1.2: Basic Terminology

Toxicology Defined

Toxicology is an evolving medical science and toxicology terminology is evolving with it. Most terms are very specific and will be defined as they appear in the tutorial. However, some terms are more general and used throughout the various sections. The most commonly used terms are introduced in this section.

- **Toxicology** is the study of the adverse effects of chemicals or physical agents on living organisms.
- A **toxicologist** is a scientist who determines the harmful effects of agents and the cellular, biochemical, and molecular mechanisms responsible for the effects.
- **Toxinology**, a specialized area of study, looks at microbial, plant and animal venoms, poisons, and toxins.

Terminology and definitions for materials that cause toxic effects are not always consistently used in the literature. The most common terms are toxicant, toxin, poison, toxic agent, toxic substance, and toxic chemical.

Toxicant, toxin, and poison are often used interchangeably in the literature but there are subtle differences as shown below:

Toxicants:

- Substances producing adverse biological effects of any kind.
- May be chemical or physical in nature.
- Effects may be acute or chronic.

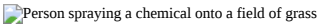

Figure 1.2.1: *Pesticide chemicals are toxicants*
(Image Source: iStock Photos, ©)

Toxins:

- Peptides or proteins produced by living organisms.
- Venoms are toxins injected by a bite or sting.

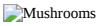

Figure 1.2.2: Amanita muscaria mushroom contains a *neurotoxin*
(Image Source: iStock Photos, ©)

Poisons:

- Toxins produced by organisms.

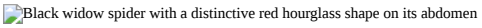

Figure 1.2.3: Black Widow spiders produce a *poison that is a toxin*
(Image Source: Texas Parks & Wildlife, ©)

A **toxic agent** is anything that can produce an adverse biological effect. It may be chemical, physical, or biological in form. For example, toxic agents may be:

Chemical (such as cyanide)

Physical (such as radiation)

Biological (such as snake venom)

The toxicity of the agent is dependent on the dose.

A distinction is made for diseases people get from *living* organisms. Organisms that invade and multiply within another organism and produce their effects by biological activity are not classified as toxic agents but as **biological agents**. An example of this is a virus that damages cell membranes resulting in cell death.

If the invading organisms excrete chemicals which are the basis for their toxicity, the excreted substances are known as **biological toxins**. In that case, the organisms are called **toxic organisms**. A specific example is tetanus. Tetanus is caused by a bacterium,

Clostridium tetani. The bacteria *C. tetani* itself does not cause disease by invading and destroying cells. Rather, a toxin (neurotoxin) that the bacteria excrete travels to the nervous system and produces the disease (Figure 8).

Toxic Substances

A **toxic substance** is simply a material that has toxic properties. It may be a discrete toxic chemical or a mixture of toxic chemicals. For example, lead chromate, asbestos, and gasoline are all toxic substances. More specifically:

- Lead chromate is a discrete **toxic chemical**.
- Asbestos is a **toxic material** that does not have an exact chemical composition but comprises a variety of fibers and minerals.
- Gasoline s a **toxic substance** rather than a toxic chemical in that it contains a mixture of many chemicals. Toxic substances may not always have a constant composition. The composition of gasoline varies with octane level, manufacturer, time of season, and other factors.

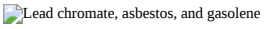

Figure 1.2.4: Examples of *toxic substances: lead chromate (left), asbestos (center), and gasoline (right)*
(Image Source: iStock Photos, ©)

Systemic Toxicants and Organ Toxicants

Toxic substances may be **systemic toxicants** or **organ toxicants**.

A **systemic toxicant** affects the entire body or many organs rather than a specific site. For example, potassium cyanide is a systemic toxicant in that it affects virtually every cell and organ in the body by interfering with the cells' ability to use oxygen.

Toxicants may also affect only specific tissues or organs while not producing damage to the body as a whole. These specific sites are known as the **target organs** or **target tissues**.

- Benzene is a **specific organ toxicant** in that it is primarily toxic to the blood-forming tissues.
- Lead is also a specific organ toxicant; however, it has three **target organs:** the central nervous system, the kidneys, and the hematopoietic system.

A toxicant may affect a specific type of tissue (such as connective tissue) that is present in several organs. The toxic site is then considered the **target tissue**.

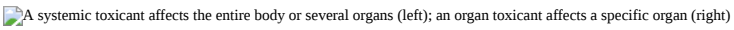

Figure 1.2.5: Systemic toxicant *and organ toxicant*
(Image Source: iStock Photos, ©)

Types of Cells

The body is composed of many types of cells, which can be classified in several ways. Table 1 shows examples of one classification of one type of cells.

Cell Types	Examples
Basic structure	cuboidal cells
Tissue type	hepatocytes of the liver
Germ cells	ova and sperm
Somatic cells	non-reproductive cells of the body

Germ cells are involved in reproduction and can give rise to a new organism. They have only a single set of chromosomes peculiar to a specific sex. Male germ cells give rise to sperm and female germ cells develop into ova. Toxicity to germ cells can cause effects in a developing fetus that lead to outcomes such as birth defects or miscarriage.

Somatic cells are all body cells except the reproductive germ cells. (Somatic cells include the "basic structure" and "tissue type"

cells listed in Table 1). They have two sets (or pairs) of chromosomes. In an exposed individual, toxicity to somatic cells causes a variety of toxic effects, such as dermatitis, death, and cancer.

Figure 6 illustrates the differences between germ cells and somatic cells.

Figure 1.2.6: Germ cells and somatic cells (Image Source: National Human Genome Research Institute, **http://www.genome.gov**)

Natural and Man-Made Chemicals

Often, people mistakenly assume that all man-made chemicals are harmful and natural chemicals are beneficial. In reality, natural chemicals can be just as harmful to human health as man-made chemicals, and in many cases, more harmful. Figure 12 compares the toxicity of several natural and man-made chemicals.

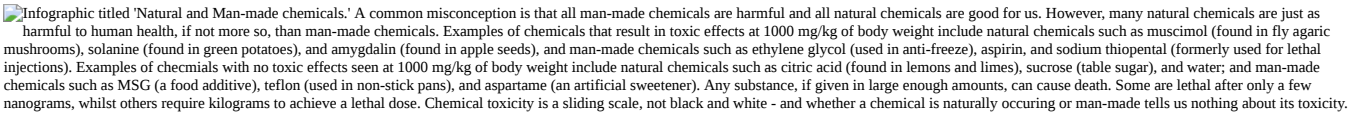

Figure 1.2.7: Natural and man-made *chemicals (Image Source: **http://pbs.twimg.com/media/CTn6HlDWwAEB1Jc.png:large**, Creative Commons license)*
