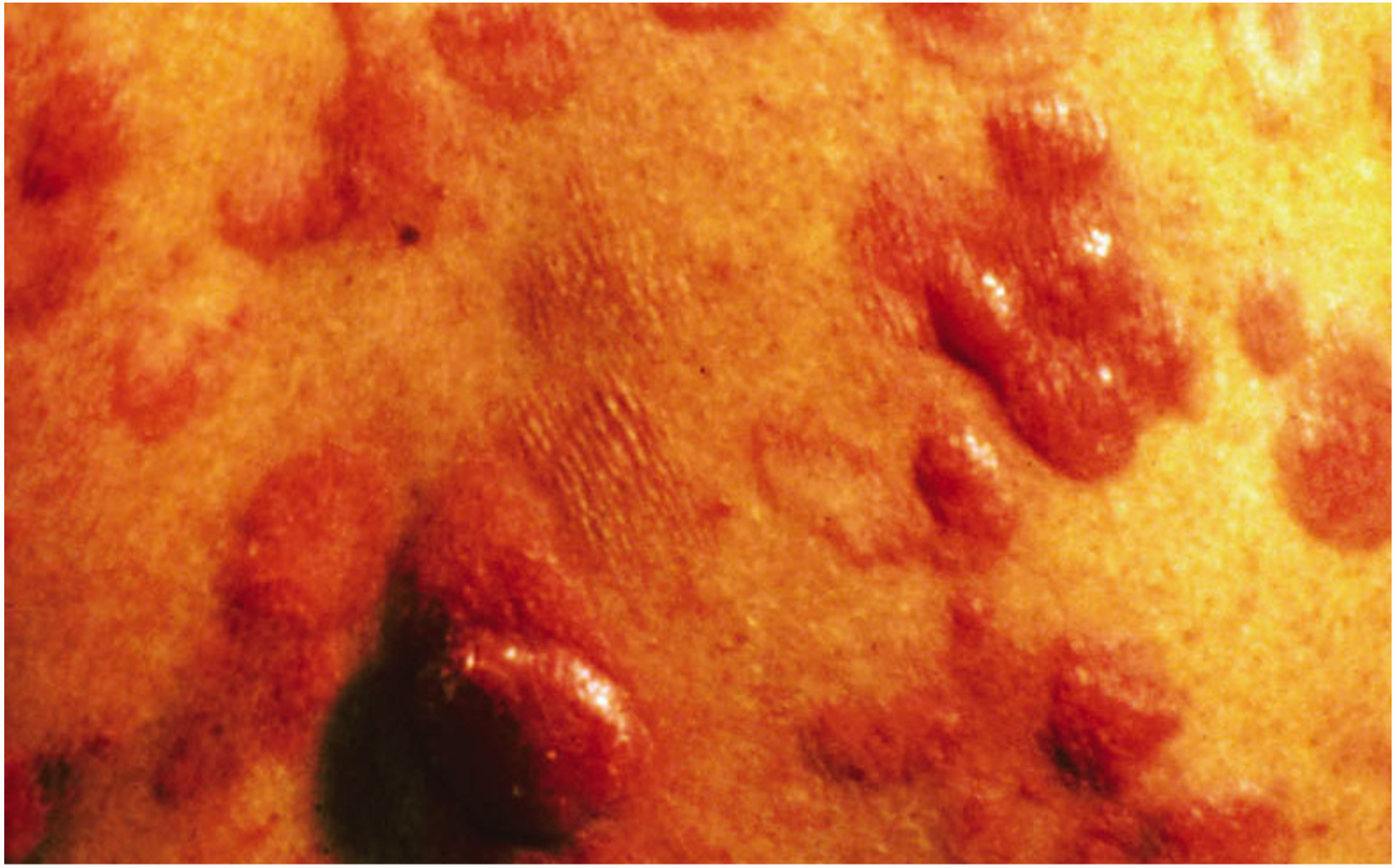
Environmental Hazards and Human Health

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



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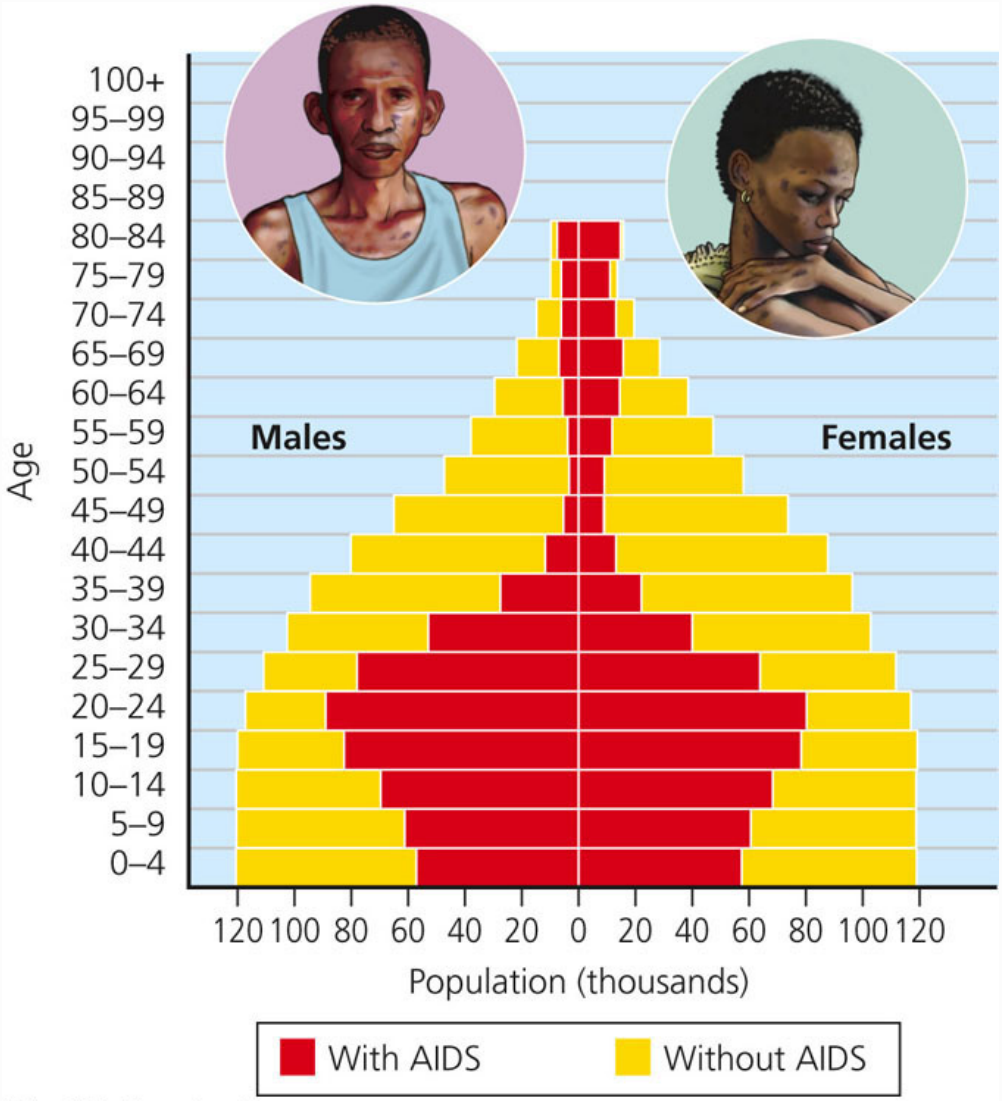
Global Outlook: Worldwide, AIDS Is the Leading Cause of Death for Ages 15–49



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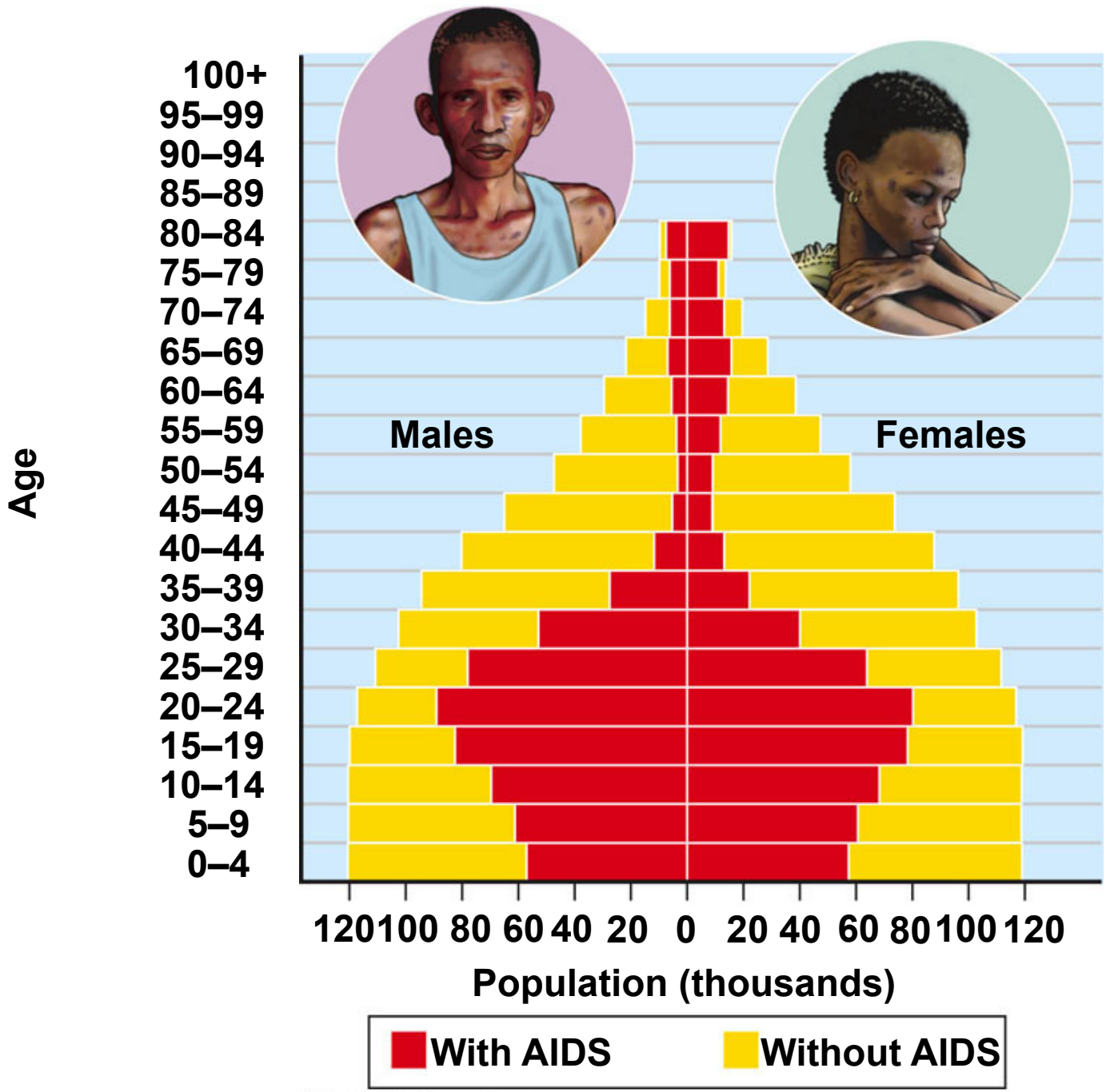

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Fig. 17-2, p. 438

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**
- Probability and possibility
- **Risk Assessment**
- **Risk Management**

Science: Risk Assessment and Risk Management

Risk Assessment

Hazard identification
What is the hazard?

Probability of risk
How likely is the event?

Consequences of risk
What is the likely damage?

Risk Management

Comparative risk analysis
How does it compare with other risks?

Risk reduction
How much should it be reduced?

Risk reduction strategy
How will the risk be reduced?

Financial commitment
How much money should be spent?

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Risk Assessment

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Fig. 17-3, p. 440

We Face Many Types of Hazards

- Five major types of hazards
  - Biological: **pathogens**
  - Chemical
  - Physical
  - Cultural
  - Lifestyle choices

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)

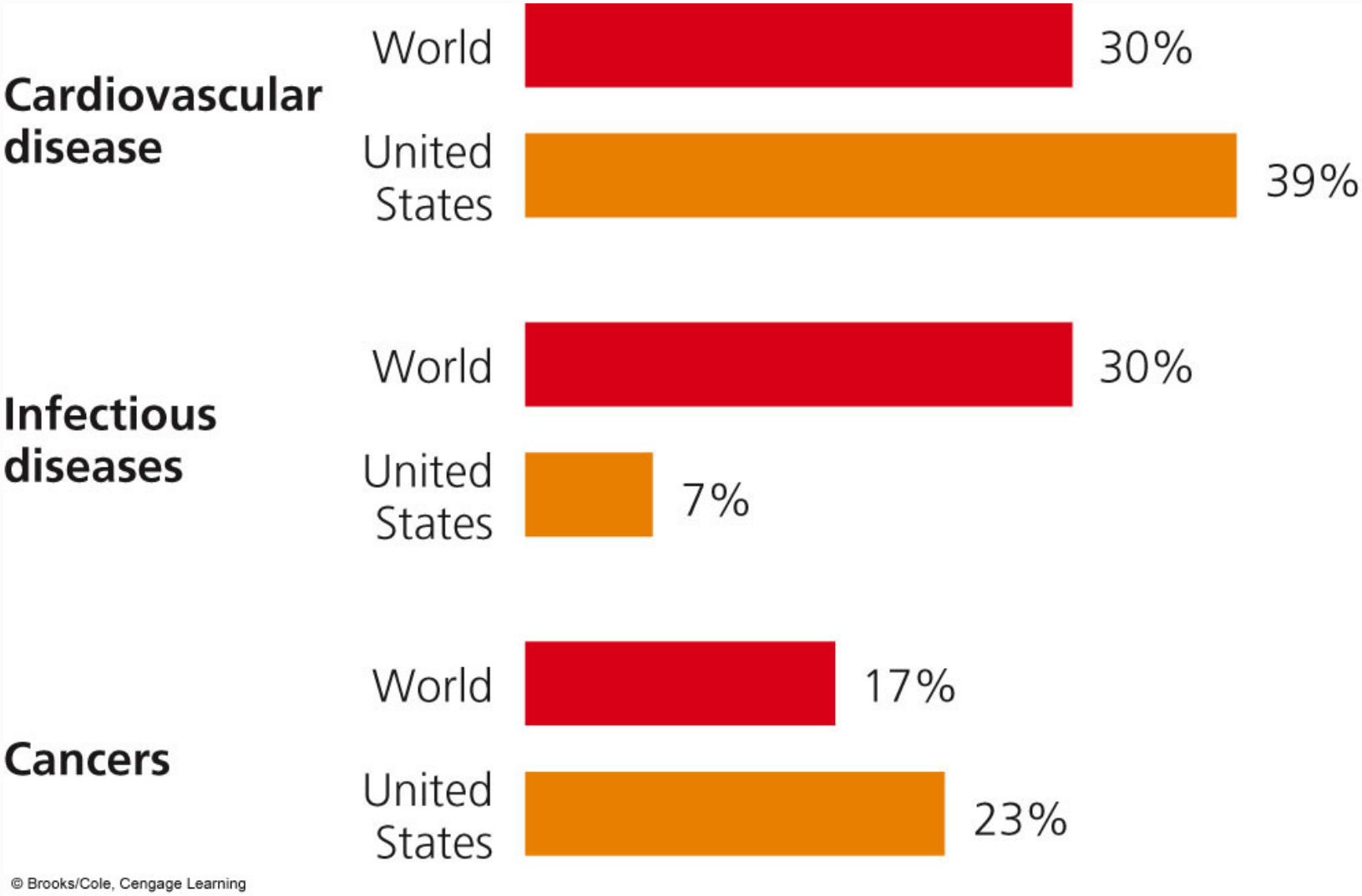
- **Nontransmissible disease**
- **Infectious disease**
- **Transmissible disease (contagious** or **communicable disease)**

