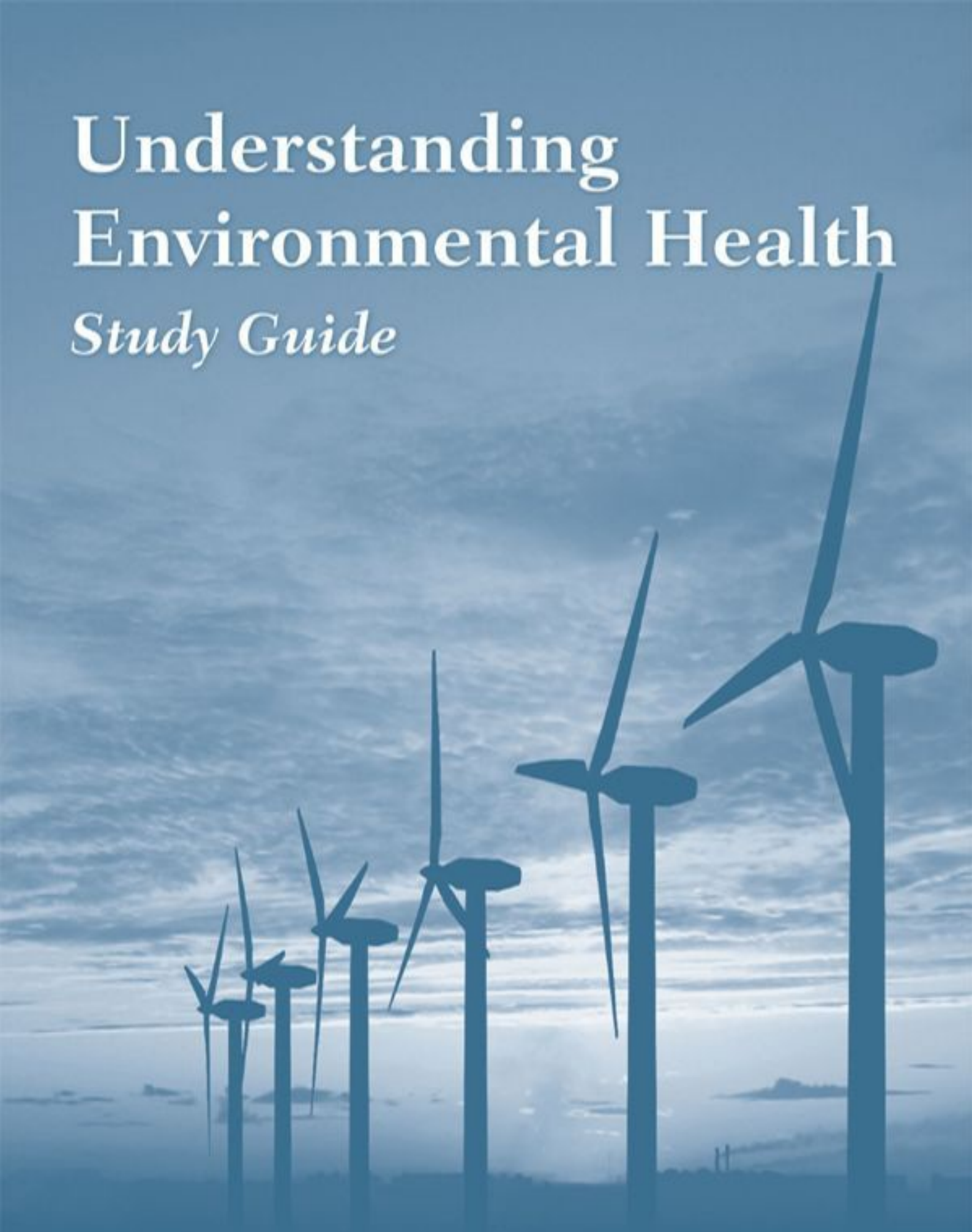
EESA10 Understanding Environmental Hea - Maxwell

Human Health and Environment (University of Toronto)

Understanding Environmental Health

Study Guide



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Understanding Environmental Health Study Guide

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Contents

Using This Study Guide

This study guide identifies key concepts in each section of the textbook. Often the key concepts are accompanied by questions or a brief exercise. These are intended to make the material more concrete and more accessible. I suggest that you first read your assignment in the textbook without using this study guide and without taking extensive notes. Then review the reading carefully using this study guide. The study guide supports and expands upon the more general learning objectives at the start of each chapter in the textbook. The cross-references to numbered figures refer to figures in the textbook.

Sometimes an entry in this study guide will present a set of related terms, with the following instructions:

Using your own words, define or explain these terms and how they relate to one another.

Though the textbook includes an extensive glossary, I suggest that you do this first without referring to the textbook or glossary; after completing the question on your own, refer back to the definitions and revise your explanation as needed. Your explanation does not need to match the glossary or the textbook word for word; the idea is not to memorize definitions but to understand terms in such a way that you remember what they mean.

CHAPTER 1

A Preview of Environmental Health

Key concept #1: Environmental health science distinguishes among chemical, physical, biological, and social hazards to human health.

Key concept #2: Modern Western-style development creates many products and wastes, some of which create hazards to human health.

Key concept #3: Modern Western-style development changes the environment in ways that are neither equitable nor sustainable at a global scale.

CHAPTER 2

The Science and Methods of Environmental Health

Section 2.1 Fate and Transport

Key concept #1: In terms of behavior in the environment, organic chemicals have characteristic tendencies.

- Compare and contrast two stereotypical groups of organic chemicals by filling in the following table.

Group	Volatile?	Persistent?	Lipophilic?	Bioconcentrate, bioaccumulate, biomagnify?	Tend to be found in which environmental media?
Low molecular weight (e.g., TCE)					
High molecular weight (e.g., PCBs, DDT)					

Key concept #2: Certain gases in the Earth's atmosphere, although they make up only a small proportion of the atmosphere, have important functions.

- Which trace gases in the troposphere function as greenhouse gases? Explain what a greenhouse gas is.

_____
_____
_____

- Ozone plays an important role in the stratosphere as well as in the troposphere. Describe the stratospheric ozone layer, explaining its significance for human health.

_____
_____
_____

Key concept #3: Water circulates through the environment, as shown in Figure 2.3 in the textbook. Important parts of the hydrologic cycle take place underground and may be unfamiliar to some readers.

- Using your own words, define or explain these terms and how they relate to one another:
  - Groundwater, aquifer

    _____
    _____
    _____
  - Zone of aeration, saturated zone, water table

    _____
    _____
    _____
  - Recharge, recharge area

    _____
    _____
    _____
  - Upgradient, downgradient

    _____
    _____
    _____
  - Confined aquifer, unconfined (water table) aquifer, watershed

    _____
    _____
    _____

Section 2.2 Toxicology

Key concept #1: Environmental chemicals can enter the body, where they may be transformed, transported, and ultimately removed from the body.

- What are the three major *routes* of human exposure to environmental contaminants?

  _____
  _____
  _____
- Using your own words, define or explain these terms and how they relate to one another:
  - Exposure, dose

    _____
    _____
    _____
  - Absorbed dose, biologically effective dose

    _____
    _____
    _____

- Name the three major routes by which chemicals are excreted from the human body. What are some other, less obvious routes of excretion?

_____
_____
_____

Key concept #2: The quantitative relationship between the dose of a toxicant and its toxic effect is usually presented as a dose—response curve.

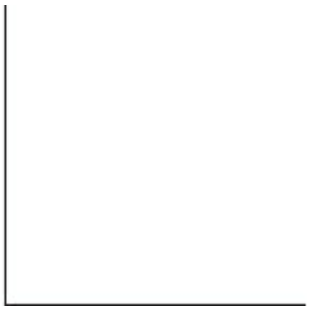
- What are the two defining characteristics of a dose—response curve?

_____
_____
_____

- What is the practical significance of a threshold (or the lack of one) in a dose—response curve?

_____
_____
_____

- Sketch a curve with the same threshold but a steeper slope than the one that is shown in Part a of Figure 2.9. What is the practical significance of a steeper slope?



- Why do most dose–response curves have the characteristic S shape?

_____
_____
_____

- Identify and explain the key difference between a dose–response curve for cancer and a dose–response curve for a noncancer effect.

_____
_____
_____

Key concept #3: The chronic rodent bioassay is the cornerstone of toxicity testing in animals.

- What is learned about a chemical's *carcinogenicity* through chronic toxicity testing in rodents?

- What is learned about a chemical's *noncancer effects* through chronic toxicity testing in rodents?

  - What do the terms *NOAEL* and *LOAEL* mean?

  - Explain the practical importance of documenting a NOAEL in addition to a LOAEL in a chronic rodent bioassay.

  - Draw a graph of each of the following sets of hypothetical data for a noncancer health effect from a chronic rodent bioassay. In each graph, label the axes, plot the locations of the points, connect them with a line, and label the LOAEL and the NOAEL (if there is one). For each graph, what can you say about the threshold of the toxic effect?

Data for rodent bioassay #1

Dose in mg/(kg*day)	Percentage of rodents showing liver toxicity
0	0
0.05	0
0.10	10
0.20	15

Data for rodent bioassay #2

Dose in mg/(kg*day)	Percentage of rodents showing neurotoxicity
0	0
0.05	10
0.10	20

Section 2.3 Exposure Assessment

Key concept #1: Given that "the dose makes the poison," it is important to measure or estimate exposure as accurately as possible. Modern science frames the assessment of exposure in terms of an exposure pathway.

- Review the structure of Figure 2.11 carefully, trying to understand rather than memorize.
  - Note that static concepts (boxes) are labeled with letters, whereas events and processes (links between boxes) are labeled with numbers.
  - Note that the event of exposure is the dividing point between events or processes outside the body and those inside the body.

