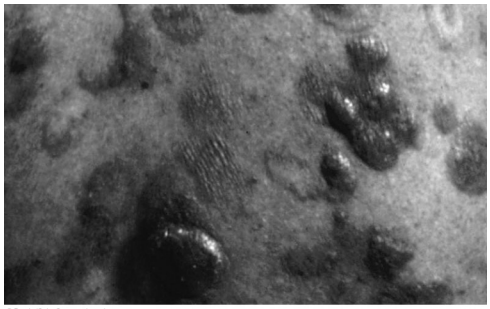
Environmental Hazards and Human Health

Chapter 17

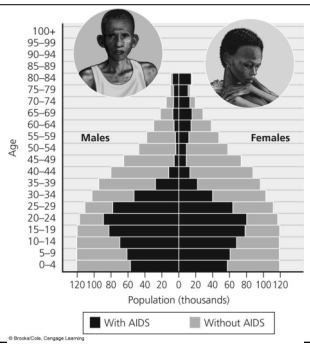
Core Case Study: The Global HIV/AIDS Epidemic

- **Acquired immune deficiency syndrome (AIDS)** caused by **human immunodeficiency virus (HIV)**; many secondary infections
- No vaccine to prevent or cure AIDS
- Expensive drugs—live longer
- 25 Million deaths, so far; alter country's age structure

Lesions That Are a Sign of Kaposi's Sarcoma



Global Outlook: Worldwide, AIDS Is the Leading Cause of Death for Ages 15–49



Animation: HIV replication

Pause Animation

Start Animation

PLAY

17-1 What Major Health Hazards Do We Face?

- ***Concept 17-1*** *People face health hazards from biological, chemical, physical, and cultural factors, and from the lifestyle choices they make.*

Risks Are Usually Expressed as Probabilities

- **Risk (Fig. 17-3)**
- Probability and possibility
- **Risk Assessment**
- **Risk Management**

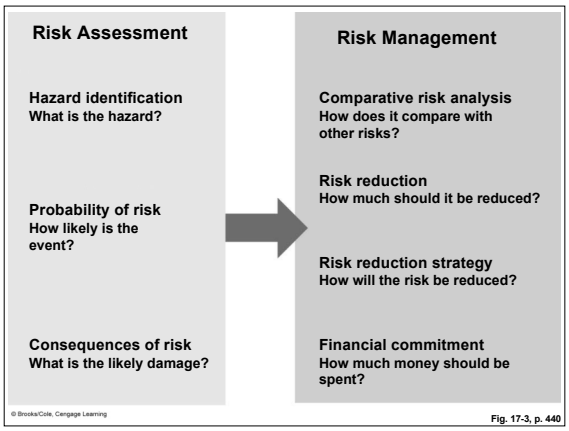


Fig. 17-3, p. 440

We Face Many Types of Hazards

- Five major types of hazards
  - **Biological**: **pathogens**
  - **Chemical**: air, water, soil, and food
  - **Physical**: fire, earthquakes, volcanoes, floods, storms
  - **Cultural**: unsafe highways, criminal assault, poverty
  - **Lifestyle choices**: smoking, alcohol, overeating, unsafe sex

17-2 What Types of Biological Hazards Do We Face?

- ***Concept 17-2*** *In terms of death rates, the most serious infectious diseases are flu, AIDS, diarrheal diseases, malaria, and tuberculosis; most of these deaths occur in developing countries.*

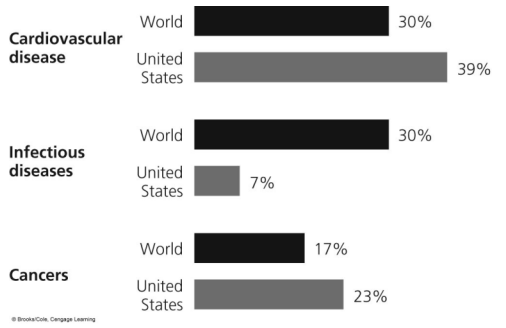
Some Diseases Can Spread from One Person to Another (1)