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)**

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



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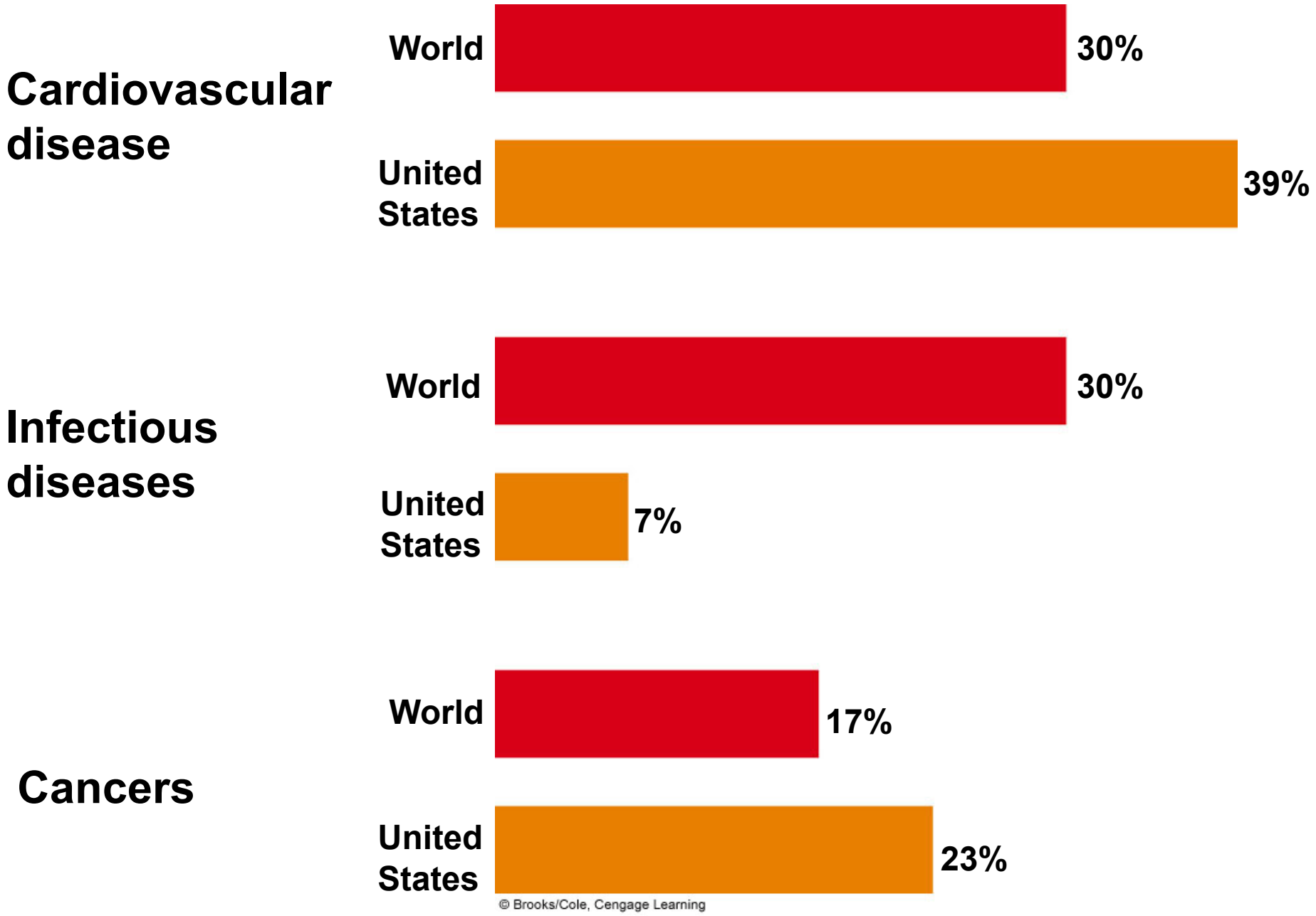
Cardiovascular disease
World
30%
United States
39%
Infectious diseases
World
30%
United States
7%
Cancers
World
17%
United States
23%
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Fig. 17-4, p. 441

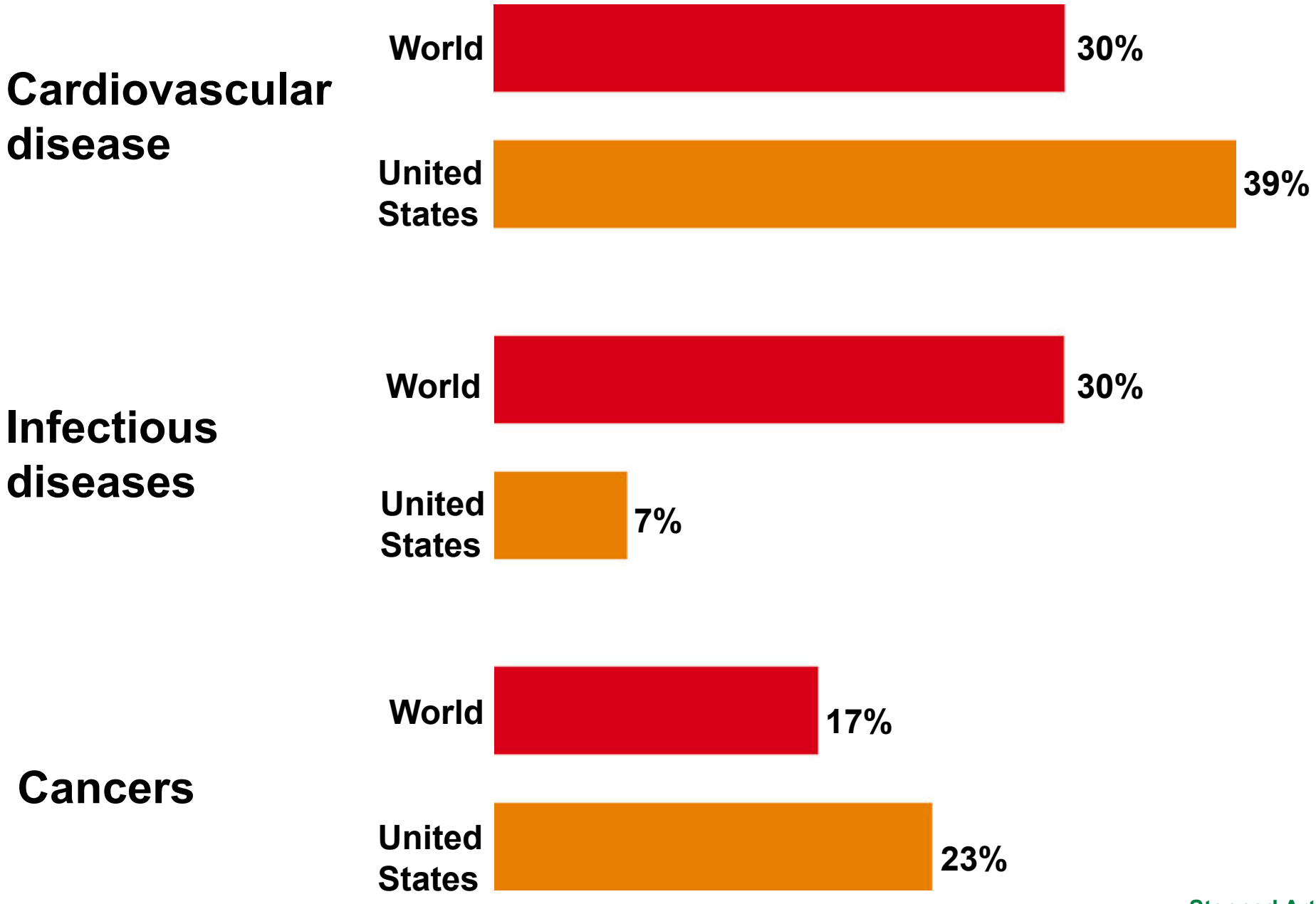

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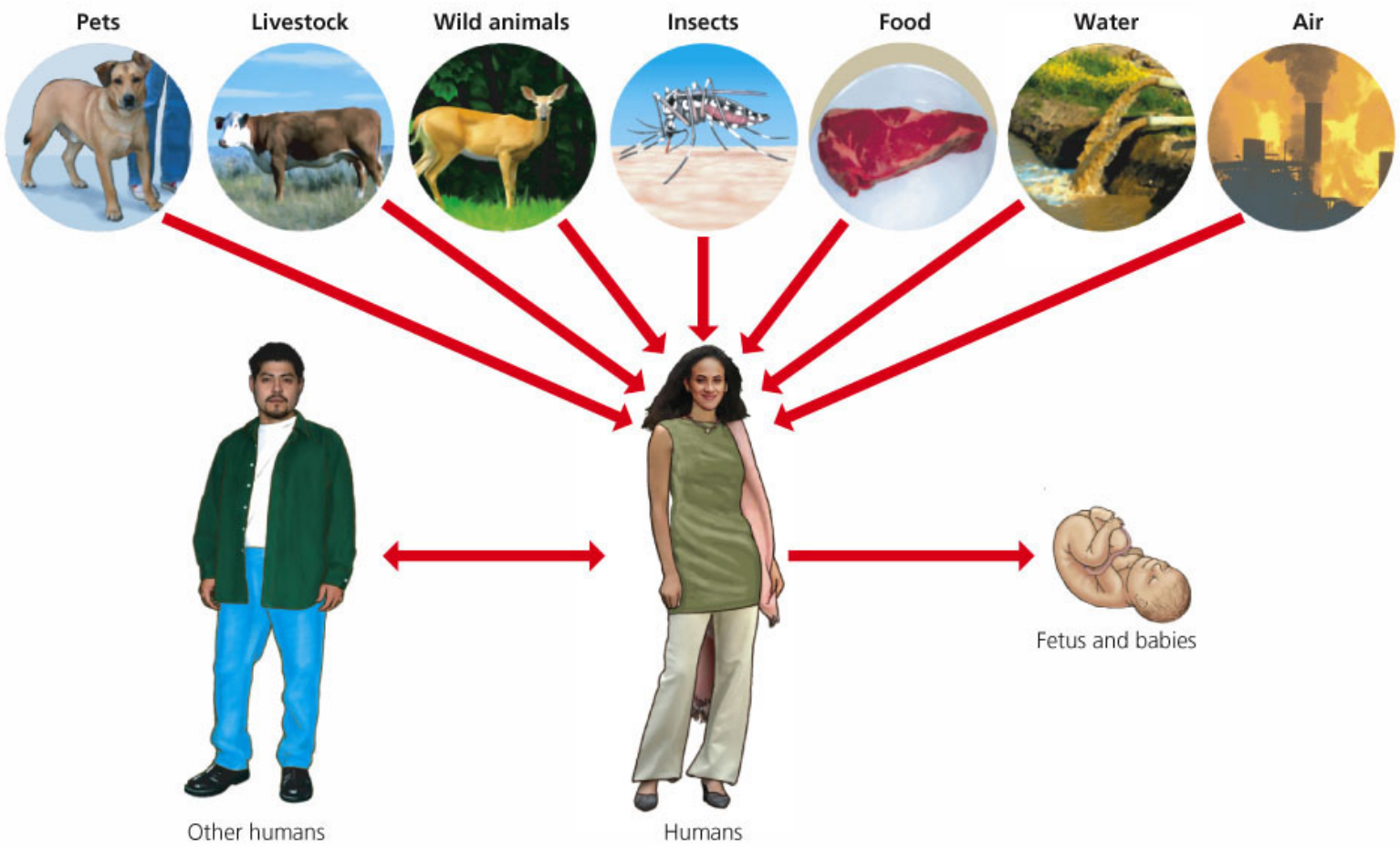
Fig. 17-4, p. 441

Infectious Diseases Are Still Major Health Threats

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

Science: Pathways for Infectious Diseases in Humans



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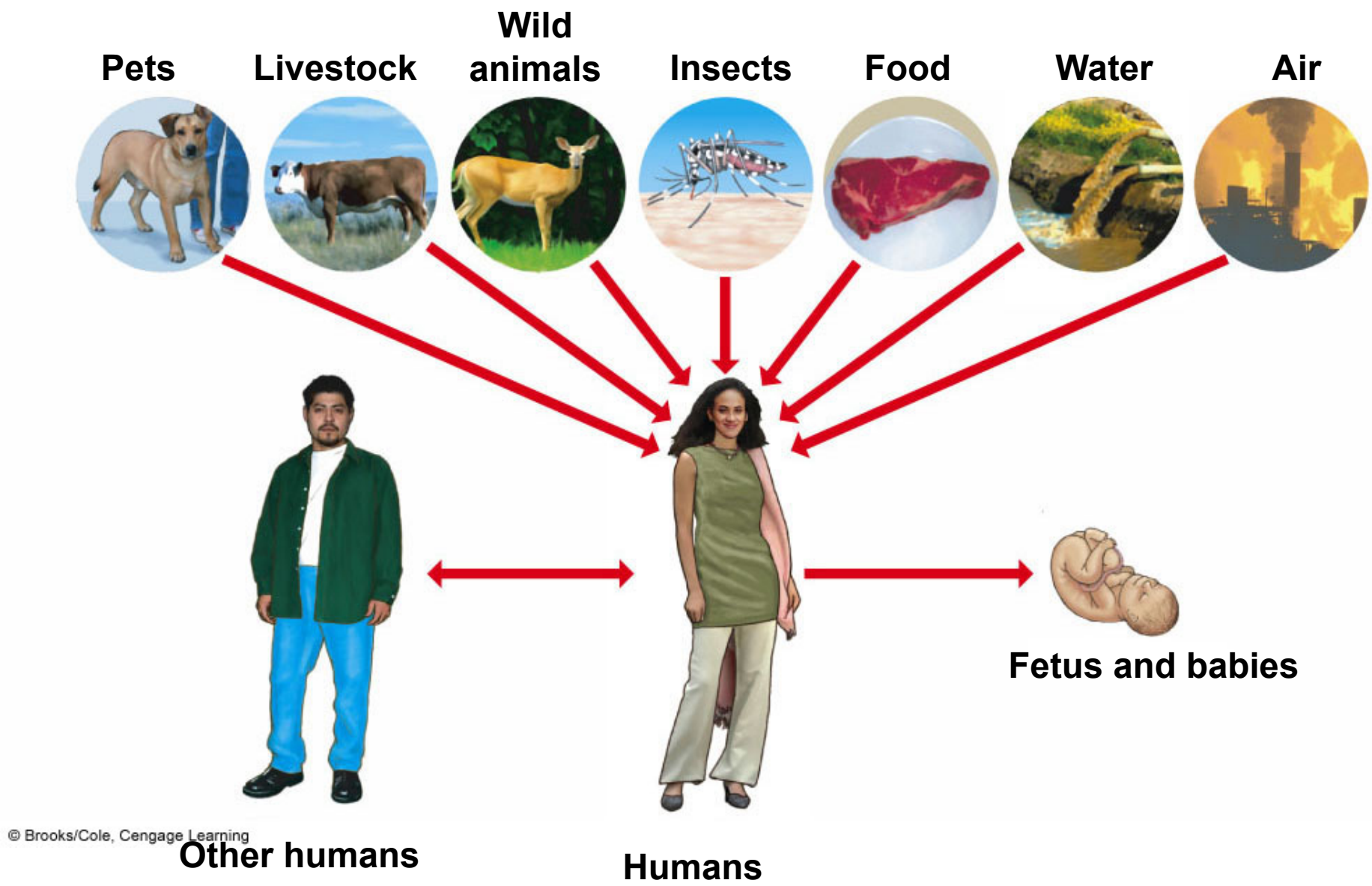