Key concept #2: Ideally, exposure is quantified inside the body. However, often this is not practical, and a measurement made in the environment is used as proxy.

- Distinguish among *ambient environment, microenvironment*, and *personal environment* by filling in the cells of the following table.

	Is this environment large or local?	Is this environment stationary or mobile?
Ambient environment		
Microenvironment		
Personal environment		

Key concept #3: As a practical matter, certain environmental media are most associated with each of the three major routes of exposure.

- Review Table 2.2, thinking about why each check mark (or the lack of one) makes sense.

Key concept #4: Modern science uses various techniques to measure or estimate exposure all along the exposure pathway.

- Review the structure of Figure 2.12 carefully, trying to understand rather than memorize.
  - As in Figure 2.11, static concepts (boxes) are labeled with letters, whereas events and processes (links between boxes) are labeled with numbers.
  - Note that this distinction parallels the use of monitoring (of static concepts) versus

modeling (of events and processes) to make quantitative estimates.

Key concept #5: The units typically used to quantify absorbed dose are milligrams of toxicant per kilogram of body weight per day, or mg/(kg*day).

- To be sure that you understand what these units mean, review the following sample calculation and then use it as a model for the practice exercise.
- Sample calculation: Andre, who weighs 100 kilograms, drinks 2 liters of tap water each day. Arsenic is present in his local tap water at a high concentration of 1.5 milligrams per liter. What is Andre's average daily dose of arsenic from this exposure, in units of mg/(kg*day)?

$$\frac{\frac{1.5 \text{ mg arsenic}}{1 \text{ liter water}} \times \frac{2 \text{ liters water}}{\text{day}}}{100 \text{ kg body weight}}$$

$$= 0.03 \text{ mg/(kg*day)}$$

- Practice exercise: In Maria's home, which is heated by a wood fire, the average concentration of particulate matter (PM_{10}) is about 1 milligram per cubic meter (1 mg/m^3). On a typical day, Maria spends a good deal of time at home and inhales about 12 m^3/day of the indoor air. She weighs 48 kilograms. What is Maria's dose of PM_{10} from the air inside her home, in units of mg/(kg*day)?

Answer: 0.25 mg/(kg*day)

Section 2.4 Epidemiology: A Quantitative Research Method

Key concept #1: Epidemiologists use three distinct measures—incidence, prevalence, and mortality—to quantify a given disease in a population.

- How is prevalence related to incidence and mortality?

_____

_____

_____

Key concept #2: Surveillance epidemiologists typically use one of two measures to compare rates of death and disease in different populations: the standardized rate ratio or the standardized incidence ratio.

- Why is some kind of standardization needed when comparing rates of death or disease across populations?

_____

_____

_____

- Contrast the *standardized rate ratio* with the *standardized incidence ratio.* How is each calculated? (See Figures 2.16 and 2.17.) What advantages and disadvantages does each have compared to the other? You may find it useful to fill in a table like this one:

	SRR	SIR
Advantages		
Disadvantages		

Key concept #3: Several distinct study designs are used in environmental epidemiology, depending on the investigator's purpose and the availability of data.

- Distinguish among major study designs by filling in this table:

Study design	Studies health outcome only, or both health outcome and exposure?	Analyzes data on groups or on individuals?
Surveillance		
Case series		
Ecologic study		
Cross-sectional, cohort, or case-control study		
Intervention study		

- What two features do epidemiologic study designs that are considered analytic (hypothesistesting) have in common?

_____

_____

_____

Key concept #4: Not every statistical association represents a causal association.

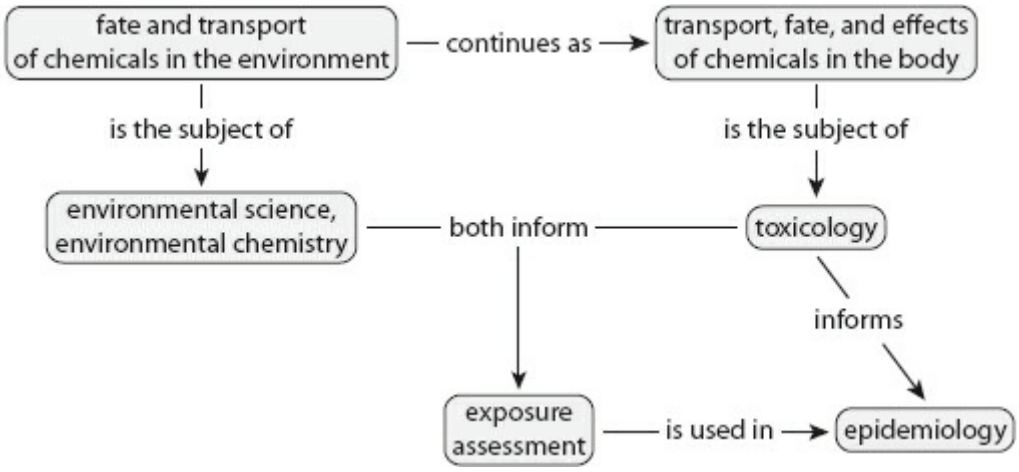
- A well-conducted epidemiologic study has found a valid and statistically significant association between exposure to Chemical X and risk of pancreatic cancer. What additional facts would provide support for the idea that this link is causal?

_____

_____

_____

Review of the Big Picture: Connections Among the Sciences that are Important in Environmental Health



Section 2.5 Risk Assessment: A Regulatory Science

Key concept #1: Risk assessment is an applied science used to evaluate the public health risk of environmental hazards, using information on exposure and toxicity.

- Name and describe the four major steps in assessing the public health risk of a chemical, explaining how the steps relate to one another (see Figure 2.18).

_____
_____
_____

Key concept #2: The conceptual divide between noncancer and cancer health effects that appeared in toxicology is carried through in the risk assessment of chemicals. Therefore, the four major steps in risk assessment are parallel, but not the same, in risk assessment for noncancer and cancer effects of chemicals.

- Using your own words, define or explain these terms and how they relate to one another:
  - Reference dose, hazard quotient

_____
_____
_____

  - Weight-of-the-evidence classification (see Table 2.4), cancer slope factor, incremental lifetime cancer risk

_____
_____
_____

- You should understand each series of steps (each column) in Table 2.5, and you should understand, for each row, the difference in approach for a noncancer versus cancer

effect. Understanding the dose—response assessment and risk characterization steps includes understanding what the units mean.

Key concept #3: When the risk assessment approach is applied to a site, the same four steps are followed, but they play out differently in this context. This is because most sites are contaminated by multiple chemicals and because each contaminated site offers a different set of opportunities for exposure (see Table 2.6).

- Explain how hazard identification and exposure assessment are undertaken in a risk assessment for a site, as opposed to a risk assessment for a chemical.

  _____
  _____
  _____

- Explain what dose–response assessment and risk characterization are in a risk assessment for a site, as opposed to a risk assessment for a chemical.

  _____
  _____
  _____

Section 2.6 Risk Management: From Assessment to Action

Key concept #1: In environmental health, risk management consists of actions taken to control or reduce environmental health risks.

- Chemical X has been shown to have noncarcinogenic effects, and a reference dose has been derived. How could you use the reference dose to set a standard for an allowable concentration of Chemical X in drinking water? (See the backward calculation on page 57 of the textbook.)

  _____
  _____
  _____

- Chemical Z has been shown to be carcinogenic, and a cancer slope factor has been established. For purposes of this exercise, assume Chemical Z has no noncancer effects. What decision would you have to make before you could use the cancer slope factor to backcalculate a standard for an allowable concentration of Chemical Z in drinking water?

  _____
  _____
  _____

Key concept #2: Many risk management actions are not as straightforward as setting a drinking water standard.

- Imagine that you have just completed a risk assessment for an abandoned industrial site in a residential neighborhood. On the site, which is not fenced, there are high concentrations of several toxic chemical dyes in the groundwater and soil. Your risk assessment considered exposure scenarios for those living near the site, including children who play on the site or cut through it on their way to school. Describe two risk *management* approaches you might consider for this site. Explain your choices.

_____
_____
_____

Section 2.7 Risk Communication

Key concept #1: The general public's perception of risk has been called "hazard plus outrage."

- Explain what this means, and describe its implications for environmental health professionals as they communicate with the public.

_____
_____
_____

Key concept #2: Communication between epidemiologists and research subjects has expanded well beyond informed consent.

- Describe some ways in which information is exchanged between researchers and study participants.