- **Nontransmissible disease**
  - asthma, cancer, diabetes
- **Infectious disease**
  - Flu, malaria
- **Transmissible disease (contagious** or **communicable disease)**
  - HIV, Tuberculosis

Some Diseases Can Spread from One Person to Another (2)

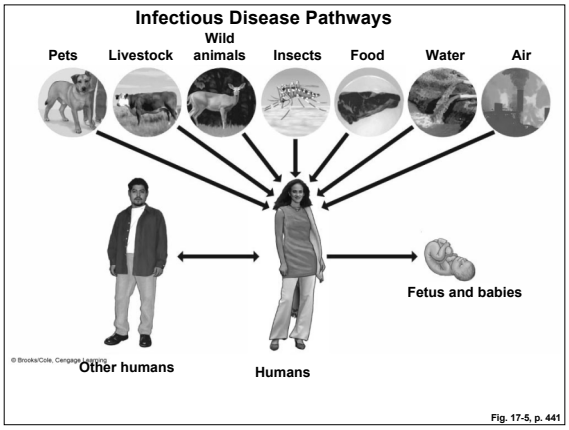
- Since 1950, death from infectious diseases have declined due to
  - Better health care
  - Antibiotics
  - Vaccines
- **Disability-adjusted life years (DALYs)**
  - Premature death due to specific diseases and injuries

Major Causes of Death in the World and in the United States in 2005

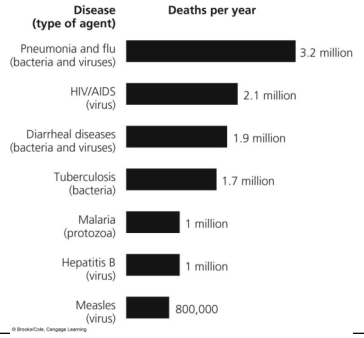


Infectious Diseases Are Still Major Health Threats

- Infectious diseases spread through
  - Air
  - Water
  - Food
  - Body fluids
- **Epidemics** and **pandemics**
- Resistance of bacteria and insects



The World's Seven Deadliest Infectious Diseases Kill 12.5 Million People



Science Focus: Genetic Resistance to Antibiotics Is Increasing

- Bacteria: rapid reproduction, easily spread
- Over use of antibiotics
- Over use of pesticides

- **Methicillin-resistant *Staphylococcus aureus* (MRSA)**
  - Resistant to most antibiotics
  - Symptoms of MRSA
  - How will it be controlled?

Case Study: The Growing Global Threat from Tuberculosis

- Why is tuberculosis on the rise?
  - Not enough screening and control programs
  - Genetic resistance to a majority of effective antibiotics
  - Person-to-person contact has increased
  - AIDS individuals are very susceptible to TB

Some Viral Diseases Kill Large Numbers of People (1)

- Influenza or flu virus
  - #1 Killer
  - Transmission
- HIV
  - #2 Killer
  - Antiviral drugs

Some Viral Diseases Kill Large Numbers of People (2)

- Global strategy to slow down the spread of HIV
  - Reduce the number of new infections
  - Concentrate on those most likely to spread HIV
  - Free testing
  - Education for prevention
  - Provide free or low-cost drugs
  - Research

Some Viral Diseases Kill Large Numbers of People (3)

- Hepatitis B virus (HBV)
  - #3 Killer
  - Mode of transmission
- Viruses that move form animals to humans
  - West Nile virus
  - Severe acute respiratory syndrome (SARS)
- Reduce chances of infection: Wash your hands

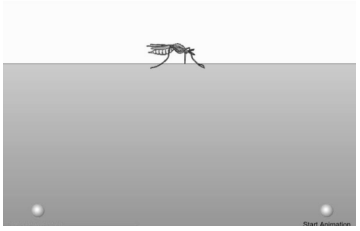
Tracking the Spread of Infectious Diseases to Humans from Other Animals

