Learning Objectives: Serious environmental health problems and diseases may arise from toxic elements in water, air, soil, and even the rocks on which we build our homes. After reading this chapter, you should understand:

- How the terms toxic, pollution, contamination, carcinogen, synergism, and biomagnifications are used in environmental health
- What the classification and characteristics are of major groups of pollutants of environmental toxicology
- Why there is controversy and concern about synthetic organic compounds such as dioxin
- Whether we should be concerned about exposure to human-produced electromagnetic fields
- What the dose-response concept is and how it relates to LD-50, TD-50 and ED-50, ecological gradients, and tolerance
- How the process of biomagnifications works and why it is important in toxicology
- Why the threshold effects of environmental toxins are important
- What the process of risk assessment in toxicology is and why such processes are often difficult and controversial
- What the precautionary principle is and why it is important

Read: Toxic Air Pollution and Human Health: Story of a Southeast Houston Neighborhood

1: What are some of the chronic health effects of exposure to Benzene?
- Blood disorders, reproductive problems, and increased probability of contracting leukemia

2: What are some of the potential sources of Benzene in the environment?
- Tobacco smoke and evaporating gasoline

3: Why is it so hard to link health problems to toxic air pollution?
- Populations settle around factories that emit toxins, and some states do not have proper regulations that tend to air quality standards.

4: Why it is said that between a state of health and a state of disease is a gray zone of suboptimal health, a state of imbalance?
- Because a person may not be healthy, but may not have a disease (such as being malnourished)

5: Explain what happened at Lake Nyos, Cameroon.
- Pressurized carbon dioxide from volcanic shafts were released into the bottom of Lake Nyos, and a disturbance eventually caused the carbonated water to rise to the top and release into the air. The carbon dioxide then flowed downhill into villages, killing animals and >1,800 people.

6: What is the difference between a pollutant and a contaminant?
- A pollutant is an element such as heat or sound that disturbs and harms the environment. Contaminants are unwanted (usually manmade) materials such as hazardous waste that are introduced into the environment.
7: Define the following:

- Toxin: Substances that are poisonous to living things
- Toxicology: The science that studies toxins or suspected toxins
- Carcinogen: A toxin that increases the risk of cancer
- Synergism: The interaction of different substances, resulting in a total effect that is greater than the sum of the effects of the separate substances
- Point sources: Give example: Sources of pollution (e.g. smokestacks)
- Area sources (non-point): Give example: Sources of pollution that aren’t released in one source area (e.g. runoff)
- Mobile sources: Give example: Sources that travel (e.g. cars)

8: Define the following: (Identify when they are used)

- ppm: parts per million, used to measure small amounts of pollutants or toxins
- ppb: parts per billion, used to measure small amounts of pollutants or toxins
- mg/L: milligrams per liter, used to measure water pollution
- μg/m3: micrograms per liter, used to measure water pollution

9: What is an Infectious Agent? (Give examples):

- A vessel or vector that spreads a disease, such as insects

**A Closer Look 10.1: Sudbury Smelters: A Point Source**

10: Explain what happened to the area surrounding the Sudbury Smelter as a result of the release of heavy metal pollution into the air.

- The Sudbury Smelter’s heavy metal particulate pollution caused nickel to settle into the soil, and sulfur dioxide acid rain to develop. Both of these occurrences killed vegetation in the ~92 square miles of land surrounding the smelter.

11: What are some common heavy metals found in the environment? What health hazards can they pose to humans?

- Mercury, lead, cadmium, nickel, gold, platinum, silver, bismuth, arsenic, selenium, vanadium, chromium, and thallium; storage in tissue and fat that could lead to overdose and death

12: What is the concept of Body Burden?

- The quantity of heavy metals in the body, and how much of a certain metal can accumulate before it becomes lethal

What are the body burdens for the following?

- Antimony: 8 mg
- Mercury: 13 mg
- Arsenic: 18 mg
- Cadmium: 30 mg
- Lead: 150 mg

13: Define biomagnification/bioaccumulation:

- Biomagnification/bioaccumulation is the process of a substance becoming more concentrated the farther it is in the food web. For example, fish may ingest .02 ppm of mercury, but a bird may need to eat multiple mercury-carrying fish to nourish itself. The mercury concentration may increase through more consumption.

14: Describe how Cadmium is a good example of biomagnification.

- Cadmium is a good example because it demonstrates the metal’s journey through the food web, where it first settles in the soil, and it is then eaten by animals, and so on.

15: How does Mercury enter the environment?

- By volcanic eruptions, erosion, fossil fuel burning, waste incineration, and metal processing

16: Define Methylation: the process in which inorganic mercury is converted to methyl mercury by bacteria

17: Define Volatilization: The conversion of liquid mercury into vapor

Read: A Closer Look 10.2- Mercury and Minamata, Japan

What are the 4 major factors that must be considered in evaluating and treating toxic environmental pollutants?

