

The Science of Chemical Safety  
Essential Toxicology

Objectives & Method of Use

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IUPAC Educators' Resource Material

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# Background

- This educational material is the result of a collaborative project of the IUPAC Commission on Toxicology and the IUPAC Committee on the Teaching of Chemistry. It follows the successful production of an undergraduate level textbook, “Fundamental Toxicology for Chemists” published by the U.K. Royal Society for Chemistry

# General Objectives

- To provide educators with a presentation and text on essential toxicology from which they can select material appropriate for local requirements
- To explain fundamental ideas in toxicology clearly so that students can understand the hazards and risks associated with chemicals

# Unit 1 - General Considerations - Objective 1

- To point out the relationship between dose and effect
  - For every substance there is a dose below which no effect occurs (threshold dose) and another above which poisoning occurs
    - Thus, all substances are potentially safe or poisonous,
      - This depends only on dose

# Unit 1 - General Considerations - Objective 2

- To point out that natural substances may be highly poisonous and manmade substances may be of low toxicity
  - For example, *Clostridium botulinum* toxin is poisonous at even very low doses but synthesized sorbitol has a very low toxicity at high doses
  - Nicotine (natural) is highly poisonous but synthetic vitamin C is highly beneficial

# Unit 2 - Factors Affecting Risk of Poisoning - Objectives

- To explain how substances move through our environment
- To explain how effective exposure depends on physiological route of exposure
- To explain how toxic effects depend upon how the body reacts with chemicals
  - toxicokinetics and toxicodynamics
  - local and systemic effects

## Unit 2 - Factors Affecting Risk of Poisoning - Objectives (continued)

- To explain the importance of fat solubility
- To explain the problem of assessing effects of mixed exposures
- To explain the difference between acute and chronic exposures
- To give some examples of harmful (toxic) effects

# Unit 3 - Environmental Toxicology - Objectives

- To explain what happens to chemicals in the natural environment
- To introduce air pollution as a problem in toxicology
  - Acid rain and particulates
  - Global warming
- To introduce ideas of movement of chemicals from the natural environment to people at risk



# Unit 4 - Hazard and Risk - Objectives

- To introduce the concepts of hazard and risk
- To introduce the concept of “safe exposure”
- To introduce the concept of chemicals causing an effect (cancer) for which no “safe exposure” exists because no threshold exposure can be identified
- To introduce “exposure guidelines” and their possible limitations

# Unit 5 - Management of Potentially Toxic Substances - Objectives

- To introduce risk management
  - cradle to the grave (life cycle) considerations
  - the preventive management approach
  - The example of chloralkali manufacture and use
    - Mining, transport, processing, use in laboratory and home, waste disposal

# Unit 5 - Management of Potentially Toxic Substances - Objectives (continued)

- To point out the importance of labelling, Material Safety Data Sheets (MSDS), and International Chemical Safety Cards as sources of information
  - Hard copy sources of information on chemicals with instructions for their safe use
- To introduce the concept of Prior Informed Consent (PIC)

# Unit 6 - Risk Assessment and Risk Management - Objectives

- To explain the concept of risk in relation to risk assessment, risk perception and risk acceptability and how these aspects relate to risk management
- To explain how exposure assessment and the dose-response relationship are part of risk assessment
- To introduce internet sources of toxicological information

# Unit 7 - Common Types of Chemical That Cause Health Risks - Objective

- To provide examples of common chemicals and their potential for toxic effects
  - Dusts, fumes and gases
  - Solvents
  - Metals
  - Acids and bases
  - Pesticides

# Summary of the Units

- 1. General Considerations
- 2. Factors Affecting Risk Of Poisoning
- 3 Environmental Toxicology
- 4. Hazard and Risk
- 5. Management of Potentially Toxic Substances
- 6. Risk Assessment and Risk Management
- 7. Common types of Chemical that Cause Health Risks
- Additional text on ethical considerations
- DDT Case Study
- Suggested Assessment Exercises

# Suggested Method of Use of this Material - 1

- Select the content which is appropriate to your students
- Arrange the slides in a logical sequence starting from the student's previous knowledge
- Add your own examples to emphasise specific points from local circumstances

## Suggested Method of Use of this Material - 2

- Use labels or safety data sheets as sources of information and ask your students to compare selected chemicals for hazard and risk as used, perhaps in your own laboratory or at home
- Use the self assessment questions to stimulate discussion