- **Ecological medicine**
- Human practices that encourage the spread of diseases from animals to humans
- Emerging infections
  - HIV
  - SARS
  - West Nile virus
  - Lyme virus

Case Study: Malaria—Death by Parasite-Carrying Mosquitoes (1)

- Malaria
  - Caused by *Plasmodium* sp. carried by *Anopheles* mosquitoes
  - Spread
  - Symptoms
  - Malarial cycle

Animation: Life cycle of plasmodium

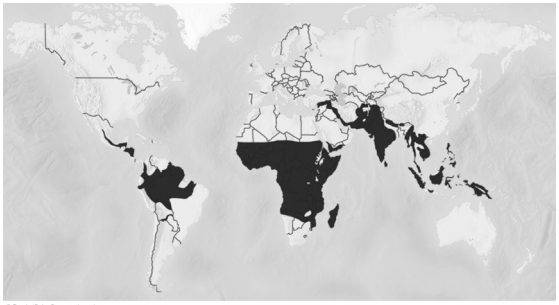


PLAY

Case Study: Malaria—Death by Parasite-Carrying Mosquitoes (2)

- Malaria on the rise since 1970
  - Drug resistant *Plasmodium*
  - Insecticide resistant mosquitoes
  - Effect of global warming
  - AIDS patients particularly vulnerable
- Prevention of spread and current research

Global Outlook: Distribution of Malaria



A Boy in Brazil's Amazon Sleeps Under an Insecticide-Treated Mosquito Net

We Can Reduce the Incidence of Infectious Diseases

- Good news
  - Vaccinations on the rise
  - **Oral rehydration therapy**
- Bad news
  - More money needed for medical research in developing countries

Fig. 17-10, p. 447

17-3 What Types of Chemical Hazards Do We Face?

- ***Concept 17-3*** *There is growing concern about chemicals that can cause birth defects and cancers and disrupt the human immune, nervous, and endocrine systems.*

Some Chemicals Can Cause Cancers, Mutations, and Birth Defects

- **Toxic chemicals**
  - **Carcinogens**
    - Arsenic, benzene, gamma radiation
  - **Mutagens**
    - Nitrite from preservatives
  - **Teratogens**
    - Lead, mercury, PCBs

Case Study: PCBs Are Everywhere—A Legacy from the Past

- Class of chlorine-containing compounds
  - Very stable
  - Nonflammable
  - Break down slowly in the environment
  - Travel long distances in the air
  - Fat soluble
  - Biomagnification
  - Food chains and webs
- Banned, but found everywhere

Potential Pathways for Movement of Toxic Chemicals

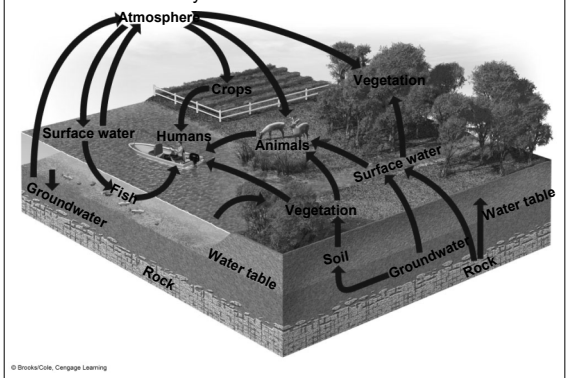


Fig. 17-11, p. 449

Some Chemicals May Affect Our Immune, Nervous, and Endocrine Systems (1)

- Some natural and synthetic chemicals in the environment can weaken and harm
  - Immune system
    - Methyl mercury, dioxin
  - Nervous system
    - PCBs, methyl mercury
  - Endocrine system
    - Atrazine, aluminum

Some Chemicals May Affect Our Immune, Nervous, and Endocrine Systems (2)