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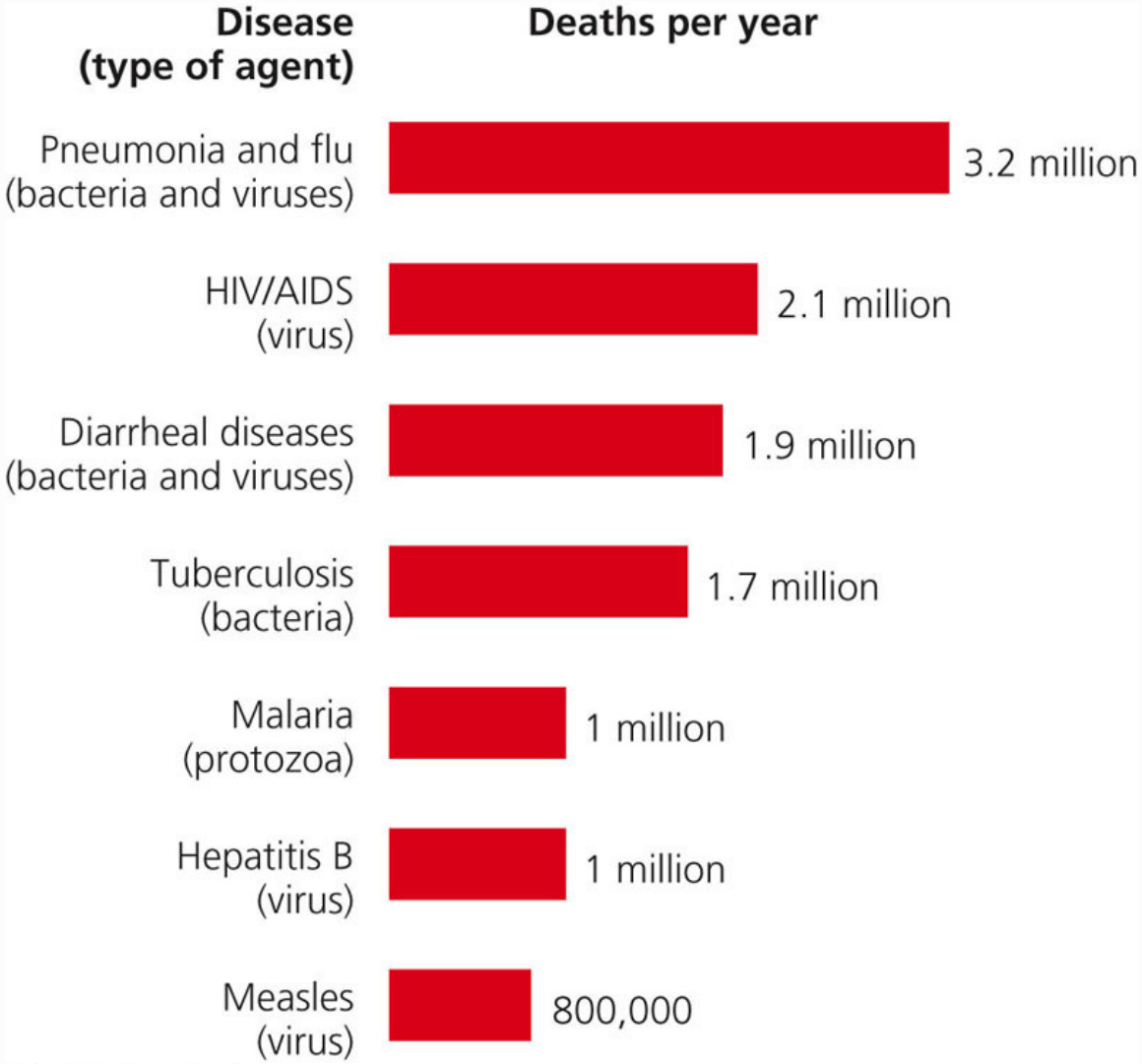
Fig. 17-5, p. 441

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



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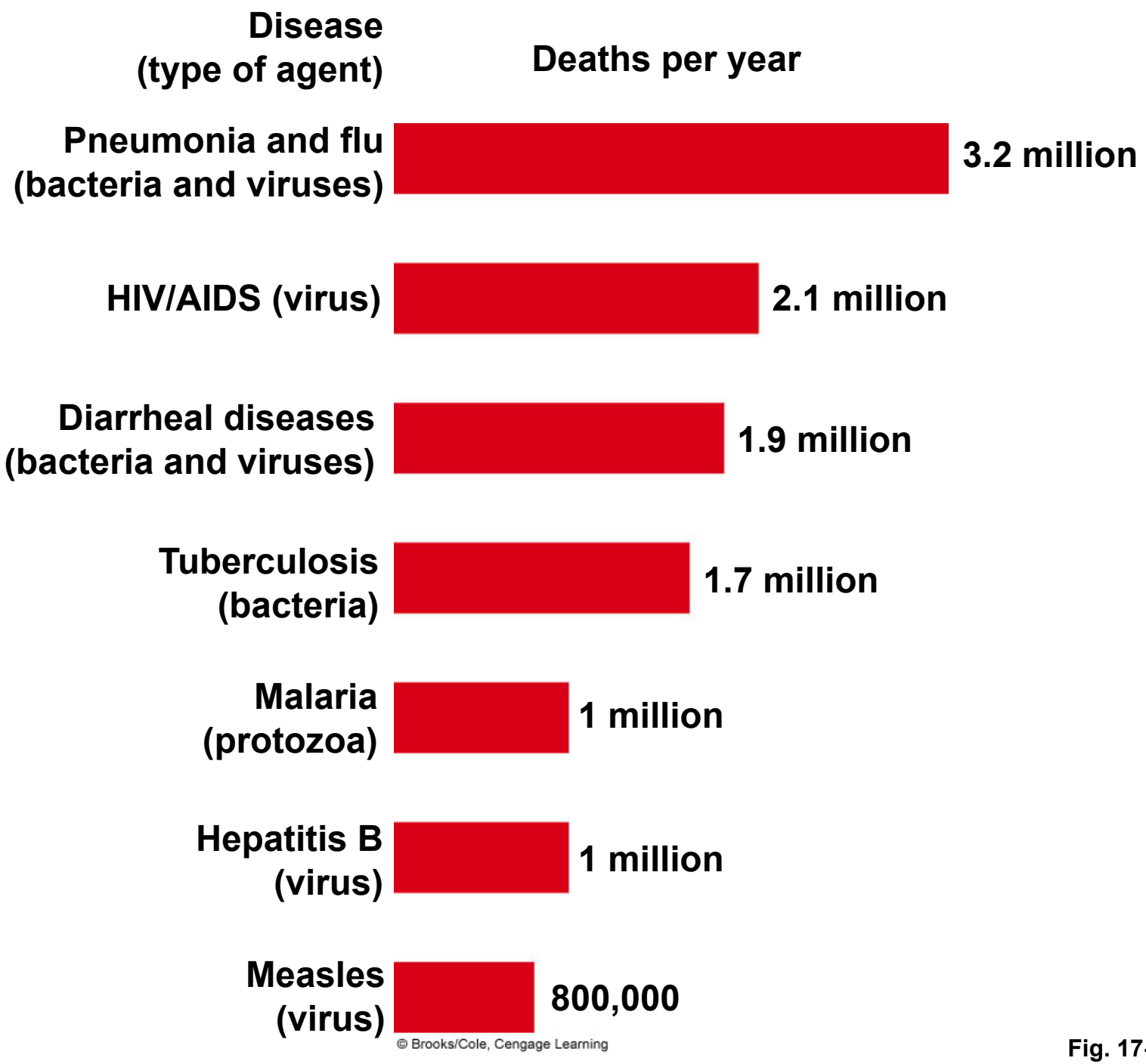
Disease
(type of agent)
Deaths per year
Pneumonia and flu
(bacteria and viruses)
3.2 million
HIV/AIDS (virus)
2.1 million
Diarrheal diseases
(bacteria and viruses)
1.9 million
Tuberculosis
(bacteria)
1.7 million
Malaria
(protozoa)
1 million
Hepatitis B
(virus)
1 million
Measles
(virus)
800,000
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Fig. 17-6, p. 442

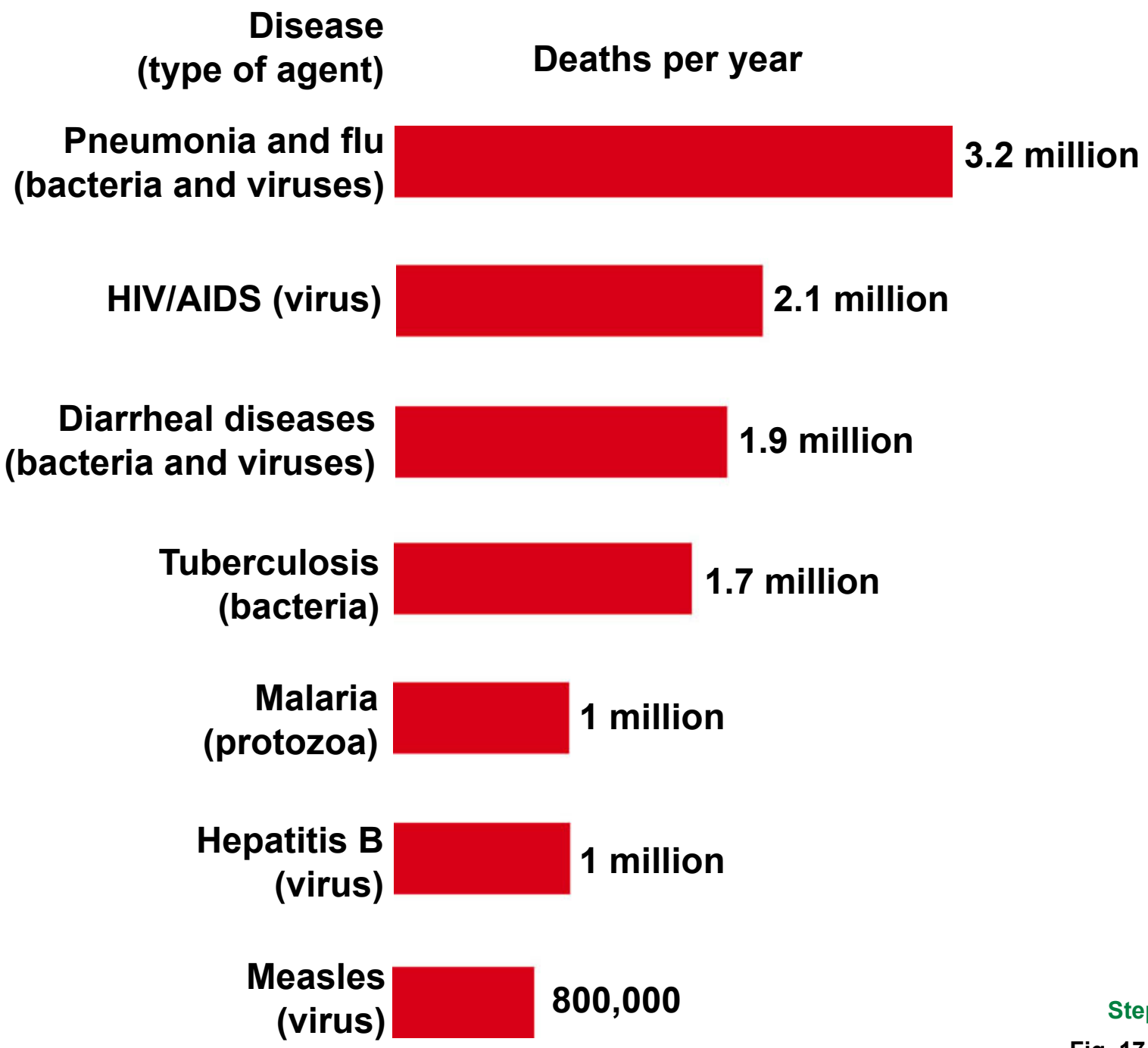

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Fig. 17-6, p. 442

Science Focus: Genetic Resistance to Antibiotics Is Increasing (1)

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

Science Focus: Genetic Resistance to Antibiotics Is Increasing (2)

- **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

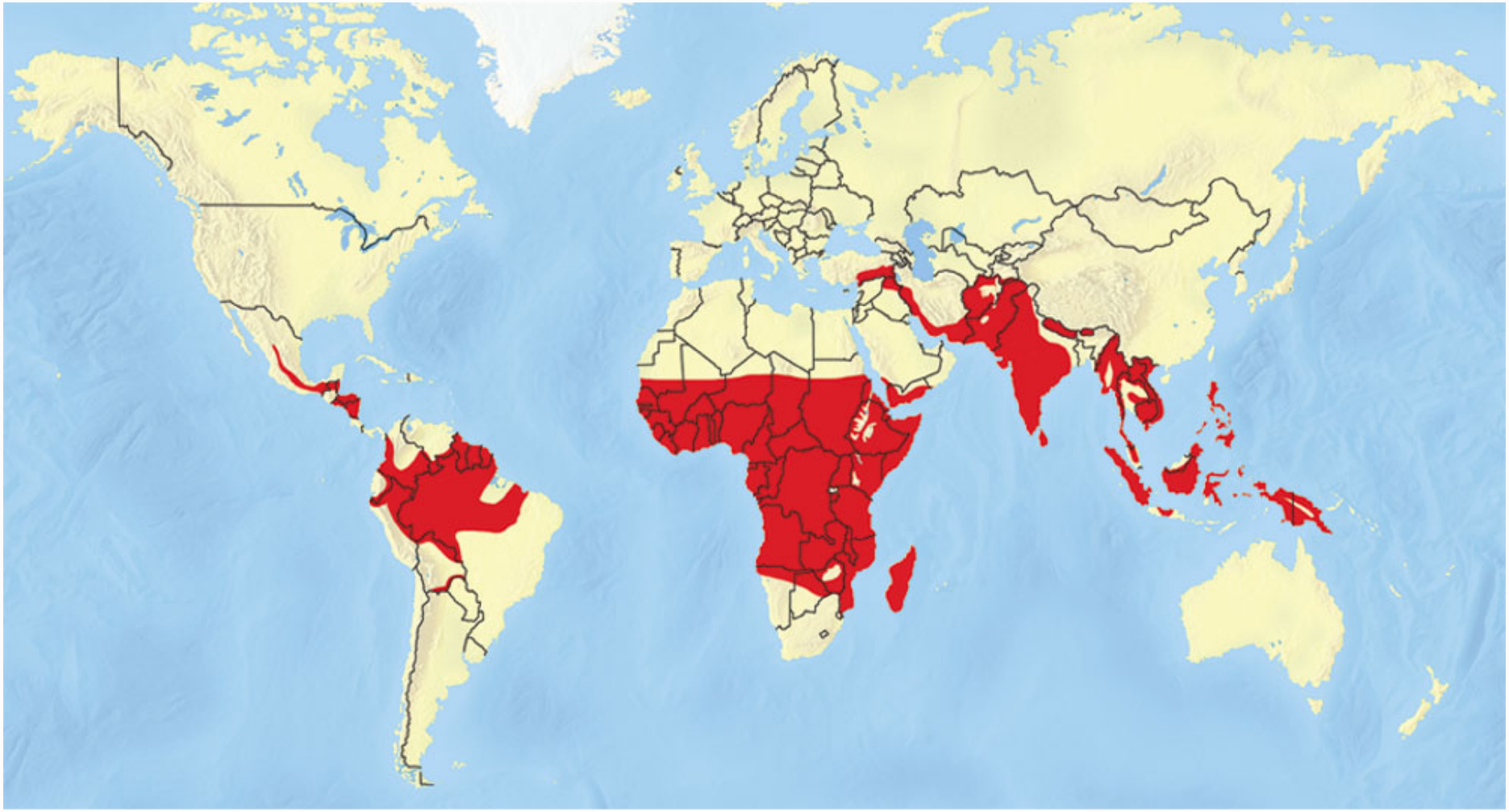
Case Study: Malaria—Death by Parasite-Carrying Mosquitoes (1)

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

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



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

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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

Solutions: Infectious Diseases, Ways to Prevent or Reduce Their Occurrence

SOLUTIONS

Infectious Diseases

- Increase research on tropical diseases and vaccines
- Reduce poverty
- Decrease malnutrition
- Improve drinking water quality
- Reduce unnecessary use of antibiotics
- Educate people to take all of an antibiotic prescription
- Reduce antibiotic use to promote livestock growth
- Require careful hand washing by all medical personnel
- Immunize children against major viral diseases
- Provide oral rehydration for diarrhea victims
- Conduct global campaign to reduce HIV/AIDS

