pesticide, there are 10,000 molecules of naturally formed pesticides.

What risks do we take, and of those, which are acceptable, or not?
Contemplate, for a minute, the following – to put it in perspective:

- To receive an LD50 dose of a particular substance that was tested for mice – a human would have to drink 70 cups of that substance – all at one – in one sitting
- LD50 can vary from animal to animal even differing between rats and mice.
- In addition, LD50 value depends on the type of exposure: ingestion (eating or drinking), inhalation (breathing) or skin contact.

Every chemical has the potential to be harmful, even the ones we take to help us. It is the dose, our susceptibility and how it reacts with other chemicals that determine it toxicity. Tough decisions need to be made to determine if it is more beneficial than harmful. Evaluation of the risks and benefits of any chemical, form the basis of how chemical use is regulated.