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Welcome to the World of Toxicology

1.1 Chemicals – They Are All Around Us

For many people the word “chemical” has many negative connotations, which include death, injury, and cancer. However, we encounter them daily – not only in our workplace but also in our home in the form of detergents, fragrances, personal care products, medicines, etc. They come in many different forms, which include solids, liquids, gases, aerosols, and mists. They can be synthetic or naturally occurring, and they are all around us (Figure 1.1).

We live in a chemical environment, and therefore, we need to be aware of the ways in which chemicals can cause harm. In other words, we need to understand **toxicology**, which is the study of the adverse effects of chemicals on living organisms. By doing this we can then put in measures to minimize the risk of any harm.

This book is therefore about the ways in which chemicals can cause harm and how we can assess the likelihood of this occurring.

Chemicals are not new to humans. Their use, often for nefarious purposes, can be traced as far back as ancient civilizations where, instead of being called chemicals, they were referred to and used as “poisons.” Since then, and particularly following the industrial revolution, the use of chemicals in other applications, such as textiles and fertilizers, has dramatically increased (Rowe 1998).

1.2 Synthetic or Naturally Occurring Chemicals – Which Are “Safer”?

Ask a group of people whether synthetic chemicals are more harmful than those that come from mother nature, i.e. naturally occurring, and it is likely that you will receive very divided opinions. However, this kind of question and

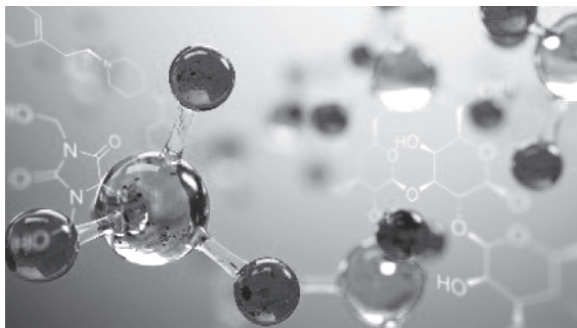


Figure 1.1 Chemicals are all around us. *Source:* E.Artem/Shutterstock.com.

others like it were investigated as far back as the early sixteenth century by a Swiss physician called Philippus Aureolus Theophrastus Bombastis von Hohenheim, or more commonly known as “Paracelsus.” From his work he concluded that in sufficient quantities everything had the potential to cause harm, and the only thing that differentiated something from being harmful or not was the dose. In other words, it is “the dose which makes the poison.” This means that irrespective of the source of the chemical, i.e. synthetically made in the laboratory or from a woodland plant, all have the potential to cause harm should the dose be sufficient. This dose–response relationship that Paracelsus discovered is a key theme in toxicology and will be covered in more detail in Chapter 3 of this book.

1.3 Chemical Control Regulations

Chemicals are an essential part of our daily lives, not just in the workplace but also in the home. However, there are often risks associated with their use, and therefore, chemical control regulations have been implemented in most countries. These ensure that hazardous chemicals are identified, which is

Chemical control regulations cover the whole chemical life cycle. This includes their manufacture, use, transport, storage, and disposal.

where knowledge of toxicology is needed, and any likely exposure is minimized. Where necessary, these regulations can restrict or ban access to particularly hazardous chemicals. For example, under Article 57 of the EU REACH

Regulation, a substance of very high concern (SVHC) is one that has been proposed to be subject to authorization for use within Europe. These substances are typically Category 1 carcinogens, mutagens, or toxic for reproduction (CMR) and are likely to have extensive human exposure (ECHA 2014).

Furthermore, classification and labeling of hazardous substances and mixtures is also a requirement (GHS 2017), the results of which are communicated in the form of a safety data sheet and/or product label. Finally, chemical control regulations also ensure that appropriate risk assessments are undertaken. This is covered in more detail in Chapter 11.

1.4 Perception of Chemical Risk

With news stories sensationalizing the harmful effects of chemicals, it is no surprise that many people are suspicious of chemicals and see no benefit to society at all. Although there may be times when this is not without due reason, it can lead to the banning of chemicals whose benefits far outweigh any perceived drawbacks in their use. Conversely, despite well-documented scientific evidence, which proves the adverse health effects associated with their use, people continue to smoke tobacco and drink alcohol (Box 1.1).

Box 1.1 A recent report by the World Health Organisation

Figure 1.2 Would you like a glass of wine?
Source: MariyanaM/Shutterstock.com.



“Globally, alcohol results in approximately 3.3 million deaths each year, and this number has already been adjusted to take into account the beneficial impact of low risk patterns of its use on some diseases. Of all deaths worldwide, 5.9% are attributable to the use of alcohol; this is greater than, for example, the proportion of deaths from HIV/AIDS (2.8%), violence (0.9%) or tuberculosis (1.7%).” The highest numbers of deaths are from cardiovascular diseases, followed by injuries (especially unintentional injuries), gastrointestinal diseases (mainly liver cirrhosis), and cancers (Figure 1.2).

Source: Reproduced with permission from WHO (2014).

1.5 Why Is Toxicology Important?

Toxicology is the cornerstone in all aspects of chemical safety. Knowledge of the subject is needed in a wide variety of disciplines, not just the chemical industry but also other areas, including medicine, the emergency services, and forensic science. Many problems arise from a lack of understanding of toxicology and exposure considerations, both of which are explored in subsequent chapters of this book.

1.6 Summary

- Chemicals comprise atoms or ions of different elements, and most chemicals we encounter are synthetic rather than naturally occurring.
- Toxicology is the study of the adverse effects of chemicals on living organisms.
- Work by Paracelsus in the early sixteenth century concluded that “it is the dose which makes the poison.” This dose–response relationship is a key theme in toxicology.
- Chemical control regulations cover the whole chemical life cycle. This includes their manufacture, use, transport, storage, and disposal.

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