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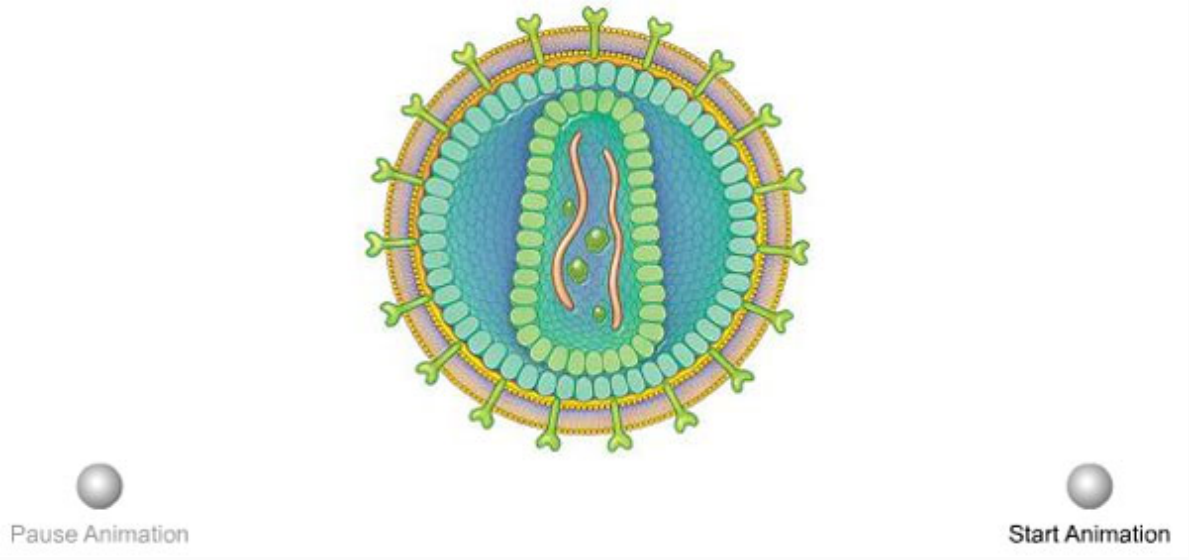
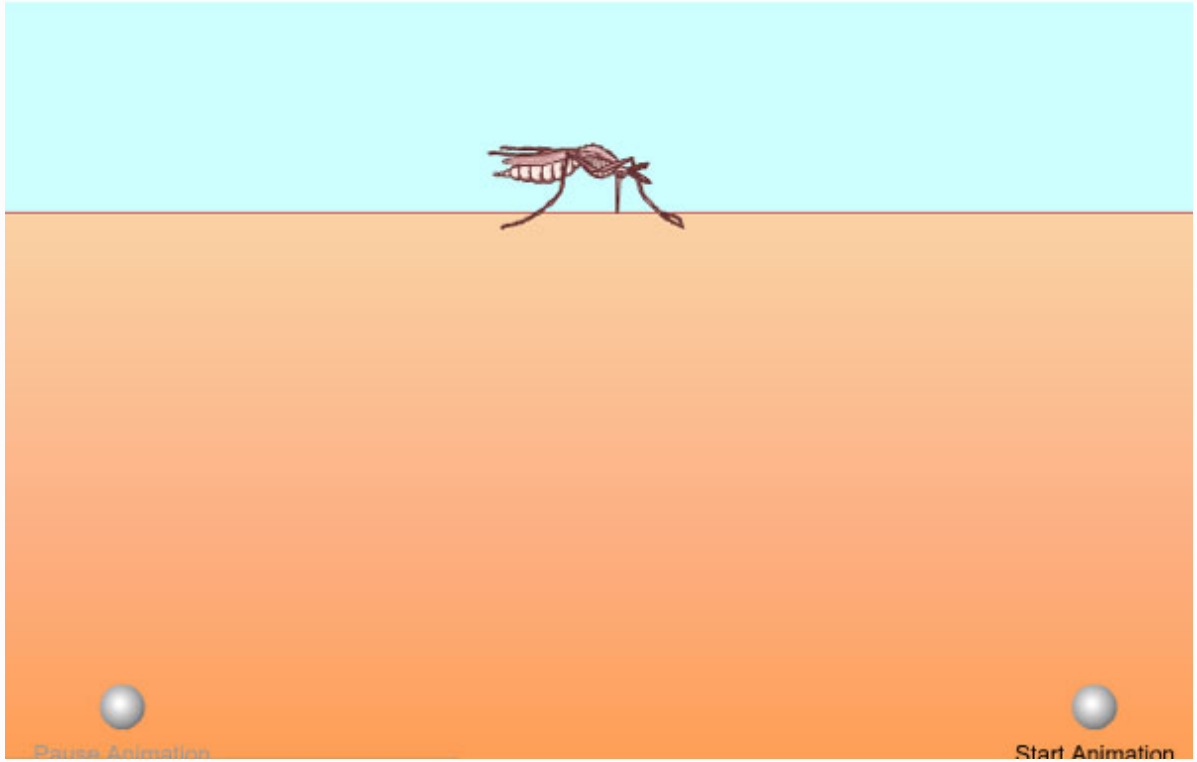
Fig. 17-10, p. 447

Animation: HIV replication



PLAY

Animation: Life cycle of plasmodium



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ABC Video: AIDS conference in Brazil

PLAY

ABC Video: Bird flu

PLAY

ABC Video: Germs in Pakistan

PLAY

ABC Video: Polio scare

PLAY

ABC Video: The problem with pork

PLAY

ABC Video: Mask of technology

PLAY

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.*

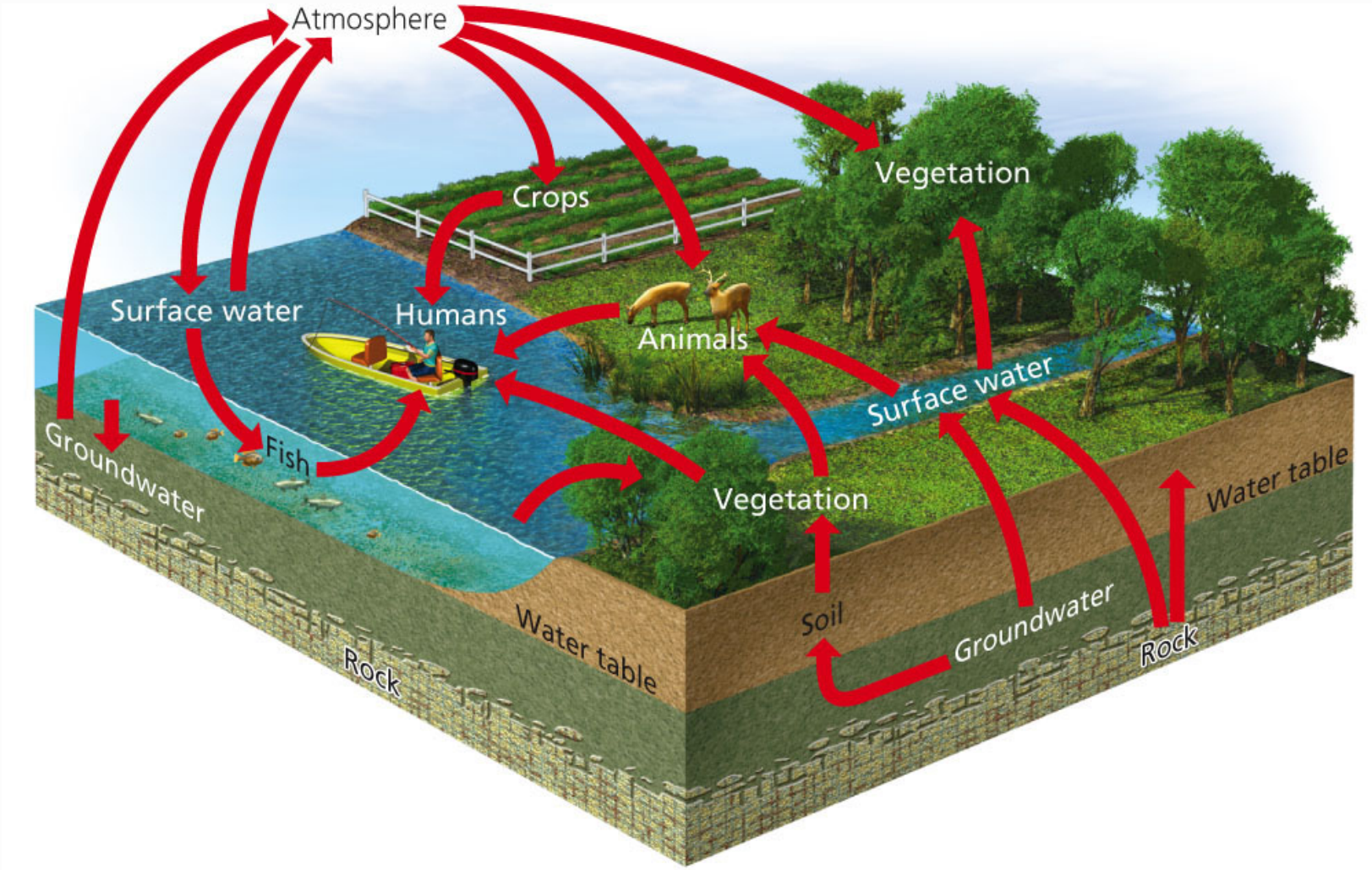
Some Chemicals Can Cause Cancers, Mutations, and Birth Defects

- Toxic chemicals
  - Carcinogens
  - Mutagens
  - Teratogens

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 on Which Toxic Chemicals Move Through the Environment



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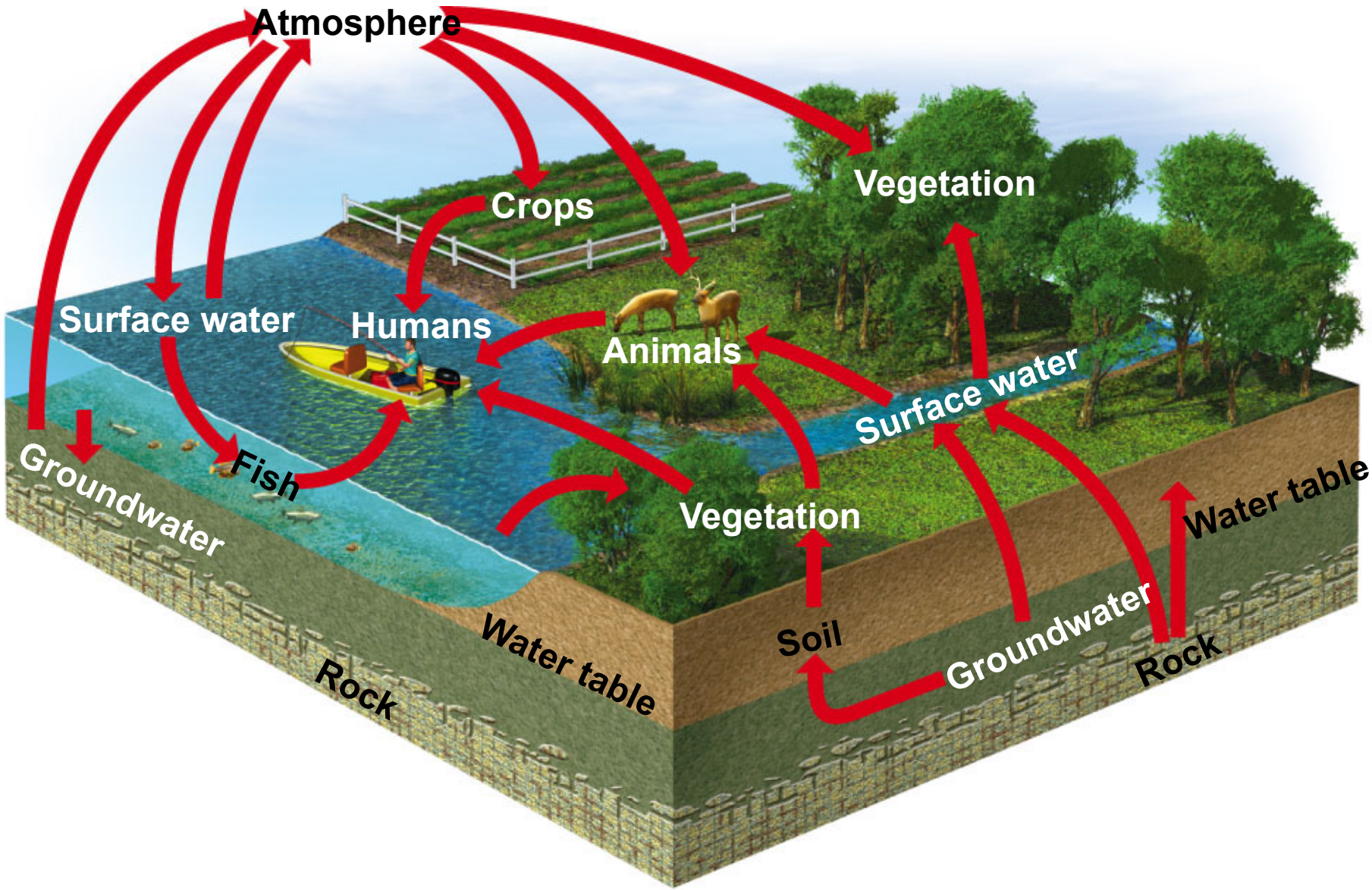

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Fig. 17-11, p. 449

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
  - Nervous system
  - Endocrine system

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

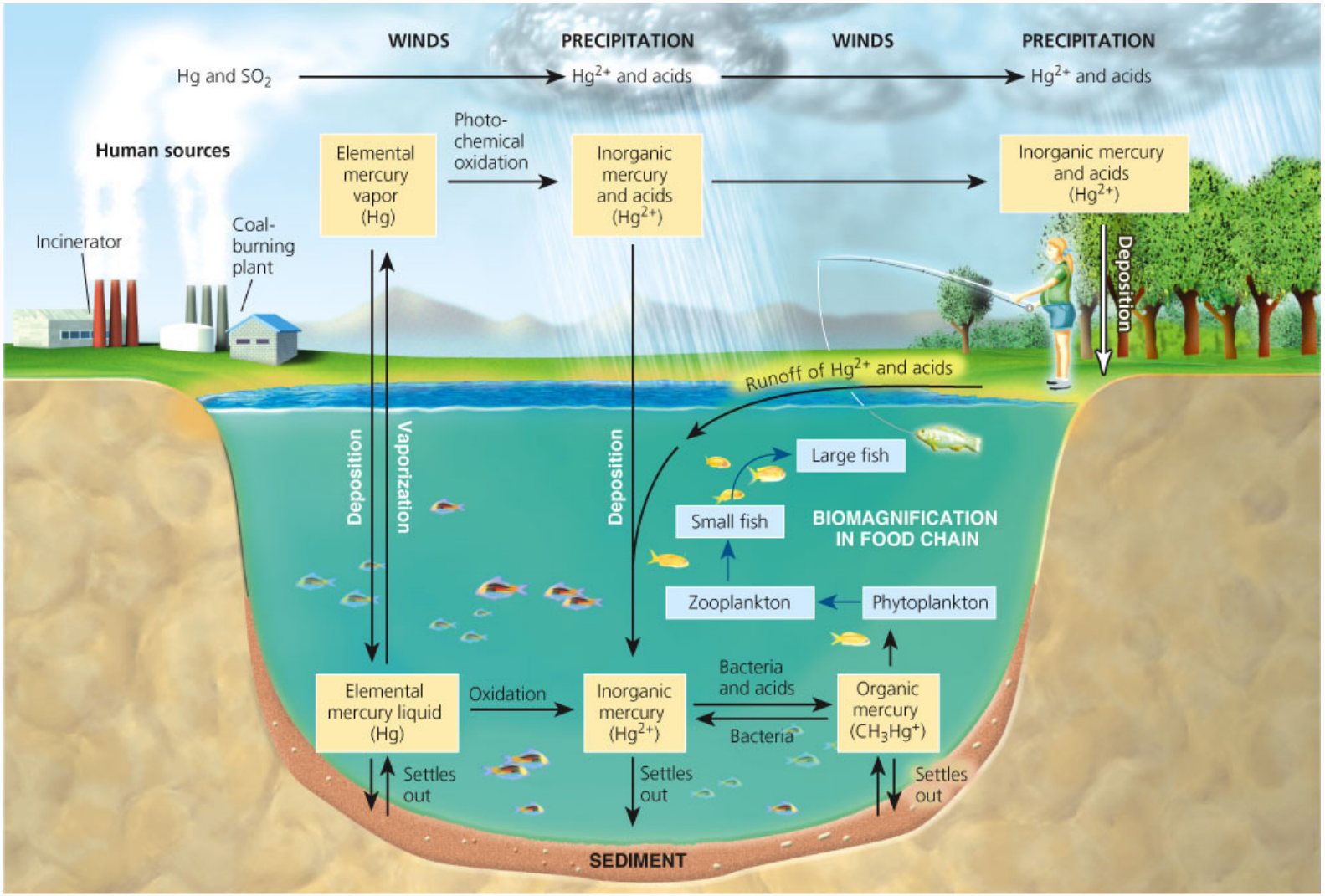
Science Focus: Mercury's Toxic Effects (1)

- 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?