- **Hormonally active agents (HAAs)**
  - **Gender benders**
  - **Thyroid disrupters**
  - **Toxic chemicals**
- **Phthlates**
- **Effects on the endocrine system**
- **Cancer**

Science Focus: Mercury's Toxic Effects (1)

- Hg: teratogen and potent **neurotoxin**
  - Once airborne, persistent and not degradable
  - 1/3 from natural sources
  - 2/3 from human activities
  - Enters the food chain: biomagnification

Science Focus: Mercury's Toxic Effects (2)

- 2007: Hg hotspots identified
- How are humans exposed?
  - Inhalation: vaporized Hg or particulates of inorganic salts
  - Eating fish with high levels of methylmercury
- Effects of Hg on humans
- Who is most at risk?

Cycling of Mercury in Aquatic Environments

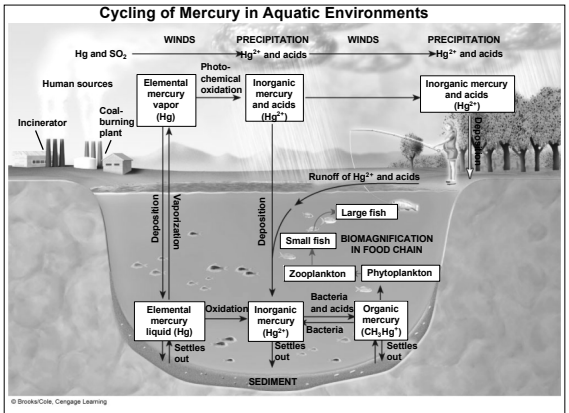


Fig. 17-A, p. 450

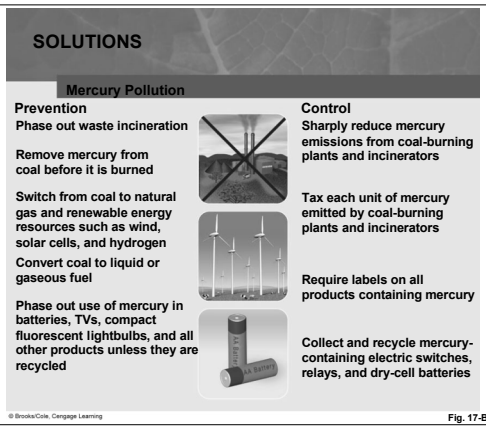


Fig. 17-B, p. 451

17-4 How Can We Evaluate and Deal with Chemical Hazards?

- ***Concept 17-4A*** *Scientists use live laboratory animals, non-animal tests, case reports of poisonings, and epidemiological studies to estimate the toxicity of chemicals, but these methods have limitations.*
- ***Concept 17-4B*** *Many health scientists call for much greater emphasis on pollution prevention to reduce our exposure to potentially harmful candidates.*

Many Factors Determine the Harmful Health Effects of a Chemical

- **Toxicology**
- **Toxicity** dependent on
  - **Dose**
  - Age
  - Genetic makeup
  - **Multiple chemical sensitivity (MCS)**
  - Solubility and persistence of the chemical
  - Biomagnification
- **Response**
  - Acute effect
  - Chronic effect

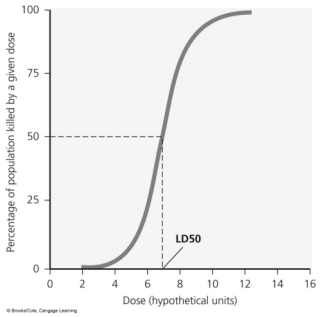
Scientists Use Live Lab Animals and Nonanimal Tests to Estimate Toxicity (1)

- **Dose-response curve: median lethal dose (LD50)**
  - **Nonthreshold dose-response model**
  - **Threshold dose-response model**
- Can the data be extrapolated to humans?