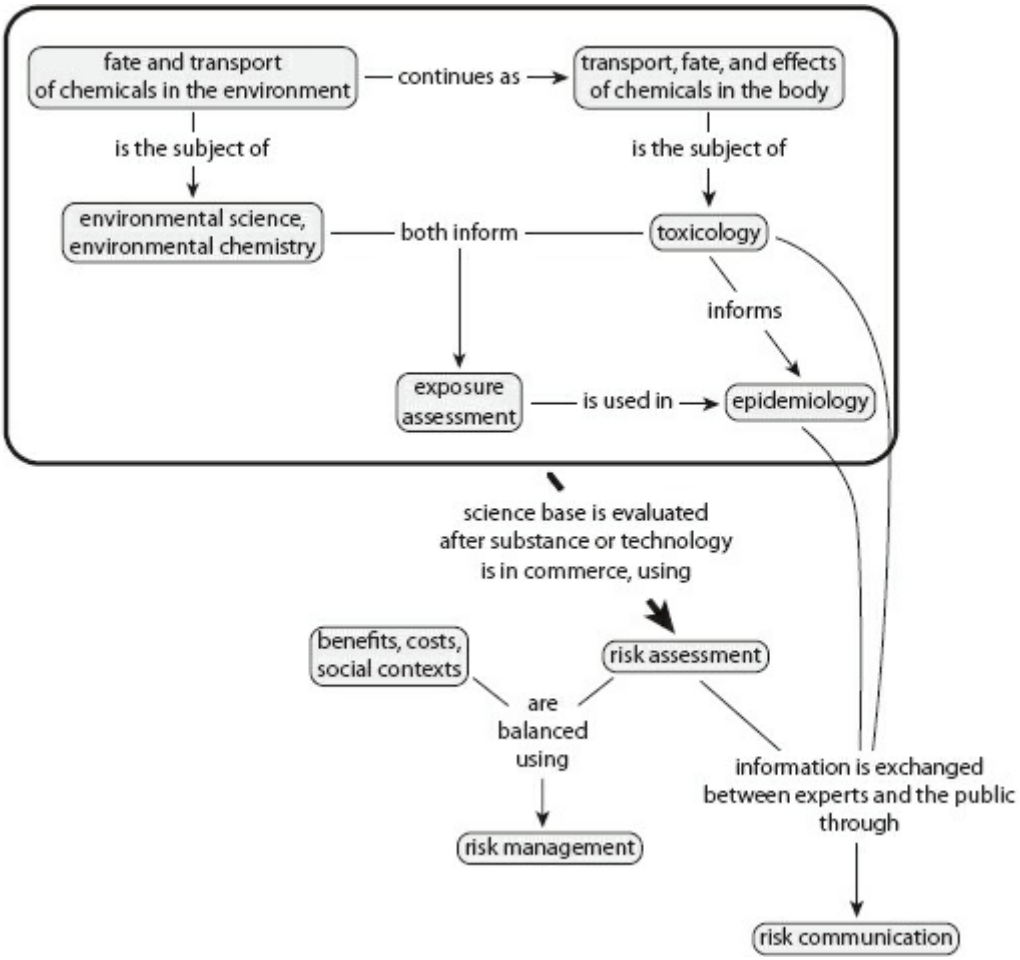
_____
_____
_____

Key concept #3: The consensus conference, rarely used in the United States, is a sophisticated form of risk communication.

- Describe how a consensus conference works and when it is particularly useful.

_____
_____
_____

More on the Big Picture: How Scientific Information is Used in Assessing, Managing, and Communicating About Risks



Section 2.8 The Precautionary Principle

Key concept #1: The precautionary principle is an alternative to the risk assessment—risk management paradigm.

- Describe the key elements of the precautionary principle as it is usually articulated in environmental health.

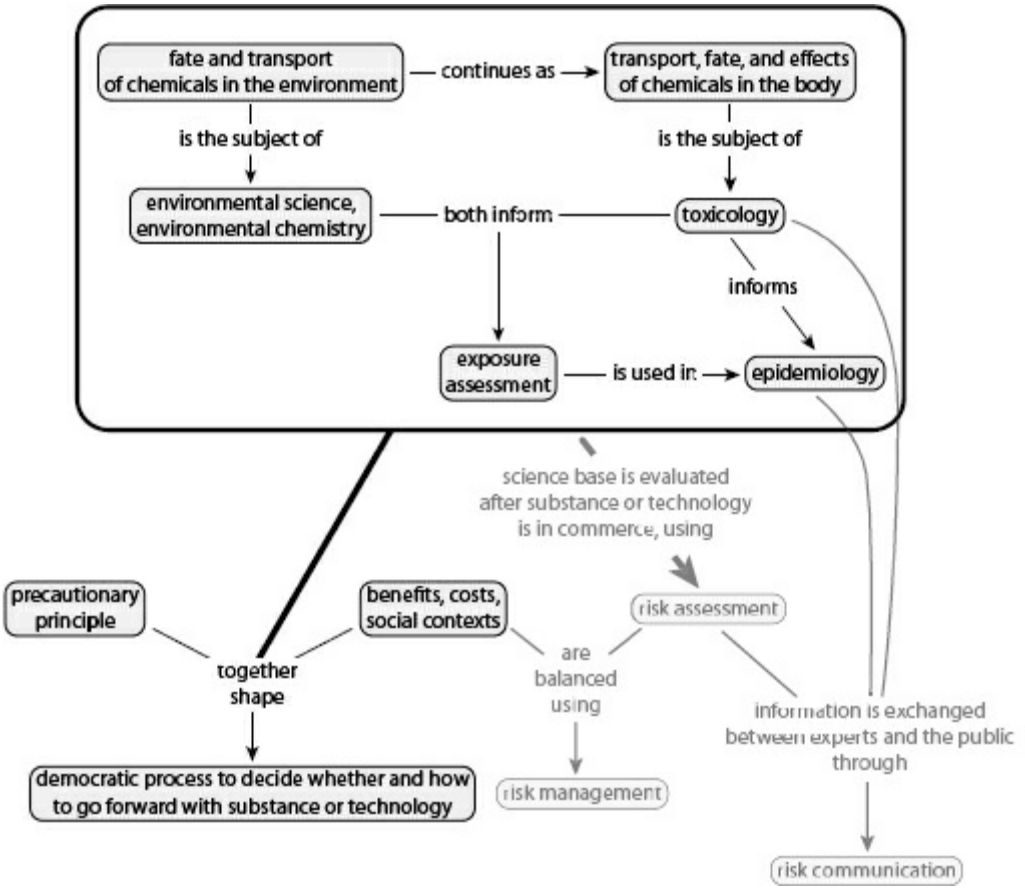
_____

_____

_____

Key concept #2: Implementing a precautionary approach in the United States would represent a major shift from the risk assessment—risk management paradigm.

An Alternative View of the Big Picture: The Precautionary Approach



CHAPTER 3

Living with Other Species

Section 3.1 Infectious Disease

Key concept #1: The human body provides a habitat for other, much smaller organisms, some of which make us sick.

- Using your own words, define or explain these terms and how they relate to one another:
  - Infectious disease, zoonosis

    _____
    _____
    _____
  - Host, pathogen, parasite

    _____
    _____
    _____
  - Worms, protozoa, bacteria, viruses, prions

    _____
    _____
    _____

Key concept #2: The human body mounts a defense against pathogens.

- Using your own words, define or explain these terms and how they relate to one another:
  - Antigen, antibody, vaccine

    _____
    _____
    _____
  - Active immunity, passive immunity, herd immunity

    _____
    _____
    _____

Key concept #3: When people are close to one another, pathogens present in bodily fluids can be transmitted from one person to another; this is transmission through closeness or contact.

- Explain how pathogens can be transmitted from person to person in droplets of saliva or respiratory secretions.

  _____
  _____
  _____

- Explain how pathogens can be transmitted from person to person through direct contact.

  _____
  _____
  _____

- Explain how pathogens can be transmitted from person to person via a fomite. What are some examples of items that commonly act as fomites?

  _____
  _____
  _____

- What are some ways in which disease transmission through closeness or contact can be prevented or reduced?

  _____
  _____
  _____

Key concept #4: Fecal—oral pathways for the transmission of infectious disease are important in public health.

- Infectious diarrheal diseases are an important cause of mortality and morbidity worldwide, mostly in lower-income countries. Historically, this was also true in countries that are now industrialized. Feces and fecal pathogens are transmitted mainly via water, and in locations where fecal wastes are not well controlled, *diseases of fecal origin* are usually the dominant type of *waterborne illness*.
- Using your own words, define or explain these terms and how they relate to one another:
  - Fecal—oral pathway, disease of fecal origin, infectious diarrheal disease

    _____
    _____
    _____

  - Waterborne illness, waterborne transmission

    _____
    _____

_____

- Waterborne transmission appears as the dominant fecal—oral pathway in Figure 3.4 in the textbook. How does hand-to-mouth transmission of fecal disease occur?

  _____
  _____
  _____

- What are important means to prevent or reduce fecal—oral transmission of disease?

  _____
  _____
  _____

Key concept #5: Foodborne illness emerges as a distinct phenomenon only where there is clean tap water.

- Figure 3.6 adds food to Figure 3.4; food is another important vehicle by which fecal organisms can be transmitted to the mouth. How does the picture of foodborne illness differ between industrialized countries and lower-income countries?

  _____
  _____
  _____

- Describe two ways in which food can become contaminated by human fecal pathogens even if tap water is free of contamination.

  _____
  _____
  _____

Key concept #6: The keys to food safety in the kitchen are (1) preventing contamination by pathogens as much as possible and (2) managing time and temperature to minimize the growth of populations of pathogens when prevention fails.

- Cockroaches and houseflies are generally considered unwanted guests in the kitchen, but what is the specific rationale for keeping them away from food?

  _____
  _____
  _____

- At a minimum, to maintain cleanliness in the kitchen, these three things must be clean:

  _____
  _____
  _____

- Using your own words, define or explain these terms and how they relate to one another.

In particular, how do these terms relate to the food safety adage to "keep it hot, or keep it cold, or don't keep it"?

- Danger zone, lag phase, log phase

_____
_____
_____

- Table 3.1 lists important foodborne pathogens in the United States. Study the table as you read the accompanying text. Use the information in the text to think about the practical implications, in terms of preventing foodborne illness, of the various characteristics listed in the table.

Key concept #7: The term *vectorborne disease* refers specifically to diseases transmitted by a *biological* vector.

- What distinguishes a biological vector from a mechanical vector? (See Table 3.3.)

_____
_____
_____

- For the most part, what types of animals act as biological vectors? Give two examples of mammals that act as biological vectors.

_____
_____
_____

- What are two key measures to prevent or reduce vectorborne disease?

_____
_____
_____

Key concept #8: Infectious disease is an important cause of mortality and morbidity on a global scale.