Science: Cycling of Mercury in Aquatic Environments



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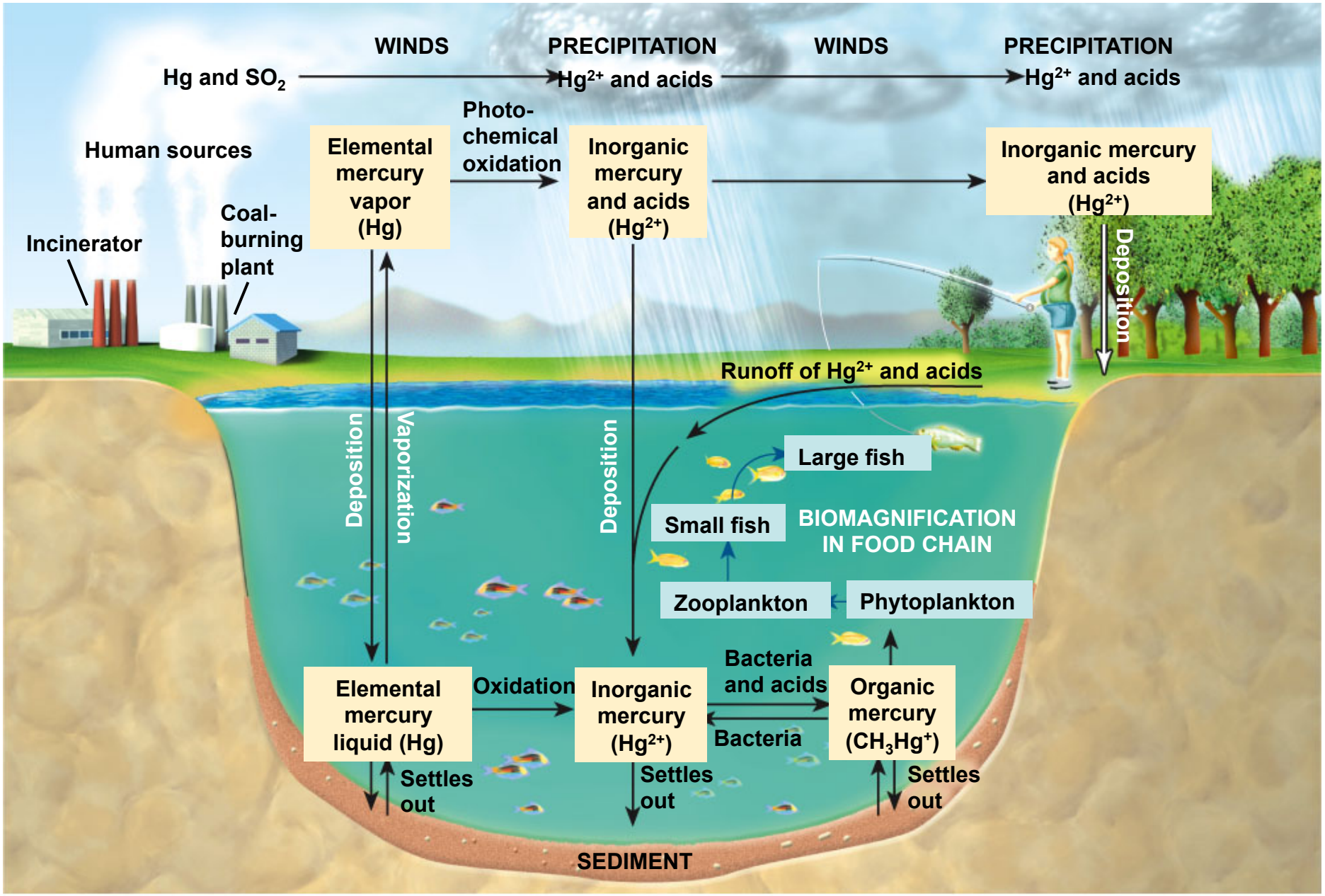

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Fig. 17-A, p. 450

Solutions: Mercury Pollution

SOLUTIONS

Mercury Pollution

Prevention

Phase out waste incineration

Remove mercury from coal before it is burned

Switch from coal to natural gas and renewable energy resources such as wind, solar cells, and hydrogen

Convert coal to liquid or gaseous fuel

Phase out use of mercury in batteries, TVs, compact fluorescent lightbulbs, and all other products unless they are recycled

Control

Sharply reduce mercury emissions from coal-burning plants and incinerators

Tax each unit of mercury emitted by coal-burning plants and incinerators

Require labels on all products containing mercury

Collect and recycle mercury-containing electric switches, relays, and dry-cell batteries

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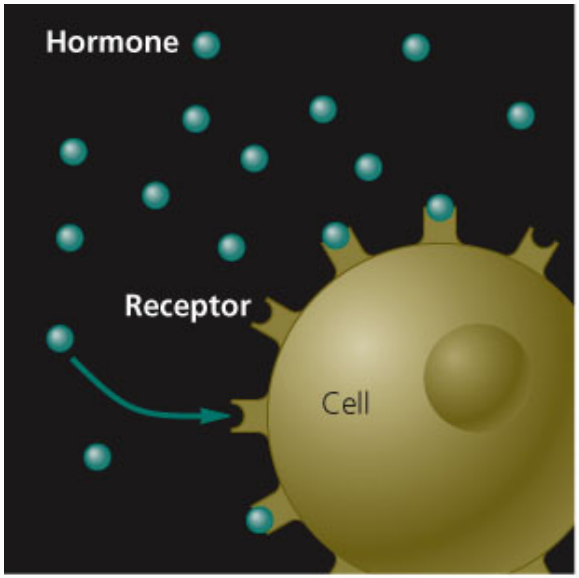
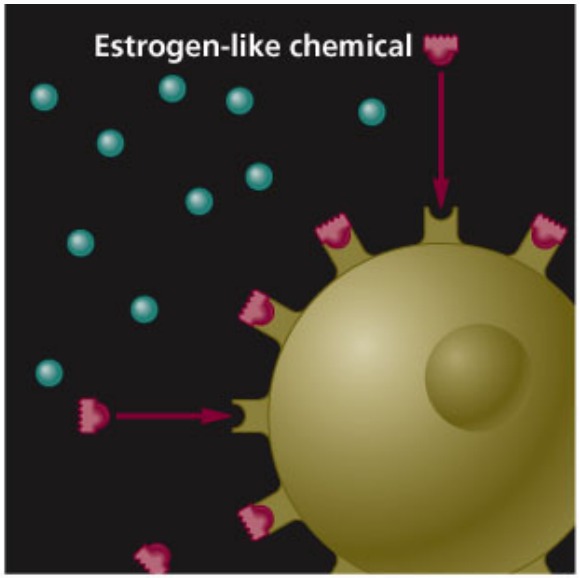
Fig. 17-B, p. 451

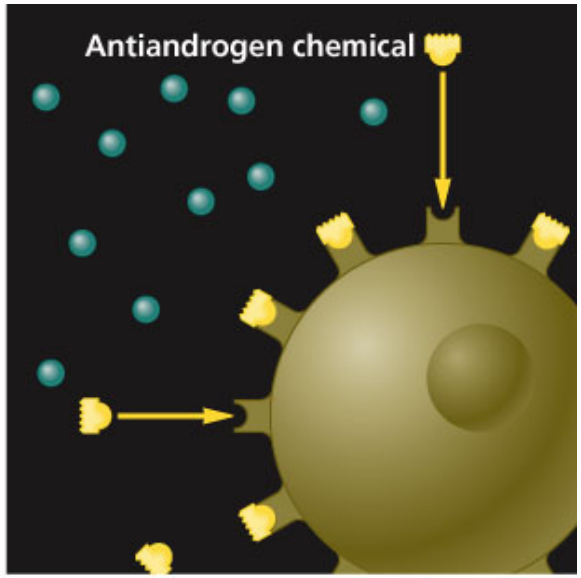
Hormones and Hormones Mimics or Blockers



Normal Hormone Process



Hormone Mimic



Hormone Blocker

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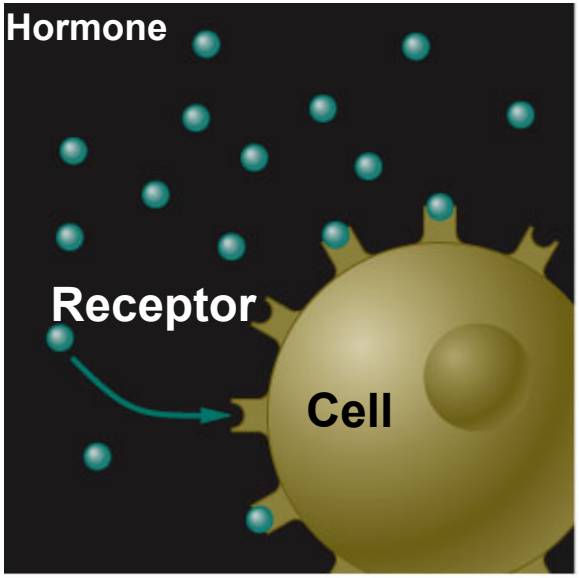

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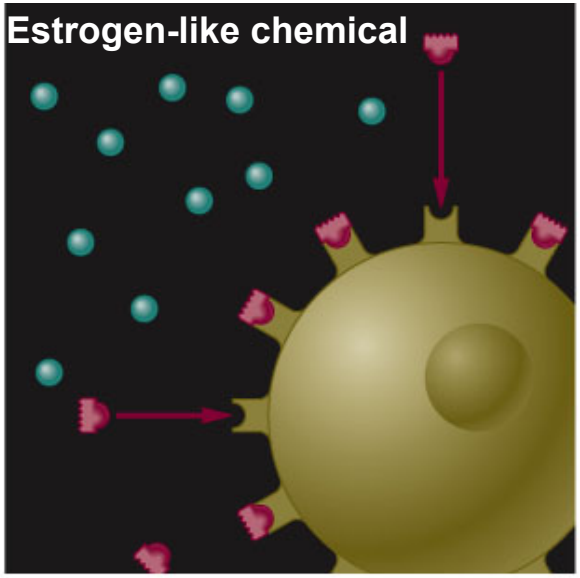
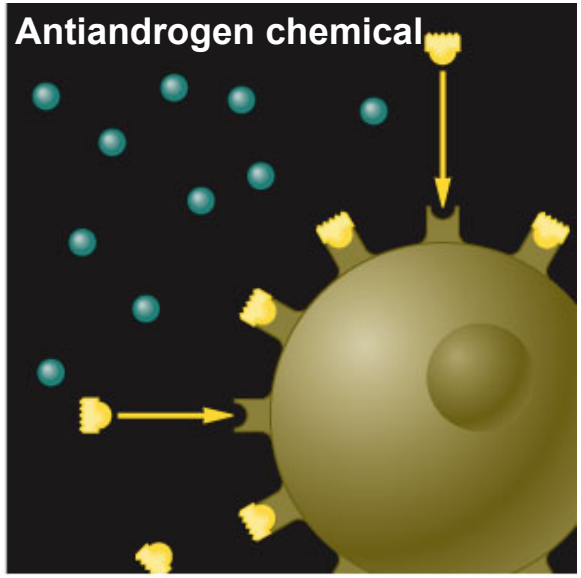
Normal Hormone Process



Hormone Mimic



Hormone Blocker

Fig. 17-12, p. 452

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Fig. 17-12, p. 452

Science Focus: Bisphenol A

- Estrogen mimic
- Found in many common products
- Laboratory findings
- Effects on human health
- Should it be banned?

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 (1)

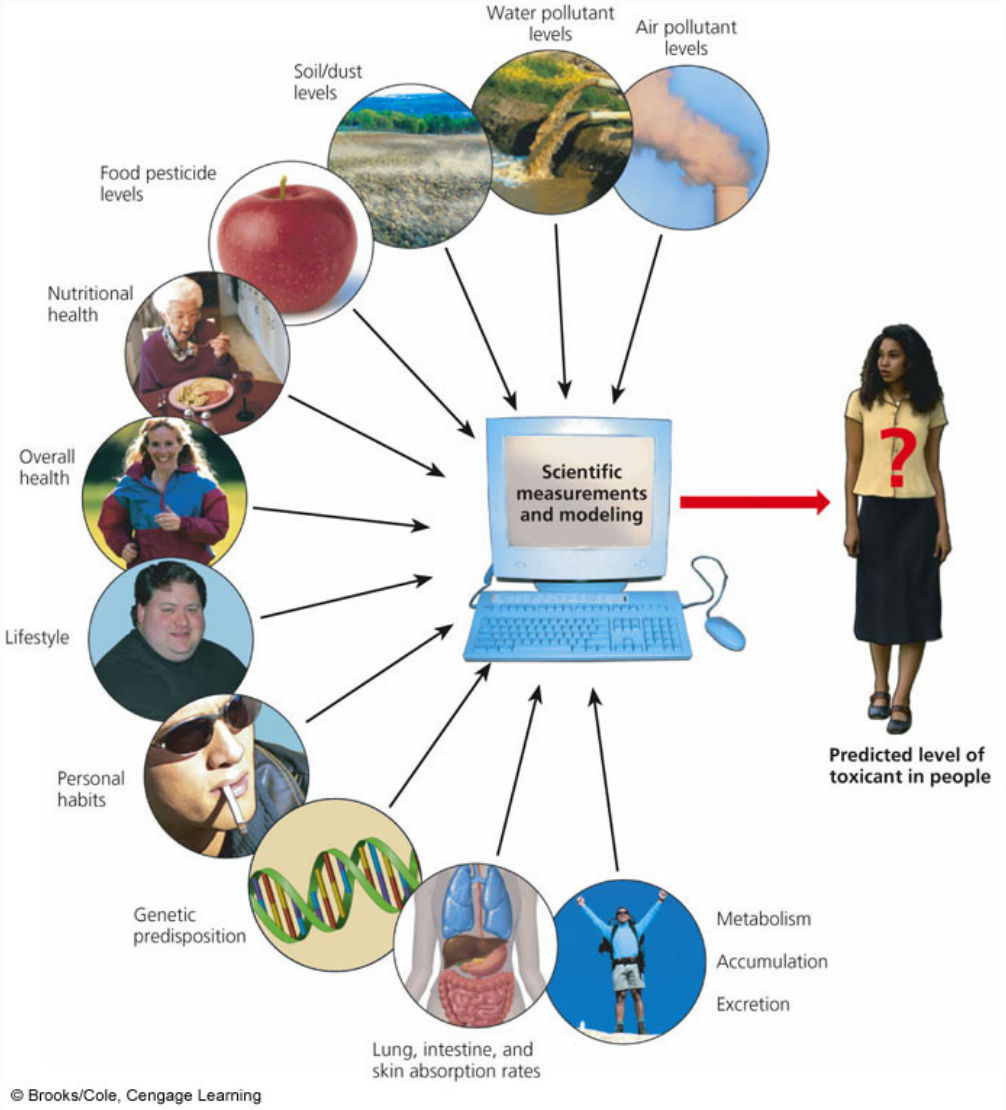
- **Toxicology**

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

Many Factors Determine the Harmful Health Effects of a Chemical (2)

