

A PRACTICAL GUIDE TO  
**TOXICOLOGY AND  
HUMAN HEALTH  
RISK ASSESSMENT**

LAURA ROBINSON

WILEY



**A Practical Guide to  
Toxicology and Human Health  
Risk Assessment**



# **A Practical Guide to Toxicology and Human Health Risk Assessment**

*Laura Robinson*

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Brighton, UK*

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*To my husband Andrew T. Austin and Nai-Ling*





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## Foreword

In 2015 a patient told me of how his life was saved in 1969 by the prompt action of his site foreman, following a mining accident when he was accidentally exposed to cyanide gas. Still here to tell the dramatic tale, 46 years later, of nitrates, oxygen, and then hospitalization, it really emphasized the need for an understanding of how we could reduce the harmful impact of chemicals.

As Laura writes in her first chapter, “we live in a chemical environment, and therefore, we need to be aware of the ways in which chemicals can cause harm.” This book allows us to do just that. Having distilled the spirit of each topic into readily comprehensible principles, which can then be used to address wider matters, the chapters are well organized and broken down into clear parts. At the back of each chapter, there are references that are useful for further study.

Anyone for whom toxicology has any relevance, e.g. nurses, doctors, paramedics, allied health professionals, pharmacists, environmentalists, chemists, pathologists, industrialists, and also toxicologists, in training and in practice, will find this book invaluable.

Dr Susan Elton, MBBS, MRCGP, DOccMed, Postgraduate Certificate in Law





## Preface

Toxicology is the cornerstone to 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 forensics.

Many problems arise from the understanding of toxicology and its application in hazard communication and chemical safety. This has been highlighted by the numerous online webinars and face-to-face toxicology training sessions that have been delivered by Toxicology Consulting Ltd over the past five years.

The overall goal of this book is therefore to provide a very practical and easy-to-use guide that will enable the reader to quickly build up his or her knowledge and understanding (in terms of its application) of toxicology.



## **Acknowledgment**

I would like to thank Dr Susan Elton for her careful review of the chapters from an occupational medicine/toxicology perspective.



## 1

## 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).

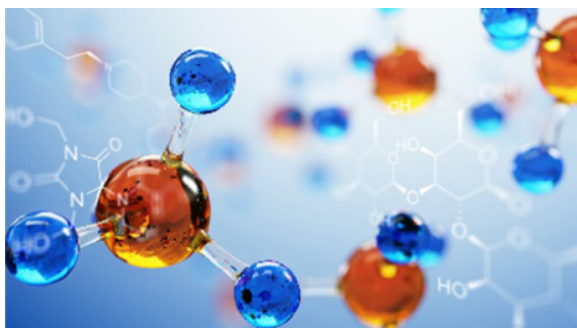
We live in a chemical environment, and therefore, we need to be aware of the ways in which chemicals can cause harm. In other words, we need to understand **toxicology**, which is the study of the adverse effects of chemicals on living organisms. By doing this we can then put in measures to minimize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