- About what proportion of deaths worldwide are attributable to infectious disease?

_____
_____
_____

- Which group of infectious diseases accounts for more than half of these deaths: diseases transmitted by closeness or contact, by the fecal—oral pathway, or by biological vector?

_____
_____
_____

- Put a check mark in the appropriate column for each of the following diseases, all of which are important in public health and are mentioned in Chapter 3. If you are younger than about age 30 years and have lived in an industrialized country all your life, most of these diseases may seem remote. This list does not include important foodborne pathogens in industrialized countries.

		Major mode of transmission			
Disease	Pathogen	Closeness–contact	Waterborne (fecal–oral)	Via soil (nonfecal)	Vectorborne
Diphtheria	Bacterial				
Pertussis	Bacterial				
Tuberculosis	Bacterial				
Cholera	Bacterial				
Typhoid fever	Bacterial				
Tetanus	Bacterial				
Malaria	Protozoan				
HIV/AIDS	Viral				
Influenza	Viral				
Measles	Viral				

Key concept #9: The effort to manage infectious disease risk incorporates several different approaches.

- What are two approaches that rest on the idea of separating individuals who pose an infectious risk to the general population?

_____
_____
_____

- What are two approaches that rest on managing environmental risks?

_____
_____
_____

- What are two approaches that are aspects of medical care?

_____
_____
_____

- Fill in the blank: The percentage of *deaths* attributable to infectious disease may be as much as___times greater in the high-mortality countries of Africa than in the lowmortality countries of the Americas. The percentage of *cancers* attributable to infectious agents is about___times greater in lower-income countries than in industrialized countries.

Key concept #10: In the United States, responsibilities related to infectious disease are divided between state governments and the federal government.

- Individual states retain the responsibilities to require childhood immunizations and to impose isolation and quarantine within their borders. What are the major laws and key provisions for the control of infectious disease? (See Table 3.5.)

Section 3.2 Poisons in Nature

Key concept #1: Certain plants, animals, and fungi produce poisons that are acutely toxic to humans. Most of these cause relatively isolated incidents of poisoning in individuals or local groups. In contrast, exposures to aflatoxin create a substantial public health burden.

- What is the source of aflatoxin, and how are people usually exposed to it?

_____
_____
_____

- What illness is it a risk factor for?

_____
_____
_____

- Describe the resulting global health burden.

_____
_____
_____

Section 3.3 Allergy and Asthma

Key concept #1: Allergy and asthma, which are conditions of the immune system, have been linked to some environmental factors.

- Using your own words, define or explain these terms and how they relate to one another:
  - Allergen, allergy, sensitization (also relate these to the previous terms antigen and antibody)

_____
_____
_____

  - Asthma, bronchoconstriction, asthma attack

_____
_____
_____

- What are two good reasons to believe that some causes of asthma are environmental?

_____

CHAPTER 4

Producing Energy

Section 4.1 Energy from Fossil Fuels

Key concept #1: Fossil fuel resources are finite and are nonrenewable on the human time scale.

- What are the three major fossil fuels found in nature?

_____
_____
_____

- Explain how fossil fuels are formed and why they are nonrenewable.

_____
_____
_____

Key concept #2: Before fossil fuels can be burned, they must be extracted from the earth; these extraction processes cause substantial environmental and human health impacts.

- What are major features of acid mine drainage that make it such a difficult environmental problem?

_____
_____
_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Fibrosis, pneumoconiosis, black lung, silicosis

_____
_____
_____

- What are three major causes of acute injury or death to coal miners?

_____
_____

_____

Key concept #3: Oxides and particulates, which are basic products of any combustion, are released whenever fossil fuels are burned.

- Study Table 4.1 in the textbook as you read the accompanying text. We are concerned here with the first section of the table.
  - *All* the major combustion sources release two pollutants. What are these pollutants?

    _____
    _____
    _____
  - Under what conditions is carbon *monoxide* produced? What kinds of processes or sources produce oxides of *nitrogen? Sulfur* dioxide?

    _____
    _____
    _____

Key concept #4: Burning of fossil fuels also releases metals and volatile organic compounds that are present in fuels—whether put there by nature or by humans.

- We are concerned here with the second section of Table 4.1.
  - What is the major source of releases of mercury through the burning of fossil fuels? Why?

    _____
    _____
    _____
  - Describe the typical exposure *pathway*, including the typical *route* of exposure, for exposure to mercury from power plants.

    _____
    _____
    _____
  - What is the source of releases of lead through the burning of fossil fuels? Why?

    _____
    _____
    _____
  - Describe the typical exposure *pathway*, including the typical *route* of exposure, for *current* exposure to lead from the *prior* use of leaded gasoline in the United States.

    _____
    _____
    _____
  - What is the most important source of volatile organic chemicals that are released

through the burning of fossil fuels? Why?

_____
_____
_____

Key concept #5: After the burning of fossil fuels releases pollutant gases, chemical reactions in the atmosphere produce new pollutants; these are called *secondary air pollutants*.

- Table 4.2 adds secondary air pollutants to the pollutants listed in Table 4.1.
  - Ground-level ozone, which is a key element in the formation of photochemical smog, is created through complex reactions in the atmosphere involving NO_x, VOCs, and sunlight. What is the major source of these VOCs, and why is photochemical smog a problem particularly in urbanized areas?

    _____
    _____
    _____
  - What major source of air pollution contributes most to acid deposition?

    _____
    _____
    _____

Key concept #6: People are exposed to the particulates and pollutant gases that result from burning fossil fuels mainly via inhalation; these pollutants have both respiratory and nonrespiratory health impacts.

- Using your own words, define or explain these terms and how they relate to one another:
  - PM_{10}, $PM_{2.5}$

    _____
    _____
    _____
  - Respirable particulates, fine particulates, ultrafine particulates

    _____
    _____
    _____
- Describe the key sources of particulate matter and what happens to particulates after they are inhaled as related to the diameter of the particulates (see Table 4.3).

  _____
  _____
  _____
- In epidemiologic studies, four major air pollutants (particulate matter, nitrogen dioxide,

sulfur dioxide, and ozone) have been linked to acute *morbidity* related to two major body systems. Which body systems are these? For each, give an example of a specific disease or condition known to be exacerbated by these four air pollutants.

_____
_____
_____

- In terms of *numbers* of deaths, air pollution's greatest impact on overall mortality is through exacerbation of disease in one major body system. Which system is this? Why is this true?

_____
_____
_____

Key concept #7: People are exposed to the mercury and lead released by burning fossil fuels mainly via noninhalation pathways; both of these metals are neurotoxicants.

- What is the most important medium of exposure to methylmercury for people in the United States today? What subpopulations are of most concern and why?

_____
_____
_____

- In the United States today, children's exposures to lead from earlier use of leaded gasoline are mainly via exposures to soil. Why might low-income populations today bear a heavier burden of exposure to lead from the era of leaded gasoline?

_____
_____
_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Blood lead level

    _____
    _____
    _____
  - Chelation

    _____
    _____
    _____
  - Blood lead action level

    _____
    _____
    _____

- Why has the EPA set no reference dose for lead's neurotoxicity?

_____
_____
_____

- Although a decline in individual IQ is a well-documented effect of lead exposure, the impact of lead's toxicity is more than just cognitive and more than just individual. Explain.

_____
_____
_____

Key concept #8: The atmospheric warming that results from burning fossil fuels is an anthropogenic enhancement of the naturally occurring greenhouse effect of gases in the troposphere.

- Explain how the carbon stored in fossil fuels has been reinjected into the global carbon cycle. Make an argument for considering carbon dioxide to be a pollutant gas.

_____
_____
_____

- Although there are other contributors to global warming, the burning of fossil fuels is clearly a very significant contributor. Can you offer support for this statement from the textbook?

_____
_____
_____

Key concept #9: Global climate change is more than just warming.

- The Intergovernmental Panel on Climate Change has concluded that another environmental change will result from the combined effects of warmer surface air and warmer surface ocean waters. What is this change? (See Figure 4.6.)

_____
_____
_____

- What change in *weather* patterns since the mid-20th century has been documented?

_____
_____
_____

Key concept #10: Global climate change is expected to have substantial human health impacts.

- What human health impacts are to be expected if temperatures and sea levels rise and extreme weather events become more frequent?

_____
_____
_____

Key concept #11: The 2005 Kyoto Protocol is an international agreement that commits the signatories to reduce greenhouse emissions.

- What does the Kyoto Protocol require of the nations that signed it?

_____
_____
_____

- Is the United States a signatory to the Kyoto Protocol?

_____
_____
_____

Key concept #12: The US regulatory framework uses a combination of approaches to control air pollution.

- What are the major laws and key provisions for the control of environmental health hazards associated with the fossil fuel cycle? (See Table 4.7.)

_____
_____
_____

- Use the following table to compare the Criteria Air Pollutants and Hazardous Air Pollutants, as well as the approaches taken to regulating them.

	Large or small number of pollutants?	Common pollutants?	Control ambient concentrations or emissions?	Health-based standard? (yes or no)
Criteria Air Pollutants				
Hazardous Air Pollutants				

- List the Criteria Air Pollutants.

_____
_____
_____

Section 4.2 Electricity from Nuclear Fuel

Key concept #1: Some isotopes of certain chemical elements are radioactive: such an unstable isotope ejects part of its nucleus, thus emitting radiation and "decaying" into a different element.

- Using your own words, define or explain these terms and how they relate to one another:
  - Isotope, radioactive decay

    _____
    _____
    _____
  - Alpha particle, beta particle, gamma radiation

    _____
    _____
    _____

Key concept #2: Radioactive decays occur in characteristic series; each isotope in the chain has a characteristic half-life, and each decay emits a characteristic type of radiation.