- **Response**
  - Acute effect
  - Chronic effect

Science: Estimating Human Exposure to Chemicals and Measuring Their Effects



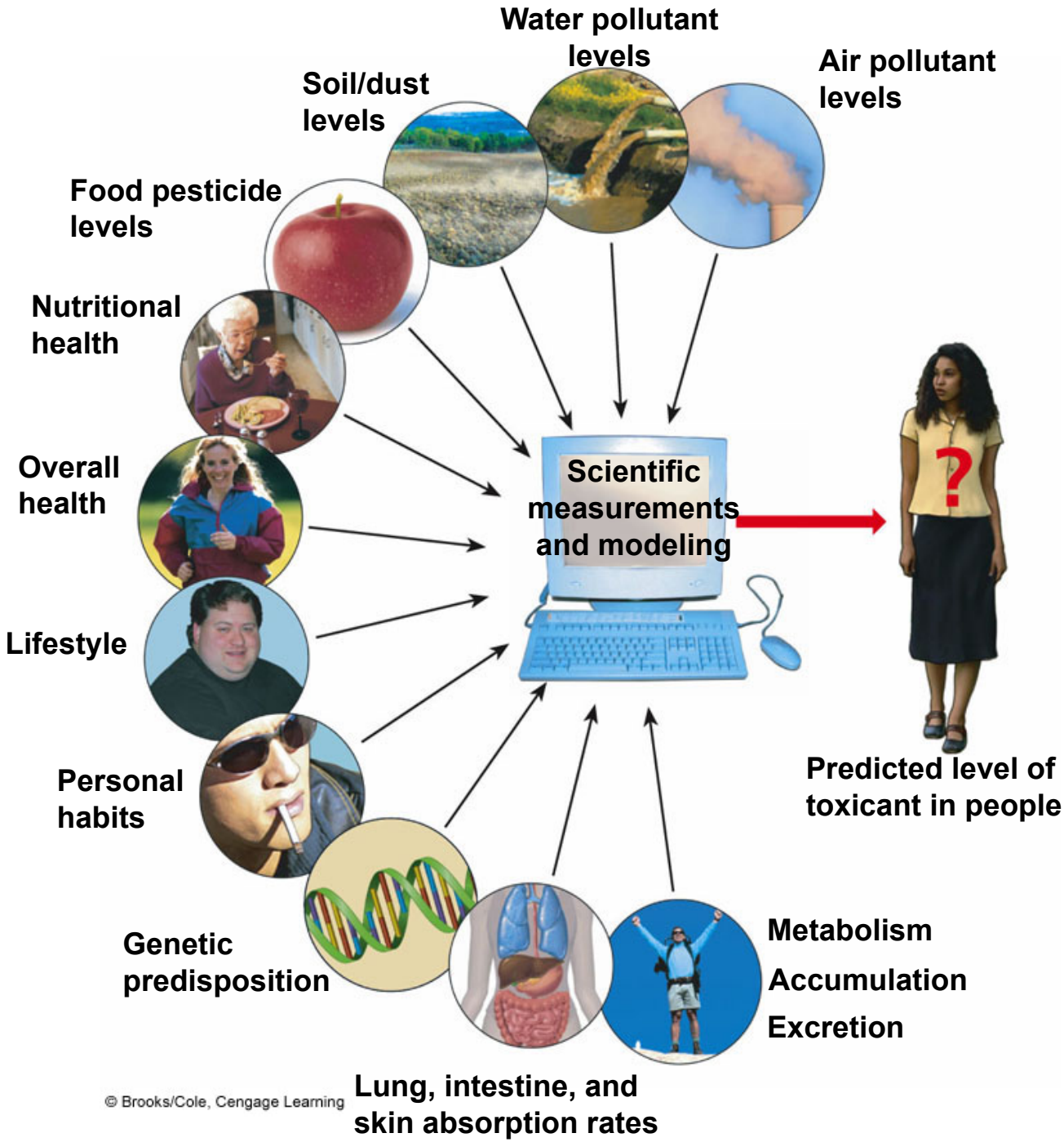


Fig. 17-13, p. 454

Case Study: Protecting Children from Toxic Chemicals

- Analysis of umbilical cord blood: significance
- Infants and children more susceptible to the toxic effects of chemicals than adults
  - Eat, drink water, and breathe more per unit of body weight than adults
  - Put their fingers in their mouths
  - Less well-developed immune systems and body detoxification processes

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

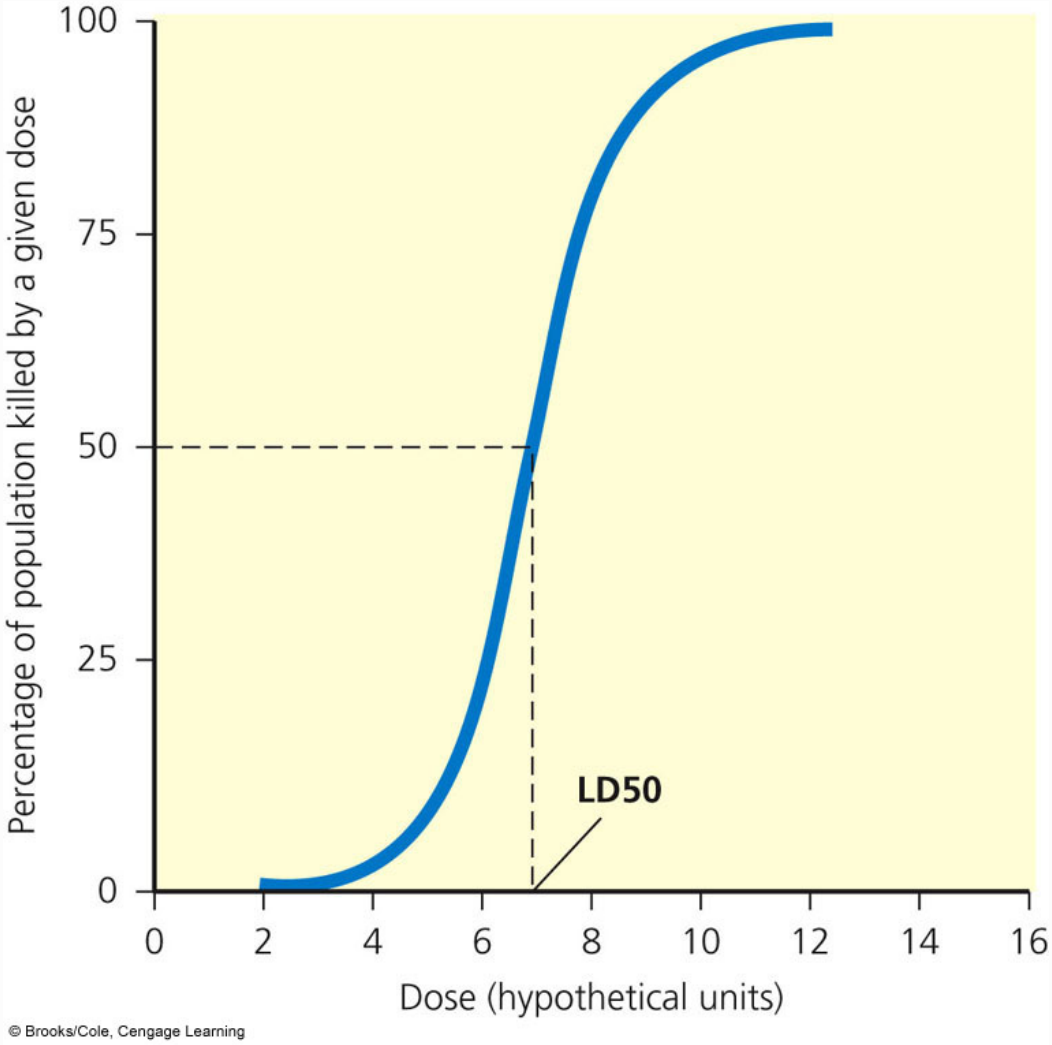
- **Dose-response curve: median lethal dose (LD50)**
  - **Nonthreshold dose-response model**
  - **Threshold dose-response model**

- 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



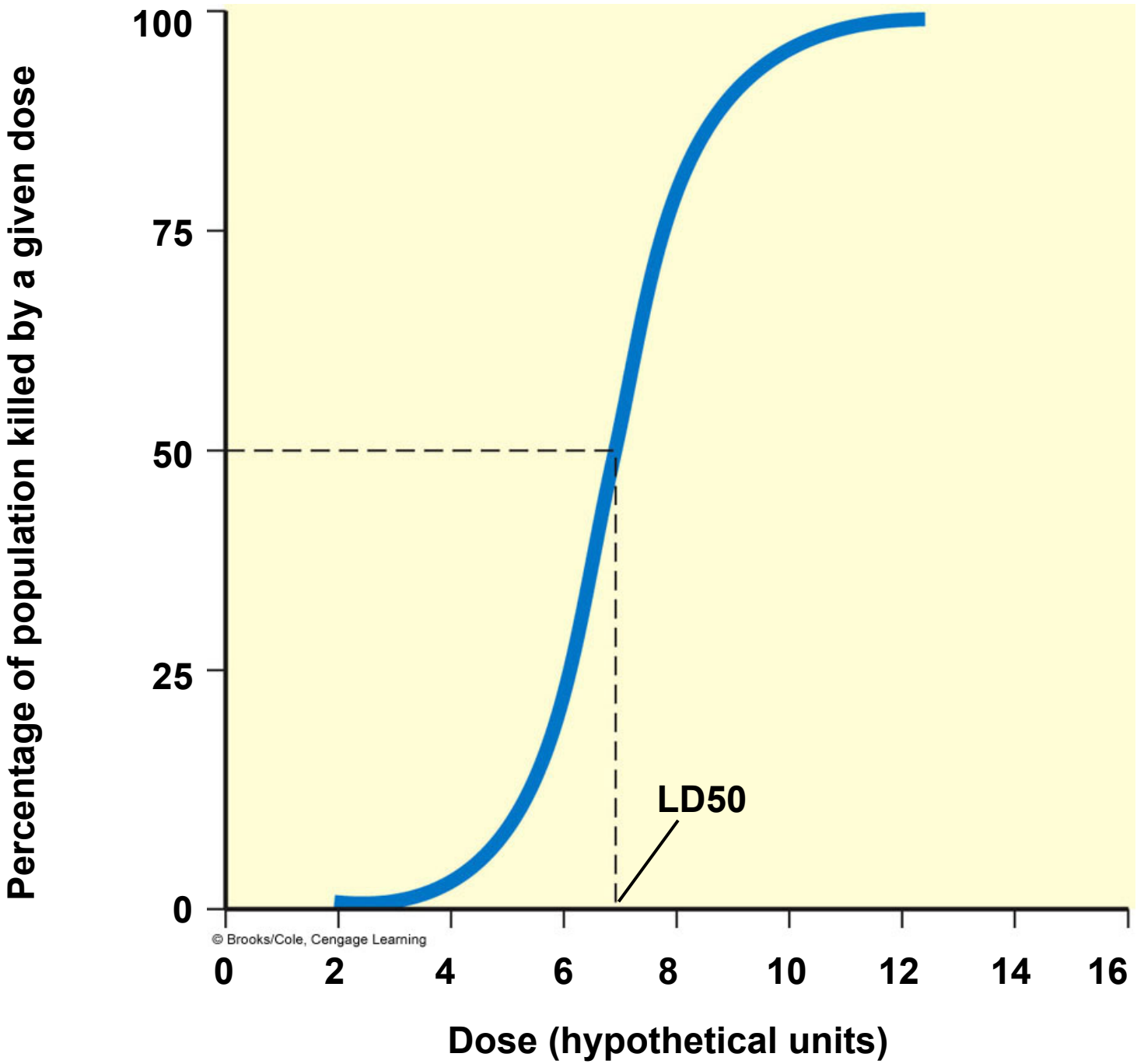


Fig. 17-14, p. 455

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.

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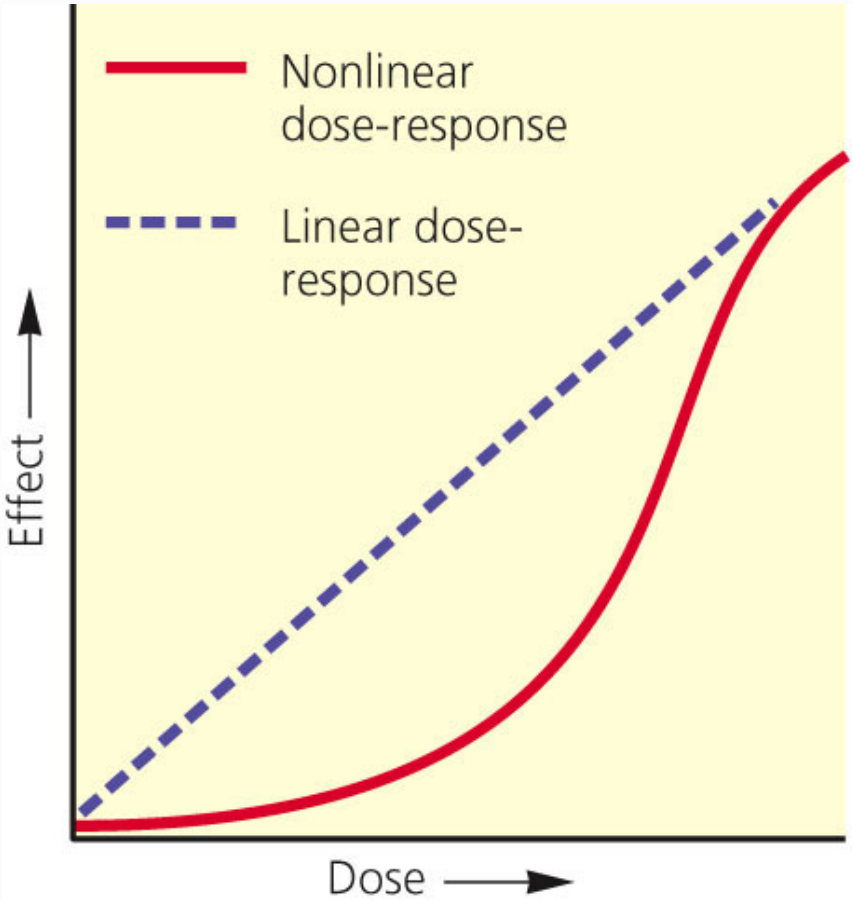
Science: Two Types of Dose-Response Curves



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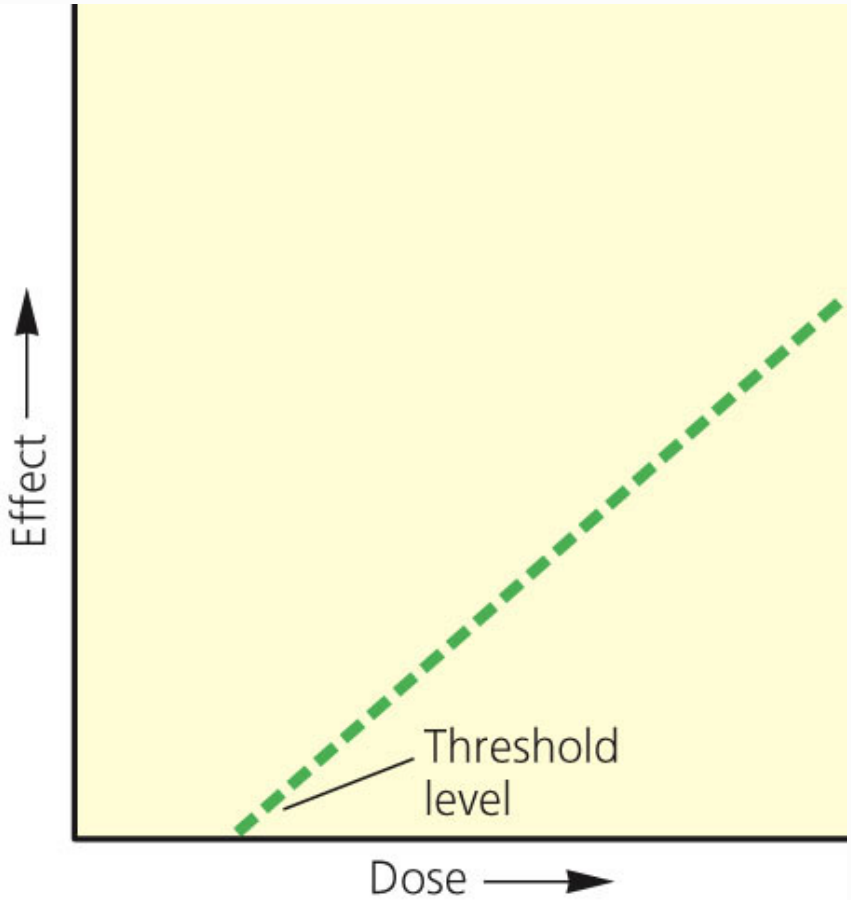

