



## Environmental Toxicology (ET)

Course: ES 535

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# Brief History of Environmental Toxicology

- **Orfila**, a Spaniard working at the University of Paris in the early nineteenth century, is generally regarded as the **father of modern toxicology**.
- He clearly identified toxicology as **a separate science** and, in **1815**, published the first book devoted exclusively to toxicology.
- **Rachel Carson** with the publication of her book, **The Silent Spring**, in **1962**, became an important influence in initiating the **modern era of environmental toxicology**.
- Her book emphasized **stopping** the widespread, **indiscriminate use of pesticides** and other chemicals and advocated use patterns based on sound ecology.
- Her book is often credited as the catalyst leading to the establishment of the U.S. EPA and she is regarded by many as the **mother of the environmental movement**.
- It is clear, however, that since the 1960s, **toxicology has entered a phase of rapid development** and has changed from a science that was largely descriptive to one in which the importance of mechanisms of toxic action is generally recognized.
- **Since the 1970s**, with increased emphasis on the use of the techniques of molecular biology, the pace of change has increased even further, and significant advances have been made in many areas, including **chemical carcinogenesis** and **xenobiotic metabolism**, among many others.

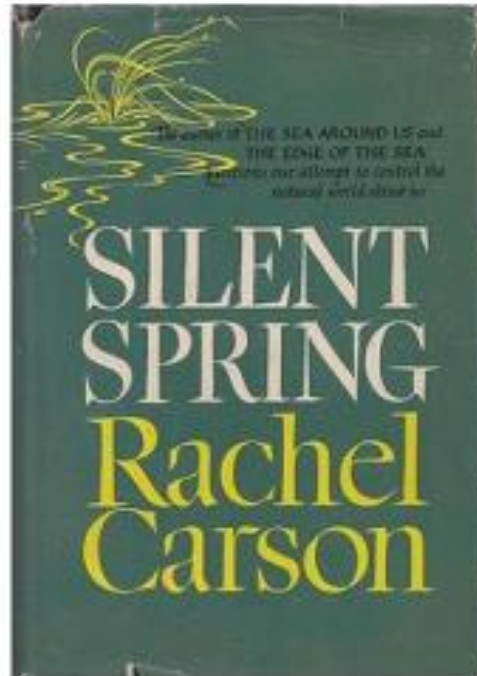


# History of Toxicology

- Rachel Carson (May 27, 1907 – April 14, 1964) is considered the mother of environmental toxicology, as she made it a distinct field within toxicology in 1962 with the publication of her book *Silent Spring*, which covered the effects of uncontrolled pesticide use.
- Rachel Louise Carson was an American marine biologist and conservationist whose book *Silent Spring* and other writings are credited with advancing the global environmental movement.

"Over increasingly large areas of the United States, spring now comes unheralded by the return of birds, and the early mornings are strangely silent where once they were filled with the beauty of bird song."

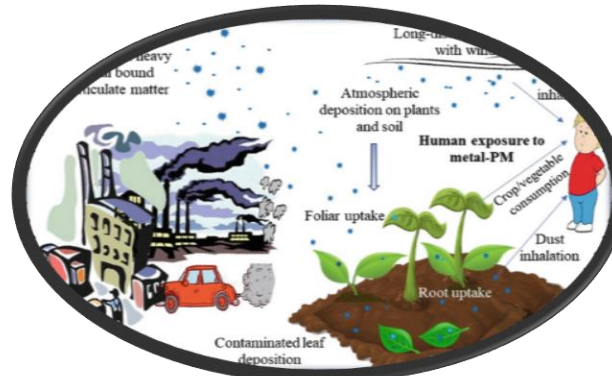
*The Silent Spring* (1962)



# Toxicology



- The literal meaning of the term ***toxicology*** is “***the study of poisons.***”
- The root word *toxic* entered the English language around 1655 from the Late **Latin word *toxicus*** (which meant *poisonous*), itself derived from *toxikón*, an ancient Greek term for *poisons into which arrows were dipped*.



# Toxicology

- *The early* history of toxicology focused on the understanding and uses of different poisons, and even today most people tend to think of **poisons as a deadly potion** that when ingested causes almost immediate harm or death.
- As toxicology has evolved into a modern science, however, it has expanded to encompass all forms of adverse health effects that substances might produce, **not just acutely harmful or lethal effects**.