- Work through Table 4.8 until you are sure that you understand radioactive decay. You should be able to relate the ejection of an alpha or beta particle to the change in mass number and the change in chemical element.
- Explain the special health significance of radon and radon progeny in the decay chain of uranium 238.

  _____
  _____
  _____

Key concept #3: In public health, we make a key distinction between radiation that has enough energy to create charged ions in the body and radiation that does not have enough energy to do this.

- Using your own words, define or explain these terms and how they relate to one another:
  - Ionizing radiation, nonionizing radiation

    _____
    _____
    _____
  - Electromagnetic radiation

    _____
    _____
    _____
- Are alpha, beta, r

_____
_____
_____

Key concept #4: The nuclear fuel cycle is actually a linear series of events. The front end consists of the steps before the actual production of power in a nuclear reactor.

- To understand these processes, study Figure 4.9.
  - Note the series of processes along the main spine of the diagram; note that mining, milling, and enrichment not only yield their intended products but also produce radioactive wastes.
  - Note that one of these types of nuclear waste has a military application. What is it?

    _____
    _____
    _____

- Using your own words, define or explain these terms and how they relate to one another:
  - Mining, mine tailings

    _____
    _____
    _____

  - Milling, mill tailings

    _____
    _____
    _____

  - Enrichment, depleted uranium

    _____
    _____
    _____

  - Fuel fabrication

    _____
    _____
    _____

Key concept #5: A nuclear reactor produces energy (heat) through the deliberate splitting of uranium atoms and the ensuing controlled chain reaction. This process creates radioactive isotopes as by-products.

- As you read the section of the textbook that describes normal operations (pages 138-140), focus on the following:
  - Understand how the temperature of the core is normally controlled, and appreciate how overheating can spiral out of control.

- Locate the two dome-shaped containment buildings in Figure 4.12, distinguishing them from the four cooling towers.
- Compare the geography of nuclear power production (see Figure 4.11) in the United States to the geography of uranium mining and milling (see Figure 4.10).
- In Figure 4.9, identify the two major types of wastes that are created by power production in a nuclear reactor.

Key concept #6: Disposal of the highly radioactive spent fuel from nuclear power reactors raises difficult technical and political challenges at the back end of the nuclear fuel cycle.

- Returning to Figure 4.9, note the dashed lines indicating processes that are not currently in place.
  - In principle, why would reprocessing of spent fuel be a good thing? On the other hand, what problems would it raise?

    _____
    _____
    _____
  - What is the current plan for spent fuel in the United States? And how is spent fuel actually being handled?

    _____
    _____
    _____
- Make an argument in favor of using the Yucca Mountain site for the disposal of spent fuel.

  _____
  _____
  _____
- Now make an argument against this plan of action.

  _____
  _____
  _____

Key concept #7: The disposal of low-level radioactive wastes, though these wastes are less hazardous and easier to manage than high-level wastes, is proving to be a thorny problem.

- Give examples of wastes that fall into the category of low-level radioactive wastes.

  _____
  _____
  _____
- Describe the current logjam in disposing of low-level radioactive wastes in the United

States.

_____
_____
_____

Key concept #8: From a public health standpoint, alpha, beta, and gamma radiation pose distinct hazards in terms of the intensity of their damage to tissue and in terms of the shielding required to protect against them. These two issues are related.

- Using your own words, define or explain these terms and how they relate to one another:
  - Grays, Sieverts, relative biological effectiveness

    _____
    _____
    _____

- Be sure that you understand the connection between relative biological effectiveness and the efficacy of various materials as shielding. See Tables 4.9 and 4.10 in your textbook. Why does alpha radiation's high RBE make it the most damaging type of radiation as an internal exposure, yet the least damaging as an external exposure?

  _____
  _____
  _____

Key concept #9: Exposures to natural and anthropogenic sources of ionizing radiation vary widely across countries and regions.

- As a global average, what is the greatest source of exposure to naturally occurring ionizing radiation?

  _____
  _____
  _____

- How does the typical US resident's exposure to ionizing radiation from diagnostic X-rays compare to the global average exposure to ionizing radiation from radon?

  _____
  _____
  _____

Key concept #10: Ionizing radiation's health effects are relatively well established and depend on the level of exposure.

- The term *radiation sickness* refers to the effects of high-level, whole-body exposures to ionizing radiation. Radiation sickness comprises well-known syndromes affecting three

body systems. What are they?

_____
_____
_____

- Low-level exposures to ionizing radiation carry a different health risk. What is it?

_____
_____
_____

- In the aftermath of a nuclear power accident, the radioactive isotopes iodine-131 and strontium-90 are typically released. At what site in the body does each of these cause cancer, and why?

_____
_____
_____

Key concept #11: The risk of exposure to ionizing radiation must be managed at each stage of the nuclear fuel cycle.

- What are the major laws and key provisions for the control of environmental health hazards associated with the nuclear fuel cycle? (See Table 4.11.)

_____
_____
_____

Section 4.3 Alternatives to Fossil and Nuclear Fuels

Key concept #1: The level of energy consumption and the degree of dependence on fossil fuels in the United States and other industrialized countries is not sustainable, and it will not be an option for lower-income countries in the years to come.

- Using your own words, define or explain these terms and how they relate to one another:
  - Sustainable, renewable

    _____
    _____
    _____
  - Energy conservation, energy efficiency

    _____
    _____
    _____
- Figure 4.17 shows that cars grew larger over a 30-year period during which fossil fuel

reserves were shrinking.

- What factors do you think contributed to this pattern?

_____
_____
_____

Key concept #2: Some alternative energy options don't rely on fuels at all.

- Wind power, hydropower, solar energy, and geothermal energy are all renewable, nonfuel-dependent technologies. What limitation do all these energy options share?

_____
_____
_____

- What are the potential downsides of large-scale wind power and hydropower?

_____
_____
_____

Key concept #3: Alternative technologies that use nontraditional fuels—biomass fuels, nontraditional fossil fuels, and hydrogen fuel cells—all have important limitations.

- What are some practical barriers to large-scale use of biomass fuels derived from plant material?

_____
_____
_____

- Why does a reliance on hydrogen fuel cell technology depend on having a renewable energy source?

_____
_____
_____

CHAPTER 5

Producing Manufactured Goods

As you begin this chapter, recall that in natural systems, resources are finite and nothing ever truly goes away; yet the consumer lifestyle means that society makes and uses enormous quantities of stuff.

Section 5.1 Synthetic Organic Chemicals

Key concept #1: Most synthetic organic chemicals are made from oil.

- Review the list of familiar chemical products given on page 178 of the textbook (third paragraph). Were you aware that these products are derived from oil?

Key concept #2: Organic solvents, as the name suggests, are used to dissolve other substances.

- Table 5.1 in the textbook lists seven widely used organic solvents. You should recognize these chemicals as solvents. (You are not responsible for knowing the alternate names for the compounds that are provided in the text.)
- Many workers are exposed to solvents on the job, and solvents are common in industrial and commercial wastes. What are some industries or businesses that use solvents?

  _____
  _____
  _____

- In the United States, what environmental medium is most widely contaminated by solvents? Why? How is the general population most likely to be exposed to solvents in groundwater?

  _____
  _____
  _____

- What body systems or organs are affected by most solvents?

  _____

_____
_____

- Benzene is well-known to cause two additional conditions or diseases. What are they?

_____
_____
_____

Key concept #3: Phthalates and bisphenol A are used in the production of a range of consumer products.

- What specific function do phthalates serve in the production of plastics?

_____
_____
_____

- Give several examples of *solid* (though perhaps flexible) polyvinyl chloride (PVC) plastic products that contain a higher-molecular-weight phthalate.

_____
_____
_____

- Give several examples of household or cosmetic products that are *spreadable or sprayable* because they contain lower-molecular-weight phthalates. (You are not responsible for knowing the names of specific phthalates used in the production of various products.)

_____
_____
_____

- How widespread is phthalate exposure in the general US population?

_____
_____
_____

- What are some exposures to phthalates that young children are likely to have that are not shared by adults?

_____
_____
_____

- Phthalates and bisphenol A are considered to be endocrine-disrupting compounds. What does this mean? What human health effects does emerging evidence suggest that phthalates cause?

_____
_____
_____

Key concept #4: One large group of synthetic organic chemicals is of particular concern in public health because the chemicals are both persistent in the environment and toxic to humans.

- What do these important persistent toxic substances have in common, in terms of chemical structure, aside from their high molecular weights?

_____
_____
_____

- It has been said that a *biological taboo* was violated when chlorinated synthetic organic compounds were introduced. What is this taboo?

_____
_____
_____

Key concept #5: Polychlorinated biphenyls (PCBs), in which *chlorine* atoms are substituted for hydrogen atoms, were manufactured mainly as insulating material for electrical equipment. US production stopped in 1977. Dioxins were created as by-products of the manufacture of PCBs.

- Why were PCBs suitable for use as insulators for electrical equipment? How have PCBs entered the environment? What other family of chemicals occurs as a by-product of PCB production?

_____
_____
_____

- Why was the defoliant known as Agent Orange a source of environmental exposure to dioxin?

_____
_____
_____

- What are other important sources of environmental exposure to dioxins?

_____
_____
_____

- What is the major source of current exposure to dioxins in the general US population?

How widespread is this exposure?

_____
_____
_____

- PCBs, dioxins, and furans share some similar health effects because they act through the same biological mechanism.
  - What is chloracne?

    _____
    _____
    _____

  - What effects of chronic low-level PCB exposure have been documented in lab studies of nonhuman primates?