Scientists Use Live Lab Animals and Nonanimal Tests to Estimate Toxicity (2)

- More humane methods using animals
- Replace animals with other models
  - Computer simulations
  - Tissue culture and individual animal cells
  - Chicken egg membranes
- What are the effects of mixtures of potentially toxic chemicals?

Hypothetical Dose-Response Curve Showing Determination of the LD50



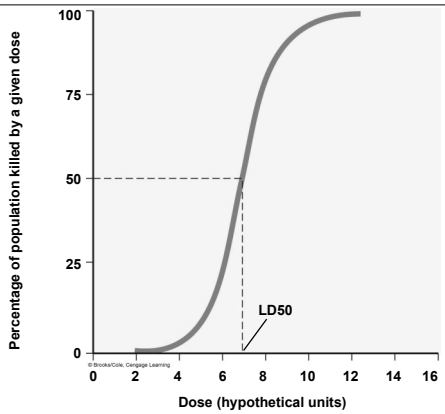


Fig. 17-14, p. 455

Toxicity Ratings and Average Lethal Doses for Humans

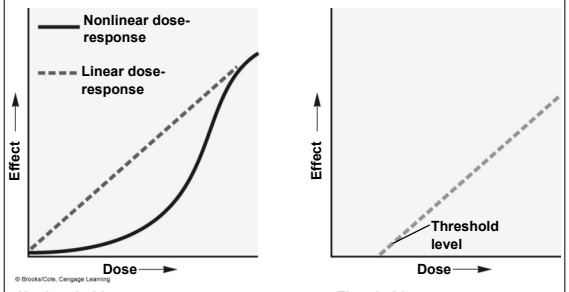
Table 17-1

Toxicity Ratings and Average Lethal Doses for Humans

Toxicity Rating	LD50 (milligrams per kilogram of body weight)*	Average Lethal Dose**	Examples
Supertoxic	Less than 5	Less than 7 drops	Nerve gases, botulism toxin, mushroom toxin, dioxin (TCDD)
Extremely toxic	5–50	7 drops to 1 teaspoon	Potassium cyanide, heroin, atropine, parathion, nicotine
Very Toxic	50–500	1 teaspoon to 1 ounce	Mercury salts, morphine, codeine
Moderately toxic	500–5,000	1 ounce to 1 pint	Lead salts, DDT, sodium hydroxide, sodium fluoride, sulfuric acid, caffeine, carbon tetrachloride
Slightly toxic	5,000–15,000	1 pint to 1 quart	Ethyl alcohol, Lysol, soaps
Essentially nontoxic	15,000 or greater	More than 1 quart	Water, glycerin, table sugar

*Dosage that kills 50% of individuals exposed.
**Amounts of substances in liquid form at room temperature that are lethal when given to a 70-kilogram (150-pound) human.

Two Types of Dose Response Curves



No threshold

Threshold

Fig. 17-15, p. 456

There Are Other Ways to Estimate the Harmful Effects of Chemicals

- Case reports and epidemiological studies
- Limitations of epidemiological studies
  - Too few people tested
  - Length of time
  - Can you link the result with the chemical?
  - Can not be used for new hazards

Are Trace Levels of Toxic Chemicals Harmful?

- We do not know
- Are the dangers increasing or are the tests just more sensitive?

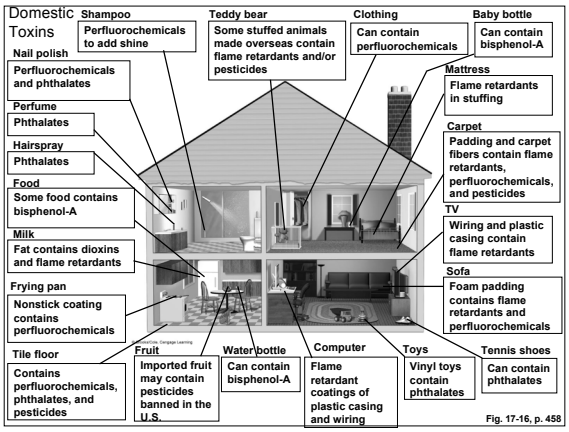


Fig. 17-16, p. 458

Why Do We Know So Little about the Harmful Effects of Chemicals?