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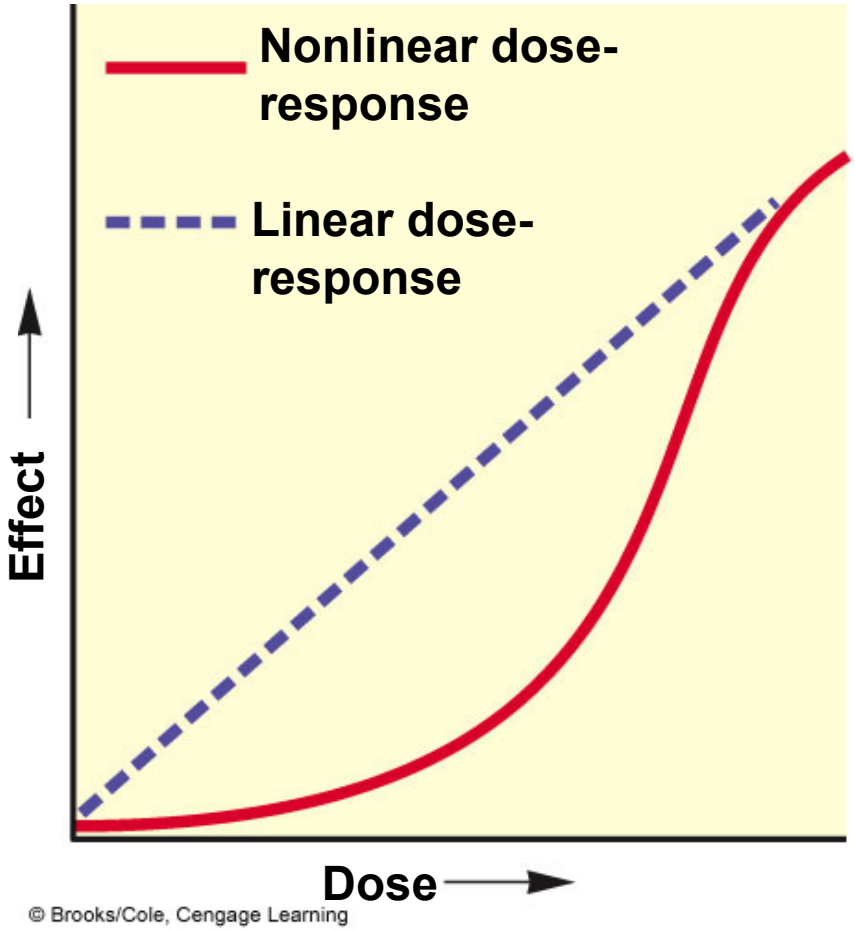

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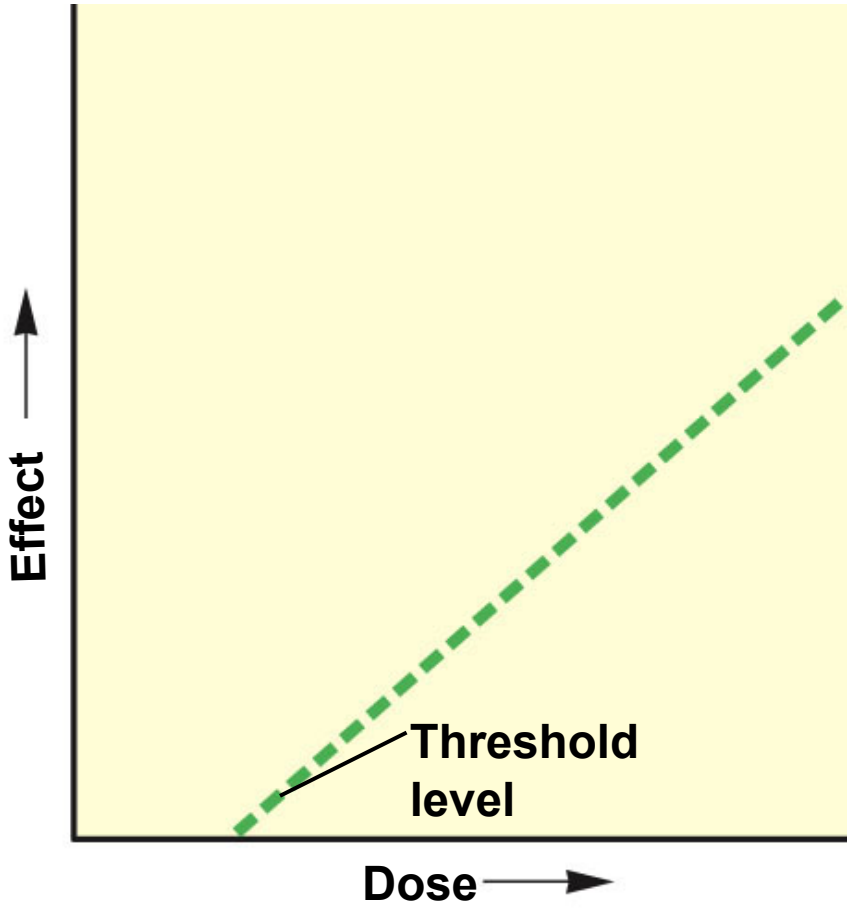


Threshold

Fig. 17-15, p. 456

There Are Other Ways to Estimate the Harmful Effects of Chemicals

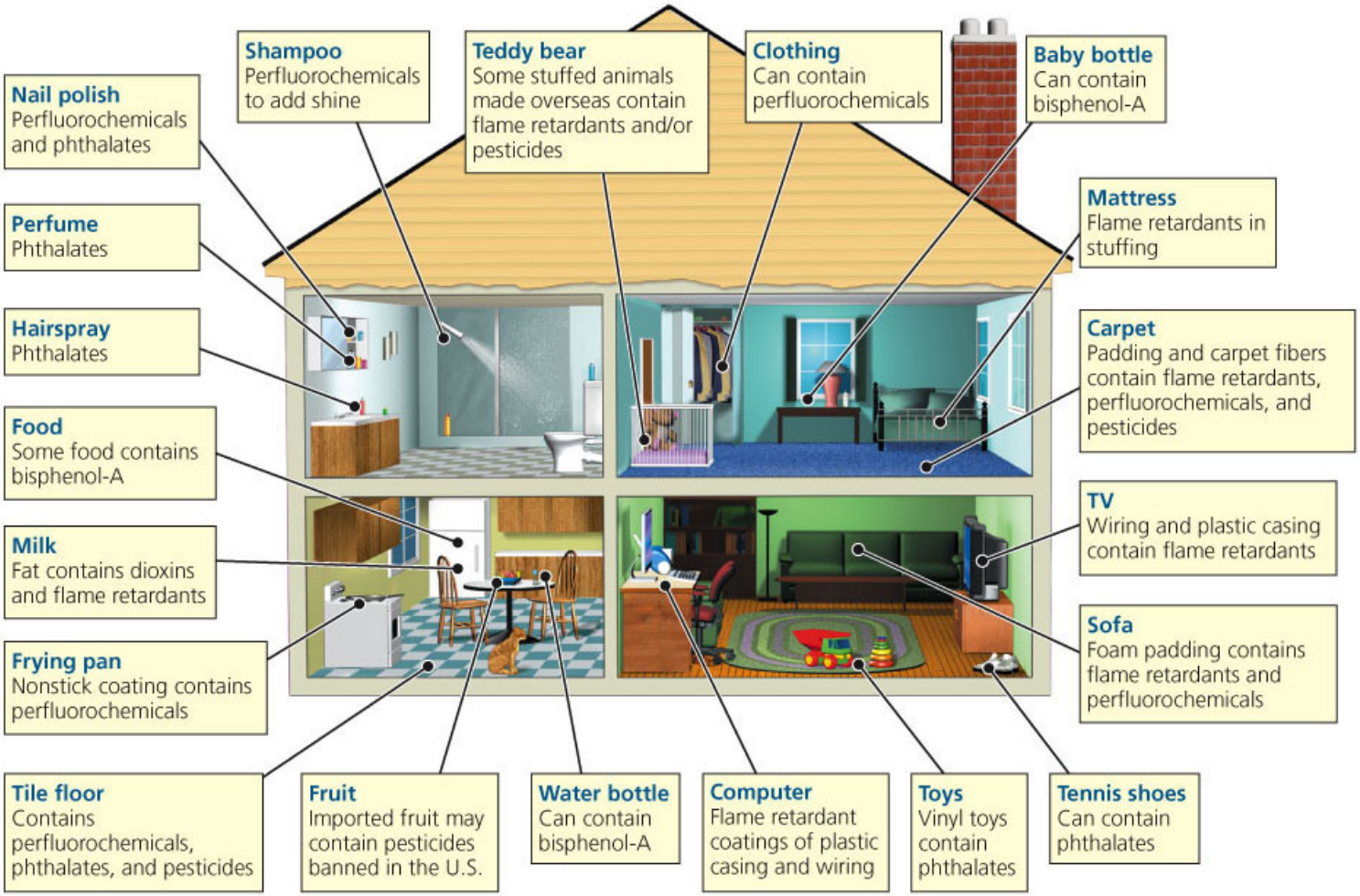
- Case reports and epidemiological studies

- 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?

Some Potentially Harmful Chemicals Found in Most Homes



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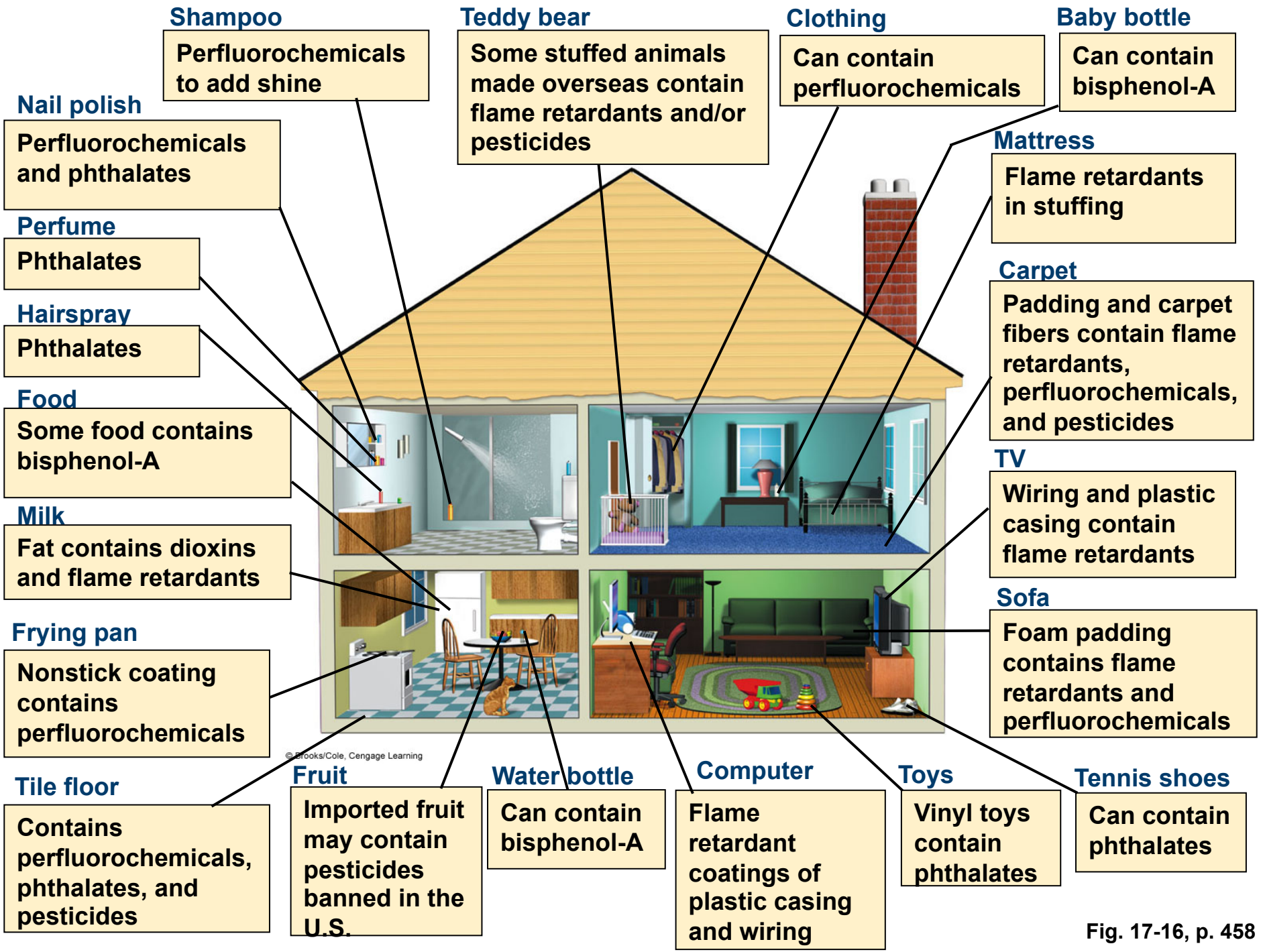

Fig. 17-16, p. 458

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)

Individuals Matter: Ray Turner and His Refrigerator

- 1974: Ozone layer being depleted by chlorofluorocarbons (CFCs)
- 1992: International agreement to phase out CFCs and other ozone-destroying chemicals
- Ray Turner: citrus-based solvents to clean circuit boards

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
  - Poverty
  - Gender
  - Lifestyle choices

Comparative Risk Analysis: Most Serious Ecological and Health Problems

COMPARATIVE RISK ANALYSIS

Most Serious Ecological and Health Problems

High-Risk Health Problems
- Indoor air pollution
- Outdoor air pollution
- Worker exposure to industrial or farm chemicals
- Pollutants in drinking water
- Pesticide residues on food
- Toxic chemicals in consumer products

High-Risk Ecological Problems
- Global climate change
- Stratospheric ozone depletion
- Wildlife habitat alteration and destruction
- Species extinction and loss of biodiversity

Medium-Risk Ecological Problems
- Acid deposition
- Pesticides
- Airborne toxic chemicals
- Toxic chemicals, nutrients, and sediment in surface waters

Low-Risk Ecological Problems
- Oil spills
- Groundwater pollution
- Radioactive isotopes
- Acid runoff to surface waters
- Thermal pollution

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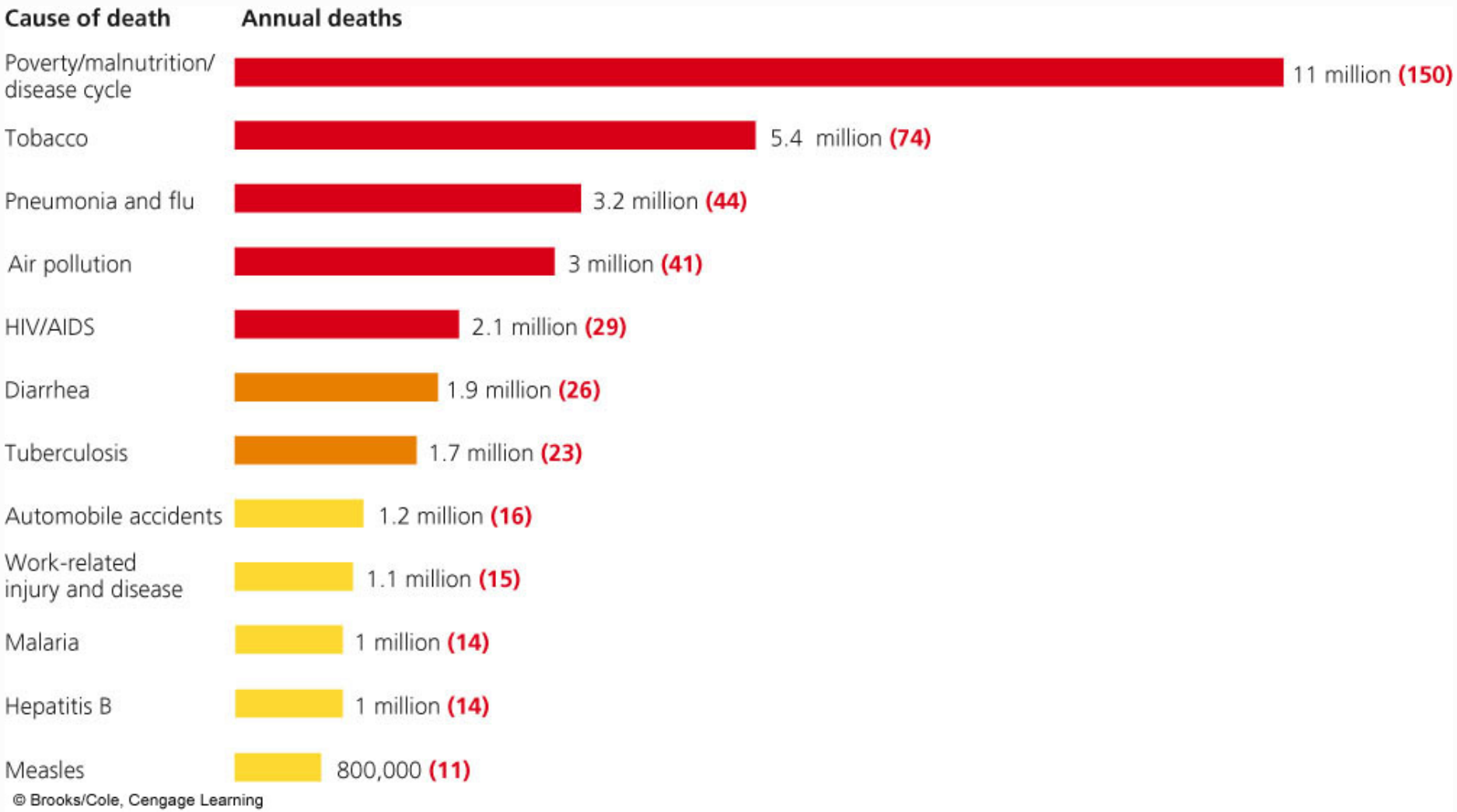
COMPARATIVE RISK ANALYSIS