    _____
    _____
    _____

Key concept #6: Polybrominated diphenyl ethers (PBDEs), in which *bromine* atoms are substituted for hydrogen atoms, are manufactured and used as flame-retardant chemicals.

- What sorts of products are PBDEs used in? How do they enter the environment?

  _____
  _____
  _____

- After PBDEs enter the environment, where do they end up? Where have they been measured?

  _____
  _____
  _____

- At this time, what is considered to be the most likely human health effect of PBDEs?

Key concept #7: Perfluorochemicals (PFCs), in which *fluorine* atoms are substituted for hydrogen atoms, have been used in the production of stain-or water-resistant coatings.

- What are some examples of products whose manufacture has released PFCs into the environment?

  _____
  _____
  _____

- Three major PFCs have been released into the environment in industrial waste streams over a long time period. What evidence indicates that PFCs are widespread in the

natural environment? What evidence indicates that people in the United States are exposed to PFCs?

_____
_____
_____

- At this time, information on the human health effects of PFCs is very limited. What health risk has been noted among highly exposed workers? In rodent studies?

_____
_____
_____

Key concept #8: Another group of chlorine-containing synthetic organic compounds (SOCs) affects human health indirectly by upsetting the natural dynamic equilibrium among oxygen atoms (O), molecular oxygen (O_2), and ozone (O_3) in the stratosphere—specifically, by tipping the balance toward the destruction of ozone.

- The major cause of stratospheric ozone depletion was a specific group of chemicals that are now banned. What is the name of this group of chemicals? What were they used for?

_____
_____
_____

- These chemicals had a seemingly positive feature that turned out to have an unanticipated negative consequence. What was this feature, and what was the consequence?

_____
_____
_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Squamous cell carcinoma, basal cell carcinoma

    _____
    _____
    _____
  - Malignant melanoma

    _____
    _____
    _____

- What are the environmental and health consequences of depleted stratospheric ozone?

_____
_____
_____

- What personal trait is a risk factor for all three types of skin cancer?

  _____
  _____
  _____

- What is a health *benefit* of exposure to ultraviolet (UV) radiation in sunlight?

  _____
  _____
  _____

Section 5.2 Toxic Metals

Key concept #1: Six metals—inorganic lead, elemental and inorganic mercury, arsenic, cadmium, chromium, and beryllium—were chosen for their substantial public health impacts, especially in the workplace.

- Which one of these metals is *not* a heavy metal?

  _____

- Which four of these metals are classified by the International Agency for Research on Cancer (IARC) as Group 1 carcinogens (i.e., carcinogenic to humans)?

  _____
  _____
  _____

Section 5.3 Nanotechnology

Key concept #1: This new technology takes advantage of the fact that the physical and chemical properties of a given material are sometimes different when the material is formed into extremely fine particles.

- Using your own words, define or explain these terms and how they relate to one another:
  - Nanoparticles, nanomaterials, nanotechnology

    _____
    _____
    _____

  - Ultrafine particulates

    _____
    _____
    _____

- Give examples of emerging nanomaterials from the worlds of medicine and consumer goods.

  _____

_____

_____

- Give two reasons that could be used to invoke the precautionary principle in the development of nanomaterials for consumer goods (see page 62 of the textbook).

_____

_____

_____

Section 5.4 Physical Hazards

Key concept #1: Workers generally have much higher exposures to particles and fibers than the general public.

- What are some occupational groups that are highly exposed to asbestos?

_____

_____

_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Asbestos, asbestosis

    _____

    _____

    _____
  - Mesothelioma, sentinel illness

    _____

    _____

    _____
  - Byssinosis, brown lung

    _____

    _____

    _____

Key concept #2: There are parallels between the stories of asbestos and cotton as occupational hazards.

- During what decades did US workers and/or the medical establishment become well aware of the health effects of these occupational exposures?

_____

_____

_____

- About how long was the lag before these hazards were regulated in the United States?

_____

_____
_____

- What has been the consequence, at a global scale, of the regulatory protection of US workers?

_____
_____
_____

Key concept #3: Mechanical hazards in the workplace are usually more visible than harmful substances. They are also more fatal.

- What two occupations stand out as having the highest risk of death on the job in the United States? (See Table 5.2.)

_____
_____
_____

- When US occupational fatalities are broken down by manner of death (see Figure 5.6), how important are exposures to harmful substances? What about mechanical hazards?

_____
_____
_____

- Explain how chronic exposures to vibration or repetitive tasks can cause injury.

_____
_____
_____

Key concept #4: Exposure to noise in the workplace can cause temporary or permanent hearing loss, as well as high blood pressure and the secretion of hormones associated with stress.

- Using your own words, define or explain these terms and how they relate to one another:
  - Decibels

    _____
    _____
    _____

  - Volume threshold, threshold shift

    _____
    _____
    _____

- What occupational sector probably accounts for the largest share of cases of noise-

induced hearing loss?

_____
_____
_____

Key concept #5: Shift work that exposes workers to light during the biological night is now deemed likely to increase the risk of cancer.

- What are some employment sectors in which a substantial percentage of employees work night shifts?

_____
_____
_____

Section 5.5 Asthma-Causing Agents in the Workplace

Key concept #1: Certain organic chemicals, metals, and physical agents in the workplace are known to cause asthma in workers—that is, occupational asthma.

- Give an example of an asthma-causing substance in each of these classes.

_____
_____
_____

Section 5.6 Social Disparities in Exposure to Industrial Pollution

Key concept #1: At both the national and international scales, socially disadvantaged populations bear a heavier burden of exposure to industrial pollution.

- Give examples of social disparities in the burdens of industry, urban air pollution, and hazardous wastes in the United States, as documented by researchers.

_____
_____
_____

- Characterize the concept of *environmental justice* as this term has been used in the United States in recent decades.

_____
_____
_____

- Describe two occupational hazards and two hazardous waste streams currently being exported to lower-income countries by some industrialized countries, including the United States.

_____
_____

Key concept #2: A framework exists for managing the international trade in hazardous wastes.

- What is this international agreement? Has the United States ratified it?

_____
_____
_____

Section 5.7 Regulation of Industrial Pollution

Key concept #1: Examining the US regulatory framework in stepwise fashion, moving generally upstream in a conceptual sense, highlights missed opportunities for preventing public health impacts of industry.

- What are the major laws and key provisions for the control of environmental health hazards associated with manufacturing? (See Table 5.3.)

_____
_____
_____

- To what extent do you think each law embodies a precautionary approach?

_____
_____
_____

CHAPTER 6

Producing Food

Section 6.1 Modern Crop Production Practices

Key concept #1: The use of nitrate fertilizers is not completely benign.

- Explain how the use of nitrogen-containing fertilizers can have a direct effect on human health.

_____
_____
_____

Key concept #2: *Pest* is not a category in nature, but this grouping is important enough to humans that we have developed and used toxic chemicals to control them.

- What makes *a pest* a pest? Give some examples of problems caused by pests.

_____
_____
_____

- In what way are pesticides unique as chemical hazards to health?

_____
_____
_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Pesticide, insecticide, herbicide, fungicide, rodenticide

_____
_____
_____

Key concept #3: Inorganic insecticides and natural organic (botanical) insecticides were used for many years before synthetic organic insecticides were developed.

- List three toxic metals that were once used in inorganic pesticides and thus were spread

widely in the environment.

_____
_____
_____

- What natural pesticide is extracted from chrysanthemums?

_____
_____
_____

Key concept #4: Synthetic organic insecticides are usually grouped by chemical structure (specifically, the chemical structure of the active ingredient). Insecticides in these groups were introduced to the marketplace more or less sequentially.

- Name five major organochlorine pesticides, two major organophosphate pesticides, and one carbamate pesticide.

_____
_____
_____

- Compare and contrast the organochlorines, organophosphates, and carbamates. Following acute exposure, which body system does each affect most strongly in humans? How acutely toxic is each group of pesticides in humans?

_____
_____
_____

- Compare and contrast organochlorine and organophosphate pesticides in terms of their persistence in the environment.

_____
_____
_____

Key concept #5: Synthetic organic herbicides are usually grouped according to their effects on different classes of plants.

- What is the difference between a nonselective herbicide and a selective herbicide?

_____
_____
_____

- How is a selective herbicide useful in agriculture? In lawn care? In warfare?

_____
_____

_____

- Give examples of how nonselective herbicides have typically been used.

_____
_____
_____

- How has a *nonselective* herbicide (Roundup) been made useful in agriculture?

_____
_____
_____

Key concept #6: Pesticides have some inherent limitations as weapons against pests.

- Some individuals in a population of pests (e.g., insects) may have a genetic makeup that makes them invulnerable to the effects of a given pesticide. Explain the effect over time, at the population level, of such individual resistance to pesticides.

_____
_____
_____

- Using your own words, define or explain these terms and how they relate to one another (see Figure 6.3 in the textbook):
  - Target pest

    _____
    _____
    _____
  - Target pest resurgence

    _____
    _____
    _____
  - Secondary pest outbreak

    _____
    _____
    _____

Key concept #7: Synthetic organic pesticides have chronic health effects in humans. This burden falls most heavily on certain subpopulations.

- With what types of chronic human health effects has pesticide exposure been most clearly linked?

_____
_____

_____

- What populations are at special risk of higher chronic (or acute) exposure to pesticides? Why?

_____
_____
_____

Key concept #8: Integrated pest management is an alternative to the routine use of pesticides.

- What key features distinguish *integrated* pest *management* (IPM) from the routine use of pesticides? What are some examples of IPM tactics?

_____
_____
_____

Key concept #9: The long-term risks and benefits of genetically modified crops are still unclear.