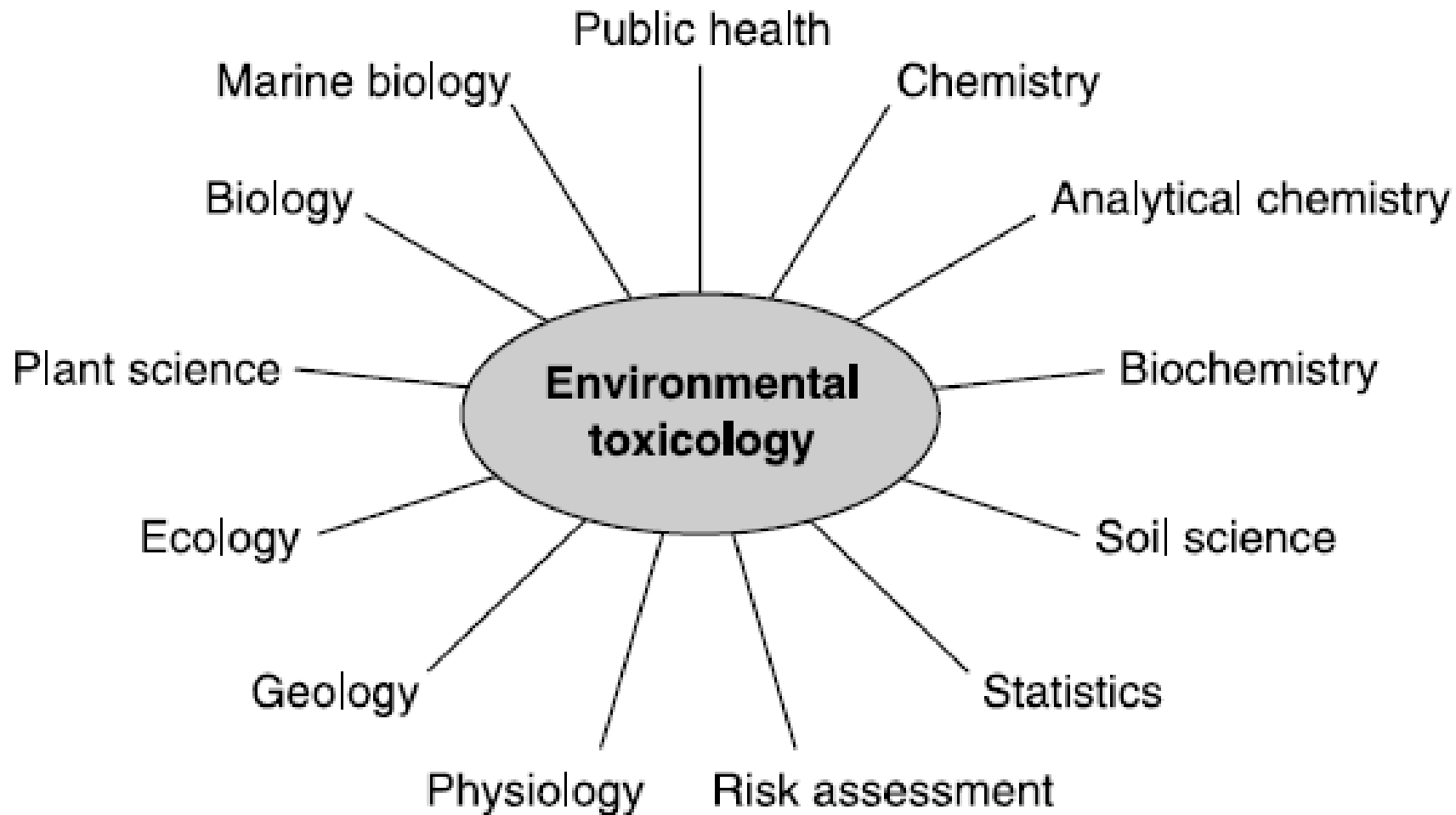
# Toxicology

- The science that deal with the **adverse effects of chemicals on living systems**.
- Environmental Toxicology, is a **multi-disciplinary field of science** concerned with the study of the **harmful effects** of various **chemical, biological and physical agents on living organisms**.
- Environmental Toxicology deals with the effects of **environmental toxicants** on health and environment. Environmental toxicants are agents released into the general environment that can cause adverse effects on the health of living organisms, including humans, animals, and plants.
- It is a science that attempts to qualitatively identify all the hazards (i.e., organ toxicities) associated with a substance, as well as to quantitatively determine the exposure conditions under which those hazards/toxicities are induced.
- Toxicology is the science that experimentally investigates the occurrence, nature, incidence, mechanism, and risk factors for the adverse effects of toxic substances.
- Environmental toxicology is a multidisciplinary science that encompasses several diverse areas of study, such as biology, chemistry (organic, analytical, and biochemistry), anatomy, genetics, physiology, microbiology, ecology, soil, water, and atmospheric sciences, epidemiology, statistics, and law.

## **Classifications:**

- Descriptive toxicology • What?
- Mechanistic toxicology • Why?
- Analytical toxicology • How much?