Most Serious Ecological and Health Problems

Stepped Art

Fig. 17-17, p. 461

Global Outlook: Number of Deaths per Year in the World from Various Causes



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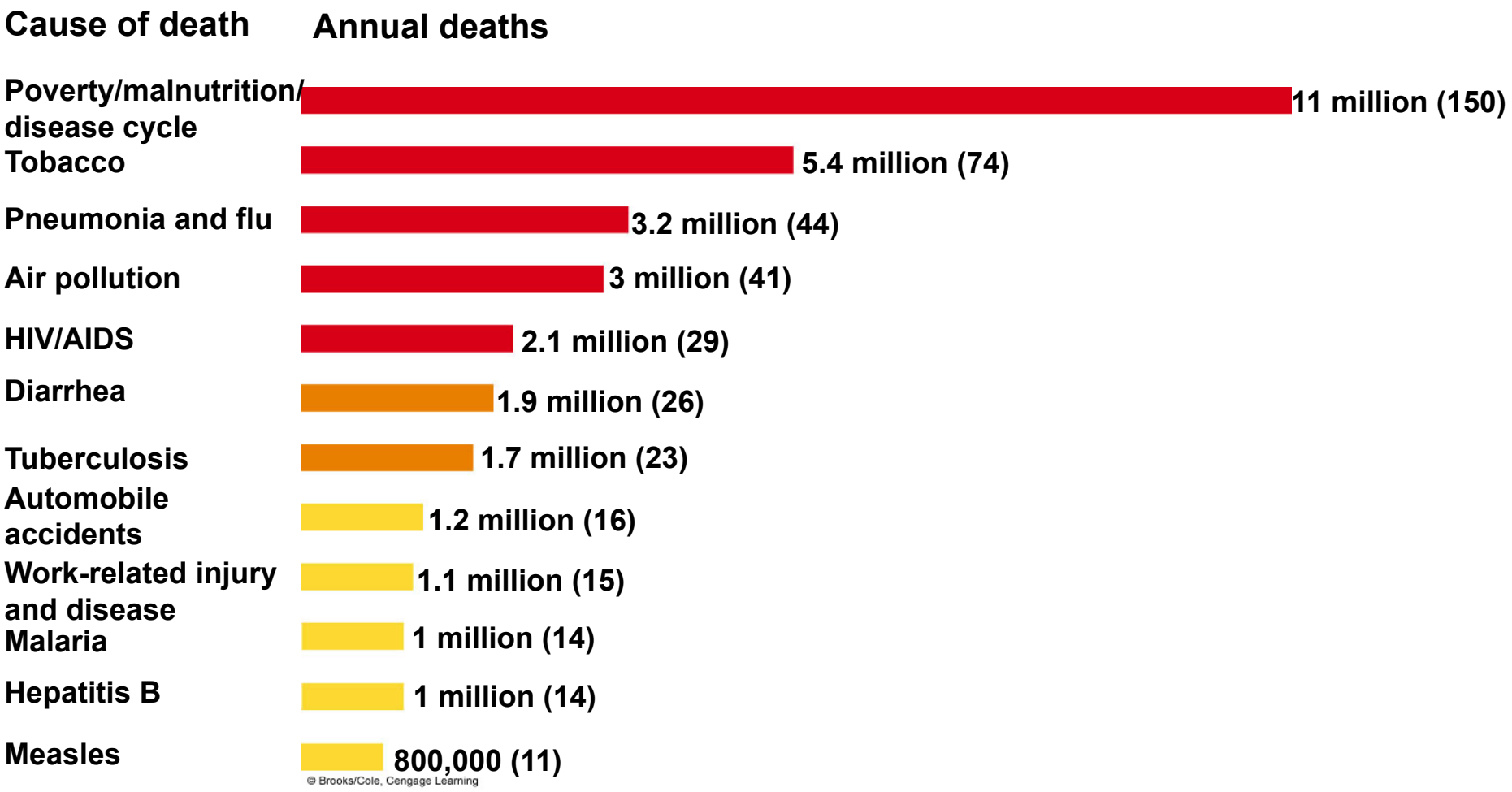
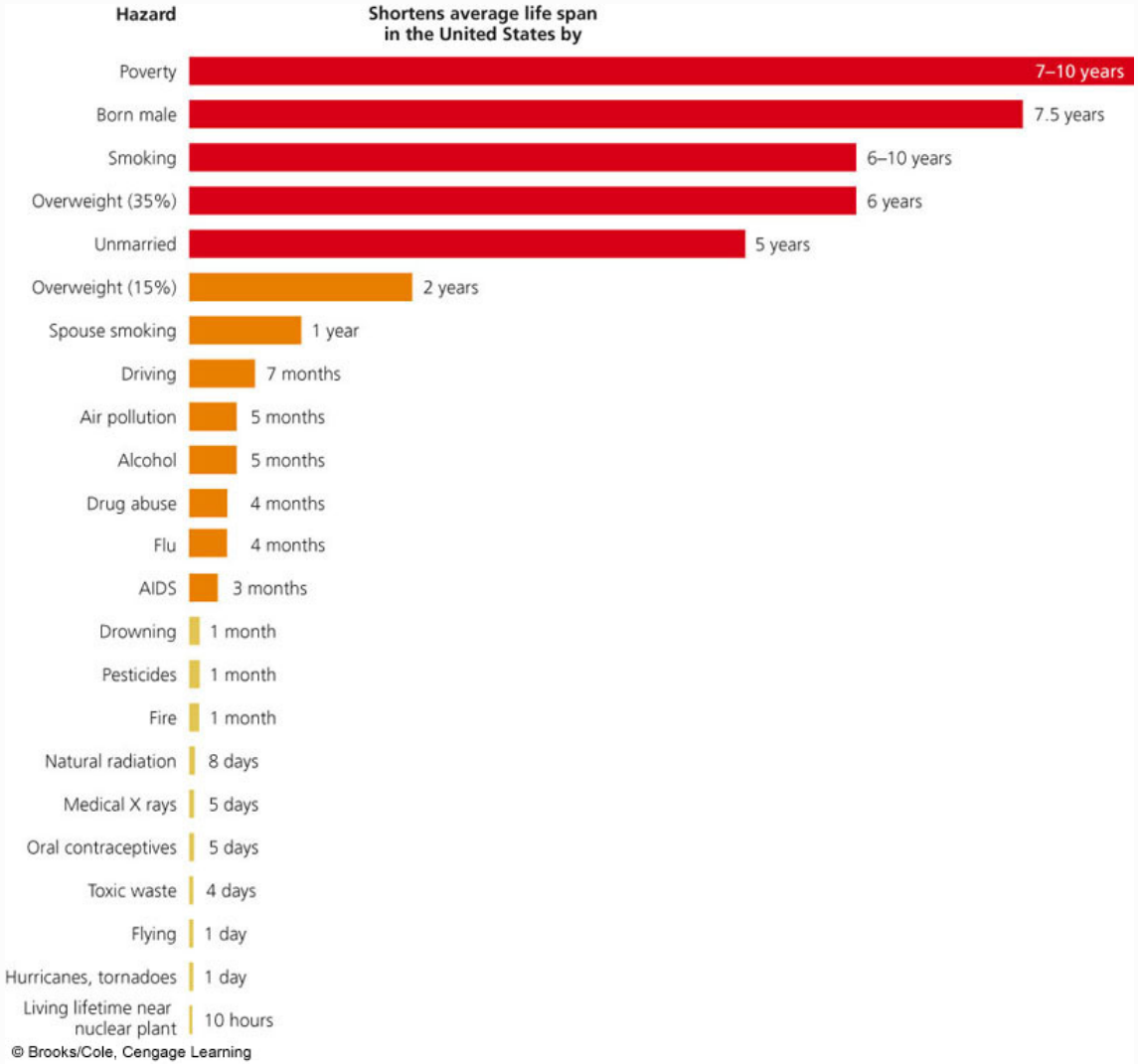


Fig. 17-18, p. 461

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



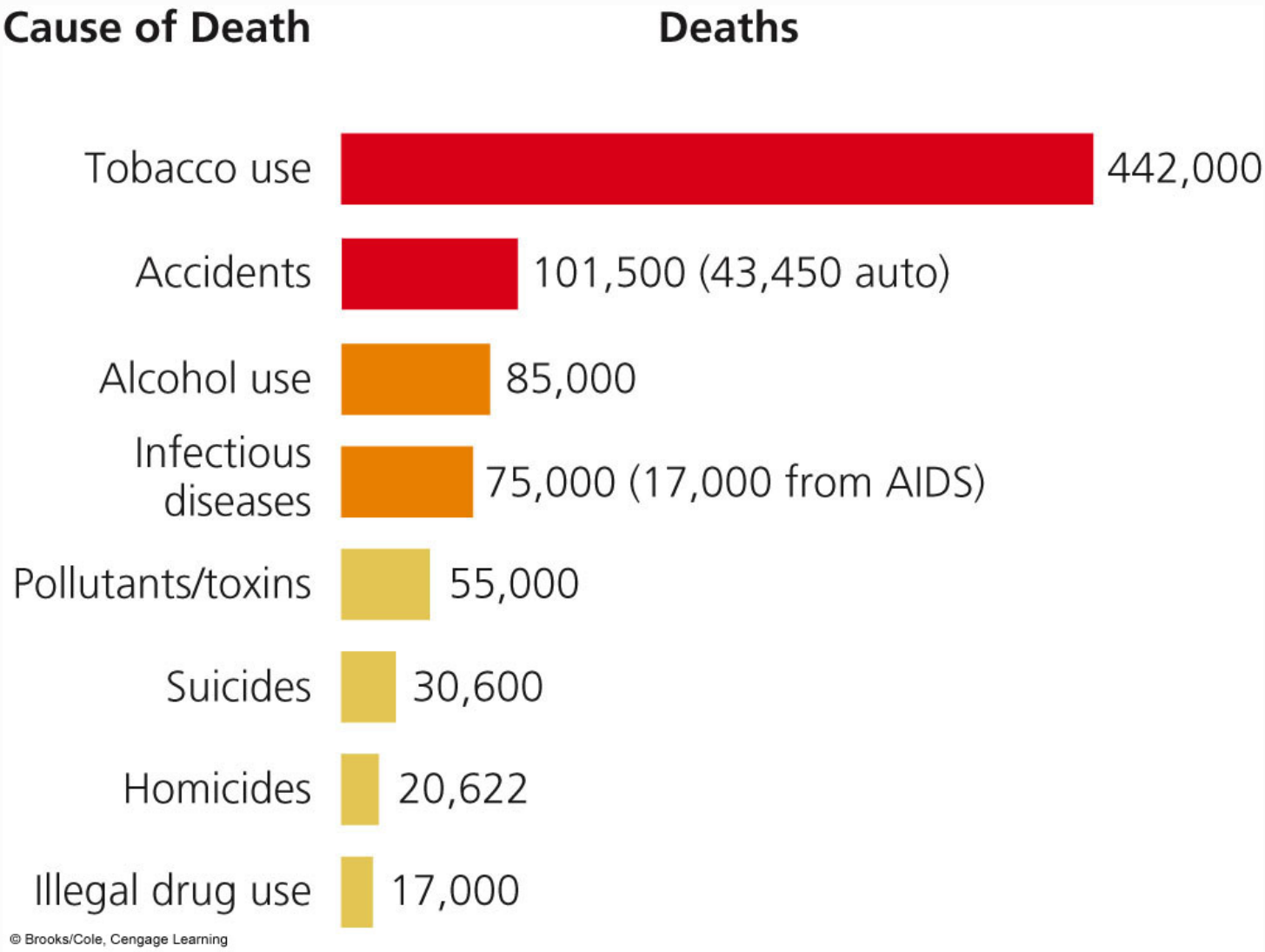
Case Study: Death from Smoking (1)

- Most preventable major cause of suffering and premature death
- Nicotine: additive
- Effects of **passive smoking** (secondhand smoke)

Case Study: Death from Smoking (2)

- How to reduce smoking
  - Taxes
  - Ban
  - Classify and regulate nicotine
  - Education

Annual Deaths in the U.S. from Tobacco Use and Other Causes in 2004



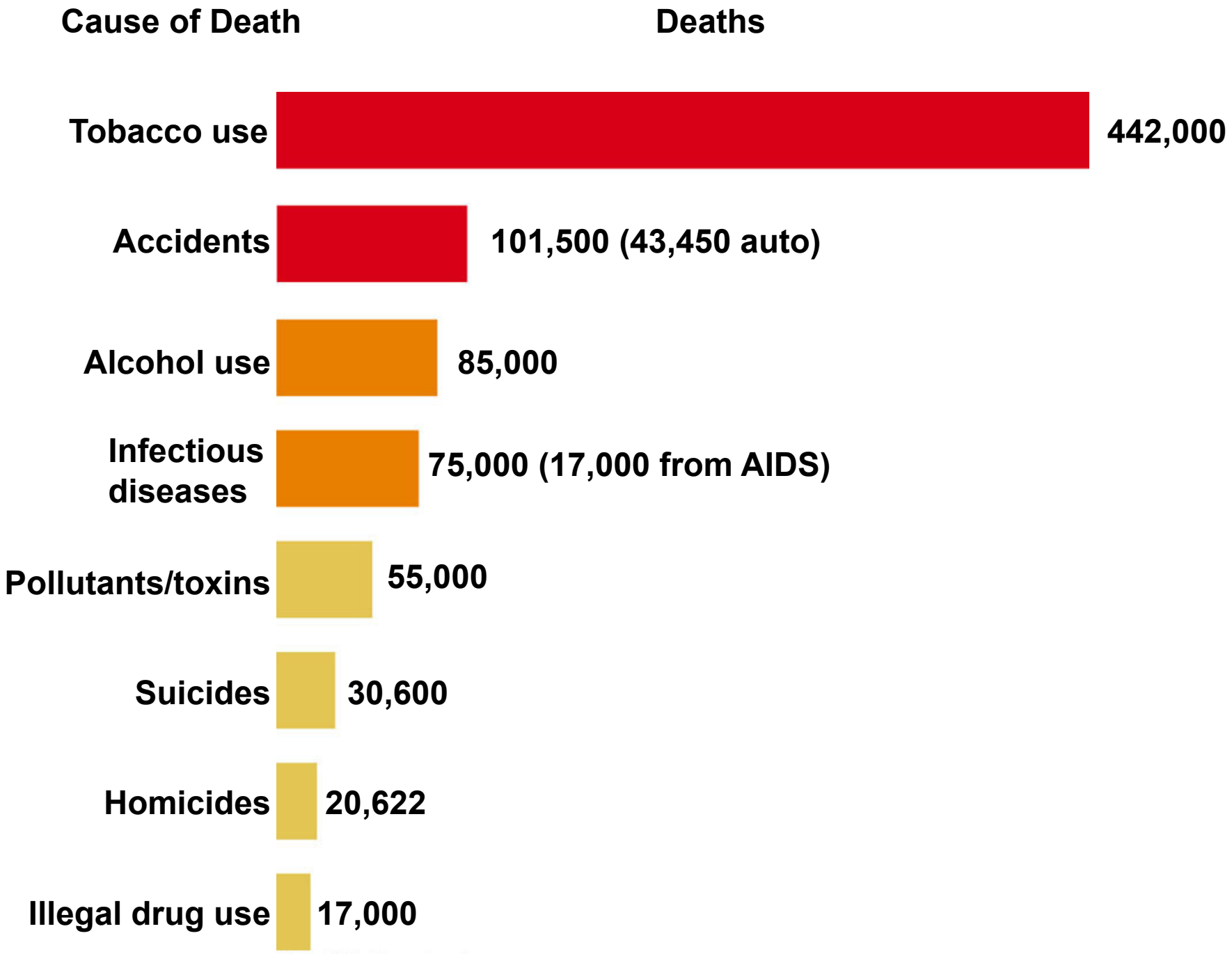


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Fig. 17-20, p. 463

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