- Using your own words, define or explain these terms and how they relate to one another:
  - Genetically modified, genetically engineered, transgenic

    _____
    _____
    _____
  - Transgene, biotech gene

    _____
    _____
    _____
- What is the main rationale for the development of genetically modified crops?

_____
_____
_____

- Explain why and how a genetically modified food can elicit an allergic reaction.

_____
_____
_____

- Explain why and how genetically modified foods may contribute to the spread of antibiotic resistance.

_____
_____

_____

Section 6.2 Modern Livestock Production Practices

Key concept #1: Modern livestock-rearing practices, which take place on a very large scale, for the most part ignore the welfare of the animals.

- Describe the conditions under which cattle, hogs, and chickens are reared in confined animal feeding operations (CAFOs).

  _____
  _____
  _____

- What is the most common cause of death for young cattle and hogs that die in CAFOs before being slaughtered?

  _____
  _____
  _____

Key concept #2: The routine administration of antibiotics to livestock carries risks to human health.

- Why are antibiotics administered to food animals on a regular basis? What is a negative effect of this practice?

  _____
  _____
  _____

- What is the direct human health impact of antibiotic resistance among bacteria found in the guts of food animals?

  _____
  _____
  _____

- What is the broader public health impact of the presence of antibiotic-resistant bacteria in waste streams of CAFOs, slaughterhouses, or human communities?

  _____
  _____
  _____

Key concept #3: By the turn of the last century, it had become clear that the incorporation of animal remains into livestock feed could lead to human disease.

- Using your own words, define or explain these terms and how they relate to one another (see Figure 6.8):

- Rendering, meat and bone meal, tallow

_____
_____
_____

- What basic change in livestock-rearing practices made rendering particularly useful in the livestock industry? How does rendering benefit livestock producers?

_____
_____
_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Prion, transmissible spongiform encephalopathy (see page 72)

_____
_____
_____

  - Ruminant

_____
_____
_____

  - Scrapie, Creutzfeldt-Jakob disease

_____
_____
_____

  - Bovine spongiform encephalopathy (BSE), mad cow disease

_____
_____
_____

  - Variant Creutzfeldt-Jakob disease (vCJD), kuru

_____
_____
_____

- Explain how scientists came to believe that variant Creutzfeldt-Jakob disease was caused by aberrant prions being transmitted through the rendering process. What evidence was important?

_____
_____
_____

- How did the first cow get BSE? What was the key factor that turned the first case of BSE into an epidemic?

_____
_____
_____

- What *biological taboo* is broken by the rendering cycle?

_____
_____
_____

- Do you think there is a larger lesson to be taken from the BSE—vCJD experience? If so, what do you think it is?

_____
_____
_____

Crosscutting Concepts in Sections 6.1 through 6.4

Key concept #1: Industrialized agricultural and fishing practices have substantial impacts on the natural environment.

- Summarize the local environmental impacts of CAFOs.

_____
_____
_____

- Summarize the ways in which agriculture contributes to global climate change.

_____
_____
_____

- Identify at least one additional way in which either industrialized growing of crops or industrialized fishing (see Figure 6.11) is not environmentally sustainable over the long term.

_____
_____
_____

Key concept #2: Industrialized agriculture and fishing impose substantial health burdens on workers.

- Characterize the occupational hazards to those who work on farms, in CAFOs, in slaughterhouses or plants that process meat or poultry, and in fishing.

_____
_____
_____

Section 6.5 From Source to Table

Key concept #1: The modern system of making and distributing food products creates both benefits and challenges.

- Distinguish between *food defects* and *food additives*, giving examples of each.

_____
_____
_____

- Gamma radiation can be used to kill microbes in food. When in the production process is food irradiated, and why?

_____
_____
_____

- Characterize the challenges of tracing and recalling food products in the modern food system.

_____
_____
_____

Section 6.6 Organic Farming and Locally Grown Foods

Key concept #1: Organic farming is very different from the industrialized agriculture that dominates in the United States.

- What are two defining characteristics of organic farming?

_____
_____
_____

Section 6.7 Regulation of Food and the Activities That Produce It

Key concept #1: The US regulatory framework for food is built on a very old foundation but must deal with some very modern concerns, including chemicals used on crops or added to foods, genetically modified crops, bovine spongiform encephalopathy, and the depletion of fisheries.

- What are the major laws and key provisions for the control of environmental health hazards associated with the food supply? (See Table 6.5.)

_____
_____
_____

CHAPTER 7

Living in the World We've Made

Section 7.1 The "Metabolism" of Communities

Key concept #1: The inputs and outputs of today's cities reflect important 19th-century decisions about infrastructure, as well as 20th-century developments.

- What were the three closely related 19th-century decisions about toilet wastes that so strongly shaped US municipal water and sewer systems of the 20th century?

  _____
  _____
  _____

- Another important early decision in the United States was to have a unified supply of tap water, rather than parallel supplies for drinking water and other uses.
  - What is the public health rationale for a unified water supply?

    _____
    _____
    _____

  - What is the downside?

    _____
    _____
    _____

- A new community waste stream emerged in the 20th century, representing the advent of consumerism and its stuff. What is this waste stream?

  _____
  _____
  _____

- How much water does a typical US family of four use each day? How much trash do four people generate each day?

  _____

_____
_____

Key concept #2: As shown in Figure 7.2 in the textbook, *three* major types of household wastes leave the home as *two* waste streams.

- Using your own words, define or explain these terms and how they relate to one another:
  - Municipal wastewater

    _____
    _____
    _____
  - Municipal solid waste

    _____
    _____
    _____
- Why is there overlap in the contents of these two waste streams?

  _____
  _____
  _____

Key concept #3: In some communities, storm runoff and/or industrial wastes join the flow of municipal wastewater in the sanitary sewer system.

- How do municipal wastewater and storm runoff differ?

  _____
  _____
  _____
- Why and how are they sometimes merged? (See Figure 7.3.)

  _____
  _____
  _____
- What is the function of a combined sewer overflow (CSO)?

  _____
  _____
  _____
- What is the makeup of CSO releases?

  _____
  _____
  _____

- Using your own words, define or explain these terms and how they relate to one another (see Figure 7.4):
  - Direct discharge

    _____
    _____
    _____
  - Indirect discharge, pretreatment

    _____
    _____
    _____
- Why is pretreatment of industrial wastes important?

  _____
  _____
  _____

Section 7.2 Management of Sewage Wastes

Key concept #1: The three main objectives of sewage treatment serve the larger goal of producing a waste stream that can safely be released into a body of water.

- The first objective relates to public health. What is this objective?

  _____
  _____
  _____
- The second objective relates to ecological health. What is this objective?

  _____
  _____
  _____
- What is the third objective of sewage treatment? How does meeting this objective serve the first and second objectives?

  _____
  _____
  _____

Key concept #2: The processes used in municipal wastewater treatment (sewage treatment) are designed to achieve its three main objectives.

- Using your own words, define or explain these terms and how they relate to one another (see Figure 7.5 and the accompanying text):
  - Primary sewage treatment

_____
_____
_____

- Bar screen

_____
_____
_____

- Grinder (or comminutor)

_____
_____
_____

- Grit chamber

_____
_____
_____

- Primary clarifier

_____
_____
_____

- Secondary sewage treatment

_____
_____
_____

- Trickling filter

_____
_____
_____

- Tertiary sewage treatment

_____
_____
_____

- How do each of the major steps in municipal wastewater treatment contribute to achieving the basic objectives of treatment?

_____
_____
_____

Key concept #3: Nothing ever goes away; sewage treatment produces treated effluent and also a new by-product, sludge, which itself must be treated and then put somewhere.

- What does the stabilization step in the treatment of sewage sludge accomplish?

  _____
  _____
  _____

- What components of sludge can be of concern when sludge is spread on land?

  _____
  _____
  _____

Key concept #4: In less densely populated areas, water is used to carry toilet waste to a septic system.

- Using your own words, define or explain these terms and how they relate to one another:
  - Septic system

    _____
    _____
    _____

  - Septic tank

    _____
    _____
    _____

  - Leach field

    _____
    _____
    _____

Key concept #5: A composting toilet offers an alternative to the use of water to carry sewage, thus recognizing the value of both clean water and human waste.

- Explain in simple terms how a continuous composting toilet works and why it is a sustainable approach to sanitation.

  _____
  _____
  _____

Key concept #6: The Clean Water Act sets requirements for sewage treatment—the use of secondary treatment, standards for sewage effluent, and limits on metals and pathogens in sludge.

- What are the key provisions for the control of environmental health hazards associated with treatment of municipal wastewater? (See Table 7.2.)

_____
_____
_____

Section 7.3 Sources and Treatment of Drinking Water

Key concept #1: Safe community drinking water is of critical importance in public health; conversely, unclean water delivers illness to large groups of people.

- Why is turbidity a concern in drinking water? How is turbidity reduced through treatment?

  _____
  _____
  _____

- Summarize the positive and negative features of chlorination as a method of disinfecting drinking water.

  _____
  _____
  _____

- Why is fluoride sometimes added to community drinking water supplies?

  _____
  _____
  _____

Key concept #2: In the United States today, some people use private well water; many more either treat or supplement their publicly supplied tap water.

- Are private wells subject to federal drinking water standards?

  _____
  _____
  _____

- What are typical sources of contamination of private wells in rural or semirural areas?

  _____
  _____
  _____

- What is a point-of-use treatment system for tap water?

  _____
  _____
  _____

- Is chlorination typically used to disinfect bottled water? Why or why not?

_____
_____
_____

Key concept #3: Federal drinking water standards are in place for some biological hazards, turbidity, and a large number of chemical contaminants.

- Distinguish between a Maximum Contaminant Level Goal (MCLG) and a Maximum Contaminant Level (MCL), as defined by the Safe Drinking Water Act.