# Importance of Environmental Toxicology



Interrelationships between environmental toxicology and various scientific disciplines

# Importance of Environmental Toxicology

- The study of environmental toxicology is concerned with how environmental toxicants, through their interaction with humans, animals, and plants, influence the health and welfare of these organisms.
- The field of ET drawn in two synchronous directions: Regulation and Research
  - Regulation: Ensures standardized testing, fast and economical
  - Research: Complex interactions between individual organisms, species, physiological processes, environmental factors, and multiple anthropogenic chemical substances
  - Risk Assessment (EPA): Human induced stresses to the environment considering social and economic concern
  - Environmental toxicology diverges from traditional pharmacology or toxicology
  - The traditional methods for testing rely on the use of standard test organisms and laboratory methods to indicate relative toxicity of the various compounds in question
  - Instead, ecotoxicology addresses a more elaborate set of concerns.....



# Importance of Environmental Toxicology

- How are pollutants **transformed** after their release into the environment?
- How are organisms **exposed**?
- How do **physiological alterations** impact on population dynamics and community structures?
- What indirect impacts occur to **unexposed organisms** when their prey, predators, or competitors are affected?
- How do the impacts of multiple compounds differ from those of a single one?
- Such questions are beyond the domain of one-organism, one-compound laboratory tests.

# Importance of Environmental Toxicology

## Tools of ET are:

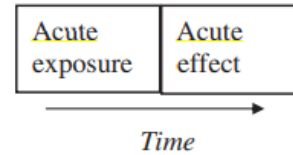
- Biological assays (study of individual growth, mortality, reproduction, metabolic rate, enzyme induction)
- Field observation (tissue concentration of toxicants, species number and density and population dynamics)
- Field experiments (containment of test organisms at contaminated sites and environmental simulations, aid in the construction and testing of theories)

# Toxicity

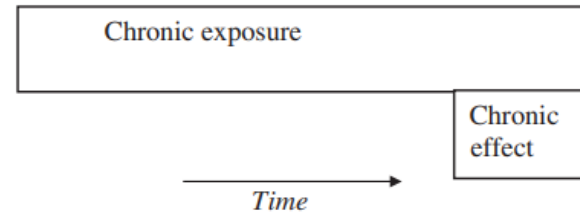
- Toxicity: The degree to which a substance can harm humans, plants or animals.
- Toxicity can be Acute, Sub-chronic, or Chronic.
  - Acute Toxicity involves harmful effects in an organism through a **single or short-term exposure**. Characterized by exposure to high concentrations of a toxicant or toxicants for a short period of time
  - Subchronic Toxicity is the ability of a toxic substance to cause effects for **more than one year but less than the lifetime of the exposed organism**.
  - Chronic Toxicity is the ability of a substance or mixture of substances to cause harmful effects **over an extended period**, usually upon repeated or continuous exposure, sometimes **lasting for the entire life of the exposed organism**. Characterized by a long-term or recurrent exposure to relatively low concentrations of toxicants

# Toxicity (Source: Ernest Hodgson (2010))

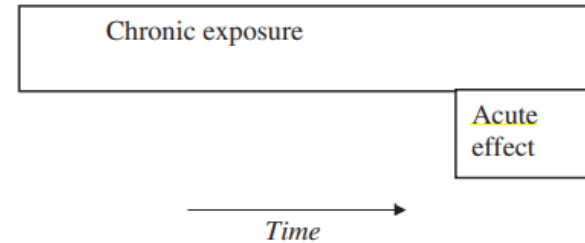
(a) Short-term exposure resulting in immediate effects



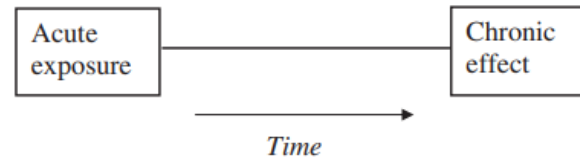
(b) Continuous exposure resulting in sublethal effects



(c) Continuous exposure resulting in acute effects



(d) Short-term exposure resulting in later sublethal effects



**Figure 10.1** Examples of exposure/effect scenarios that result in either acute toxicity (a), chronic toxicity (b), or mixed acute/chronic toxicity (c, d). Examples for each scenario are provided in the text.



Month/Year	Activities schedule (Tentative)				
Jan/23	20 Lecture	27 Lecture			
Feb/23	3 Lecture (Assignments)	10 Lecture	17 Quiz and Lecture	24 Lecture	
Mar/23	3 Mid-Term Exam.	10 Lecture Mid-Term Exam.	17 Holiday	24 Lecture	31 Lecture
Apr/23	7 Lecture (Last date for submission of Assignments)	14 Holiday	21 Holiday	28 Lecture	
May/23	5 Final Exam.	12 Final Exam.	17 Wednesday Last day of Grade submission	26	