- Severe limitations estimating toxicity levels and risks
- Acceptable levels vary between 1/100 and 1/1000 of the estimated harmful levels

Pollution Prevention and the Precautionary Principle

- Those introducing a new chemical or new technology would have to follow new strategies
  - A new product is considered harmful until it can be proved to be safe
  - Existing chemicals and technologies that appear to cause significant harm must be removed
- 2000: global treaty to ban or phase out the dirty dozen (POPs)

17-5 How Do We Perceive Risks and How Can We Avoid the Worst of Them?

- ***Concept 17-5*** *We can reduce the major risks we face if we become informed, think critically about risks, and make careful choices.*

The Greatest Health Risks Come from Poverty, Gender, and Lifestyle Choices

- **Risk analysis**
- Greatest health risks (Fig. 17-18)
  - Poverty
  - Gender
  - Lifestyle choices

COMPARATIVE RISK ANALYSIS

Most Serious Ecological and Health Problems

Stepped Art

Fig. 17-17, p. 461

Global Annual Mortality from Various Causes

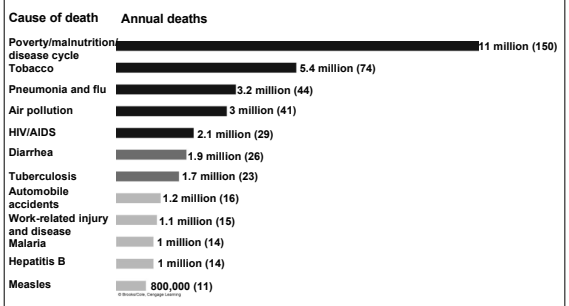
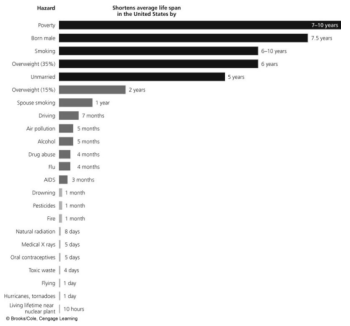


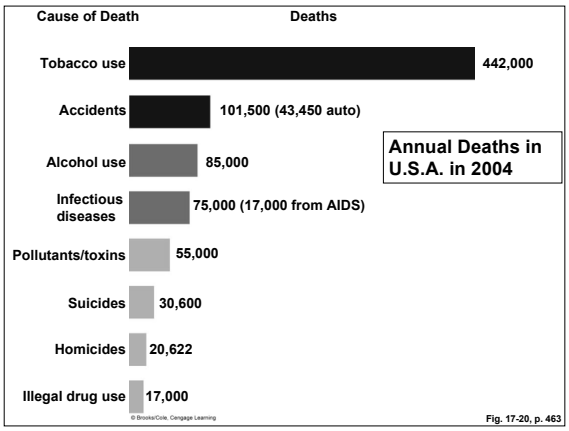
Fig. 17-18, p. 461

Comparison of Risks People Face in Terms of Shorter Average Life Span



Case Study: Death from Smoking

- Most preventable major cause of suffering and premature death
- Nicotine: additive
- Effects of **passive smoking** (secondhand smoke)
- How to reduce smoking
  - Taxes
  - Ban
  - Classify and regulate nicotine
  - **Education**



Estimating Risks from Technologies Is Not Easy

- System reliability = Technological reliability x Human reliability
- To err is human

Most People Do Not Know How to Evaluate Risks

- Fear
- Degree of control
- Whether a risk is catastrophic
- Optimism bias
- Unfair distribution of risks

Several Principles Can Help Us to Evaluate and Reduce Risk

- Compare risks
- Determine how much you are willing to accept
- Determine the actual risk involved
- Concentrate on evaluating and carefully making important lifestyle choices