_____
_____
_____

  - How is health risk assessment used in setting drinking water standards?

_____
_____
_____

- Note that not all drinking water standards are simply the highest allowable concentration of a contaminant in water.
  - What form do the MCLG and MCL take for individual pathogens (e.g., *Cryptosporidium, Giardia lamblia)?*

_____
_____
_____

  - Explain how the presence of fecal coliform bacteria acts as a warning signal for the presence of fecal *pathogens*.

_____
_____
_____

- The next time you drink bottled water, try to learn where the water actually came from. Start by checking what the label says about the source.
- Does bottled water fall under the same regulatory framework as community drinking water?

_____
_____
_____

Section 7.4 Solid Waste and Its Management

Key concept #1: Nothing ever goes away; much of our stuff eventually becomes trash—a waste stream that is mundane but still challenging to manage.

- Describe the key challenges in handling the municipal solid waste stream.

_____
_____
_____

- Taking the broad view, what are the options for managing municipal solid waste?

_____
_____
_____

Key concept #2: Source reduction is a new twist on an old idea.

- Through the first half of the 20th century, many individuals lived by the adage: "use it up, wear it out, make it do." As a 21st century consumer, what specific changes could you make in buying and using products that would reduce your contribution to municipal solid waste?

_____
_____
_____

  - Think about Figure 7.13. What are the two categories (or subcategories) of products in which you think you could make the biggest reductions in your own waste stream?

_____
_____
_____

  - Do you think you could throw away less if corporations made changes to the products they make? If so, what specific changes would you like to see?

_____
_____
_____

Key concept #3: Recycling diverts recyclable materials from the municipal solid waste stream.

- How much of the trash in your part of the United States gets recycled? (See Figure 7.14.)

_____
_____
_____

- How do you think the availability of recycling affects individual and corporate decisions about source reduction?

_____
_____

_____

- Using your own words, define or explain these terms and how they relate to one another:
  - Composting

    _____
    _____
    _____
  - Vermicomposting

    _____
    _____
    _____

Key concept #4: In the United States, municipal solid waste that is not recycled is either incinerated or placed in a landfill.

- In the United States as a whole, considerably more trash is placed in landfills than incinerated (see Figure 7.14).
  - In what parts of the country is this *not* the case? Why do you think this is?

    _____
    _____
    _____
  - See if you can find out whether your trash is placed in a landfill or incinerated and where the landfill or incinerator is located.

    _____
    _____
    _____
- A waste-to-energy incinerator not only produces energy but reduces the volume of waste by 80-90%.
  - What components of municipal solid waste create hazardous emissions when they are burned?

    _____
    _____
    _____
  - Because nothing ever goes away, incinerators produce ash. What is done with this ash?

    _____
    _____
    _____
- A modern municipal solid waste landfill has four major construction features that keep it from contaminating the environment or endangering human health. What are these features, and wh

_____
_____
_____

- In what ways do municipal solid waste landfills contribute to global warming?

_____
_____
_____

Key concept #5: Municipalities may also produce other wastes.

- What are some items in household waste that meet the regulatory definition of hazardous waste? How can such wastes be handled by municipalities?

_____
_____
_____

- What are some special types of waste produced by healthcare facilities?

_____
_____
_____

Key concept #6: Federal regulations govern the disposal of municipal solid waste.

- What are the key regulatory provisions for the disposal of municipal solid waste in landfills and waste-to-energy incinerators? (See Table 7.6.)

_____
_____
_____

Section 7.5 The Urban Environment

Key concept #1: The world is rapidly becoming more urban.

- Compare the degree of urbanization in the world's lower-income and industrialized countries.

_____
_____
_____

- How is *megacity* defined? For the most part, where are the world's megacities located?

_____
_____
_____

Key concept #2: Patterns of urban development affect human health and well-being.

- Contrast the environmental health concerns of urban settings in lower-income countries with those of urban settings in industrialized countries.

_____
_____
_____

- Contrast the environmental health concerns of urban settings and sprawled suburban settings in the United States.

_____
_____
_____

Section 7.6 Hazards of Modern Life

Key concept #1: People living in industrialized countries live with certain chemical and physical hazards that come along with the substantial benefits of modern development. Exposure to many of these hazards occurs indoors, where we spend most of our time.

- Cigarette smoking has been linked to increased risk of certain chronic diseases and cancers and also to developmental effects. What are the major health effects of smoking?

_____
_____
_____

- The toxicity of lead was already well known when lead paint began to be widely used in residential settings.
  - For the most part, *how* are children exposed to lead paint in their homes?

    _____
    _____
    _____
  - Lead paint was (mostly) banned in the United States in 1978. Compare the blood lead levels in young children at that time to levels in 2003 to 2004 (see Table 7.7).

    _____
    _____
    _____

- Compare the median blood lead level in 2003 to 2004 for *all* US children aged 1 to 5 years to the median blood lead level during the same time for African American children of the same age who were living in poverty.

_____
_____
_____

- Certain construction materials create indoor air pollution hazards.
  - Compare the likely health effects of asbestos exposure in people who live or work in buildings with asbestos insulation to health effects in workers who are exposed to asbestos on the job.

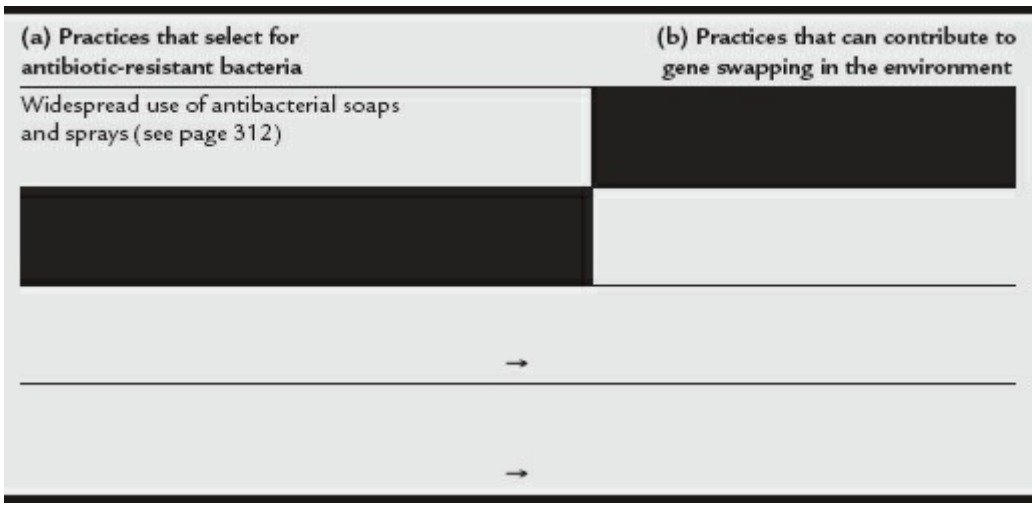
    _____
    _____
    _____
  - What are some building materials that may release formaldehyde into indoor air?

    _____
    _____
    _____
  - Contrast *sick building syndrome* with *building-related illness*.

    _____
    _____
    _____
- In a region where granite is widespread, what are the two major sources of radon in indoor air inside homes? What is the health effect of concern, and why?

  _____
  _____
  _____
- How would you go about assessing whether your exposure to chemicals in personal care products is hazardous to your health? What challenges would you face? What does *inert* mean in the phrase *inert ingredient?*

  _____
  _____
  _____
- Overuse of antibacterial soaps and sprays contributes to the problem of antibiotic resistance in bacterial populations. Revisit earlier chapters of the textbook and use the following table to list practices that select for antibiotic-resistant bacteria (in column a) and practices that can increase the spread of resistance in bacterial populations through gene swapping in the general environment (in column b). Including the widespread use of antibacterial soaps and sprays, you should be able to identify three practices in each category. As you enter practices into the cells of the table, note that two of the practices in group (a) are linked directly to a practice in group (b), as indicated by the arrows (→) in the table.



- Explain the risks of air fresheners and household pesticides, including illegal pesticides.

_____
_____
_____

- Describe common sources of exposure to nonionizing radiation in everyday life.

_____
_____
_____

- What are important exposures to noise in everyday life, outside of the workplace?

_____
_____
_____

Section 7.7 Sharing Global Impacts and Resources

Key concept #1: The IPAT equation provides a way to conceptualize the impact of development on ecosystems.

- The IPAT equation is a bottom-up conceptualization.
  - What two factors determine the total ecological impact (I) of a population?

_____
_____
_____

- The question from a top-down perspective is, What is the *maximum* total impact (I) that an ecosystem (or the Earth as a whole) can sustain? What term is used for the maximum sustainable impact of an ecosystem (or the Earth)?

_____
_____
_____

- The ecological footprint is a *measure* of ecological impact (I); it is the number of acres of the Earth's surface required to support an individual or a population that is living in a certain way.
  - The surface area supports an individual or a population by providing two key services. What are they?

    _____
    _____
    _____
  - What two important factors are *not* accounted for in the IPAT formulation?

    _____
    _____
    _____

Key concept #2: The question for the future is: At a global scale, can development become both sustainable and more equitable?

- The ecological footprint tells us that the current impact of development is *not sustainable.*
  - Compare the global carrying capacity to the global average ecological footprint.

    _____
    _____
    _____
- The ecological footprint also tells us that the use of the world's resources is *not equitable* (see Figure 7.27), and we know that lower-income countries, which use fewer resources, also bear a heavier burden of disease. Here are the key unanswered questions:
  - Can global patterns of development become *both* sustainable and more equitable?

    _____
    _____
    _____
  - Can technology be a strong positive force in achieving this goal?

    _____
    _____
    _____