-1: Individuals vary in their response to exposure to the same dose, or amount, of a pollutant; 2: Pollutants may have a threshold; 3: Some effects are reversible; and 4: The chemical form of a pollutant, its activity, and its potential to cause health problems may be changed markedly by ecological and biological processes.

18: Define: Persistent Organic Pollutant (POP) and describe the properties that define them

- Synthetic compounds that are used as insecticides, herbicides, and other preventatives; They have a carbon based molecular structure with highly reactive chlorine, they are manmade, they do not break down easily in an environment, they are polluting and toxic, They are fat soluble and they accumulate in tissue, and they occur in forms that allow them to be transported by wind, water, and sediments for long distances.

Read: A Closer Look 10.3- Dioxin: How Dangerous is it?

How is Dioxin produced?

- It is produced as a byproduct of chemical reactions such as the combustion of chlorine compounds in herbicide production.

What happened in Times Beach, Missouri?

- Dust-controlling oil that was sprayed onto the roads of Times Beach was found to contain dioxin, and the whole area was considered contaminated. Times Beach was soon evacuated and designated as a dioxin ghost town, and it was bulldozed and enclosed. It is now part of Route 66, and is a bird refuge.

19: Give some examples of HAA’s:

- DDT, other pesticides, herbicides, phthalates

20: Explain how PCB’s are harmful (found in plastics):

- PCBs may cause poor neurological performance and reproduction. They are often found in cosmetics and plastics containing chlorine.
Read: A Closer Look 10.4- Demasculinization and Feminization of Frogs

Explain how hormone disruptors (Endocrine disruptors) work

- EDs change hormones by switching the gene that produces the sex hormone and changing the hormone that is produced (testosterone, estrogen)

21: How can Thermal Pollution affect a body of water and its biodiversity? Explain.

- Thermal pollution may heat up water to the point where the body of water is not a sufficient habitat for organisms to live in, which may cause deaths or emigration.

22: What are examples of particulates?

- Arsenic, lead, sulfur, dust

23: Why is asbestos harmful to humans?

- Asbestos fibers may accumulate in the lungs and stimulate the production of cancerous tumors, which leads to mesothelioma.

24: How can EMF (Electromagnetic Fields) be harmful to humans?

- EMFs emitted from power lines were proven to increase the risk of leukemia lymphomas, and nervous-system cancers in children.

25: How is noise pollution measured?

- Decibels (dB)

26: What are some voluntary exposures to pollutants?

- Tobacco, alcohol, and drugs

27: What is meant by the quote, "everything is poisonous, yet nothing is poisonous"? Explain.

- Too much of anything is harmful to the body, a very small or moderate amount is usually harmless.
28: Describe the “dose-response”. Draw and label the generalized dose-response curve. Explain each step.
- Dose-response is an indicator of when a dose is lethal, ineffective, or beneficial.

![Dose-Response Curve](image)

The higher spike in data refers to the beneficial dose; the drop refers to the lethal dose.

29: Define the following:
- LD-50: Lethal Dose 50, the dose at which 50% of the population dies
- ED-50: Effective Dose 50, the dose that causes an effect in 50% of the observed subjects
- TD-50: Toxic Dose 50, The dose that is toxic to 50% of observed subjects
- LD-0: Lethal Dose 0, Max dose that does not cause death

30: Explain the concept of a threshold dose:
- A threshold dose is the dosage limit in which effects begin to occur above the dose, but below the dose is considered to be safe.

31: Define:
- Behavioral tolerance: the ability to resist an obstacle such as traps
- Physiological tolerance: Tolerance to exposure to something, usually built after prolonged exposure
- Genetic tolerance: When a species adapts to a toxin through evolution

32: Explain the difference between an acute and chronic effect.
- An acute effect occurs right after exposure, a chronic effect is expressed over a long period
33: Explain the steps of risk assessment:

1: Identification of the hazard and whether it is likely to cause health problems; 2: Dose response assessment, determining how much the individual was exposed to and the effects; 3: Exposure assessment, evaluating the intensity and time period of exposure; and 4: Risk characterization, determining health risk.

34: What is the precautionary principle?

- The process of dealing with a problem immediately to prevent it from expanding

**Read: “Is Lead in the Urban Environment Contributing to Antisocial Behavior”**

35: What is the main point of the discussion about lead in the bones of children and behavior?

- Lead ingested from paint flakes and other sources may be responsible for some children’s erratic behaviors and loss of motor skills. This is supported by research on the Romans and lead poisoning, which is attributed to Rome’s downfall.

36: Why is it difficult to establish standards for acceptable levels of pollution? In giving your answer, consider physical, climatological, biological, social, and ethical reasons.

- It is difficult to establish standards for acceptable levels of pollution because there are too many sources that need to be controlled (which may adversely affect industry and budget). Since many pollution sources are sparse, it would be extremely time-consuming and expensive to find every source to monitor. To limit pollution, companies must additionally process waste in order to lessen pollution, which costs even more money. These are reasons why establishing standards is usually not favored.