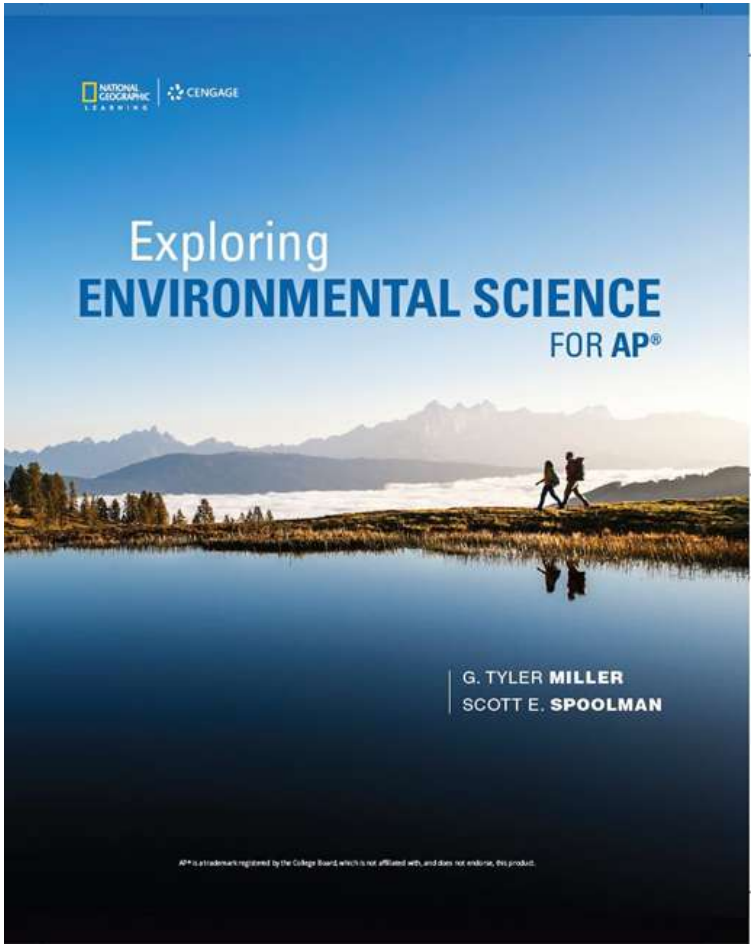
Exploring Environmental Science for AP®

1st Edition



Chapter 16
Environmental Hazards and Human Health

Core Case Study: Mercury's Toxic Effects (1 of 2)

- All mercury compounds are toxic
- One third in the atmosphere comes from natural sources
  - Human activities provide the rest
- Two main human exposures
  - Fish contaminated with mercury
  - Inhalation of vaporized mercury
- Can cause birth defects and brain damage

Core Case Study: Mercury's Toxic Effects (2 of 2)

Drake Fleege/Alamy Stock Photo

16.1 What Major Health Hazards Do We Face?

- Major types of hazards that threaten human health
  - Biological hazards
  - Chemical hazards
  - Natural hazards
  - Cultural hazards
  - Lifestyle choices

We Face Many Types of Hazards (1 of 5)

- Risk
  - Probability of suffering harm from a hazard
  - Expressed as ratio or percentage
- Risk assessment
  - Using statistical methods to estimate harm
- Risk management
  - Deciding whether and how to reduce a particular risk

We Face Many Types of Hazards (2 of 5)

- Risk assessment
  - Hazard identification
    - What is the hazard?
  - Probability of risk
    - How likely is the event?
  - Consequences of risk
    - What is the likely damage?

We Face Many Types of Hazards (3 of 5)

- 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?

We Face Many Types of Hazards (4 of 5)

- Biological hazards
  - Pathogen
    - Organism that causes disease in other organisms
- Chemical
  - Harmful chemicals in the air, water, soil, and food
- Natural
  - Fire, earthquakes, volcanic eruptions, floods, tornados, and hurricanes

We Face Many Types of Hazards (5 of 5)

- Cultural hazards
  - Unsafe working conditions, criminal assault, and poverty
- Lifestyle choices
  - Smoking, making poor food choices, and having unsafe sex

16.2 How Do Biological Hazards Threaten Human Health?

- The most serious biological hazards we face are infectious diseases
  - Examples: flu, acquired immune deficiency syndrome (AIDS), tuberculosis, diarrheal diseases, and malaria

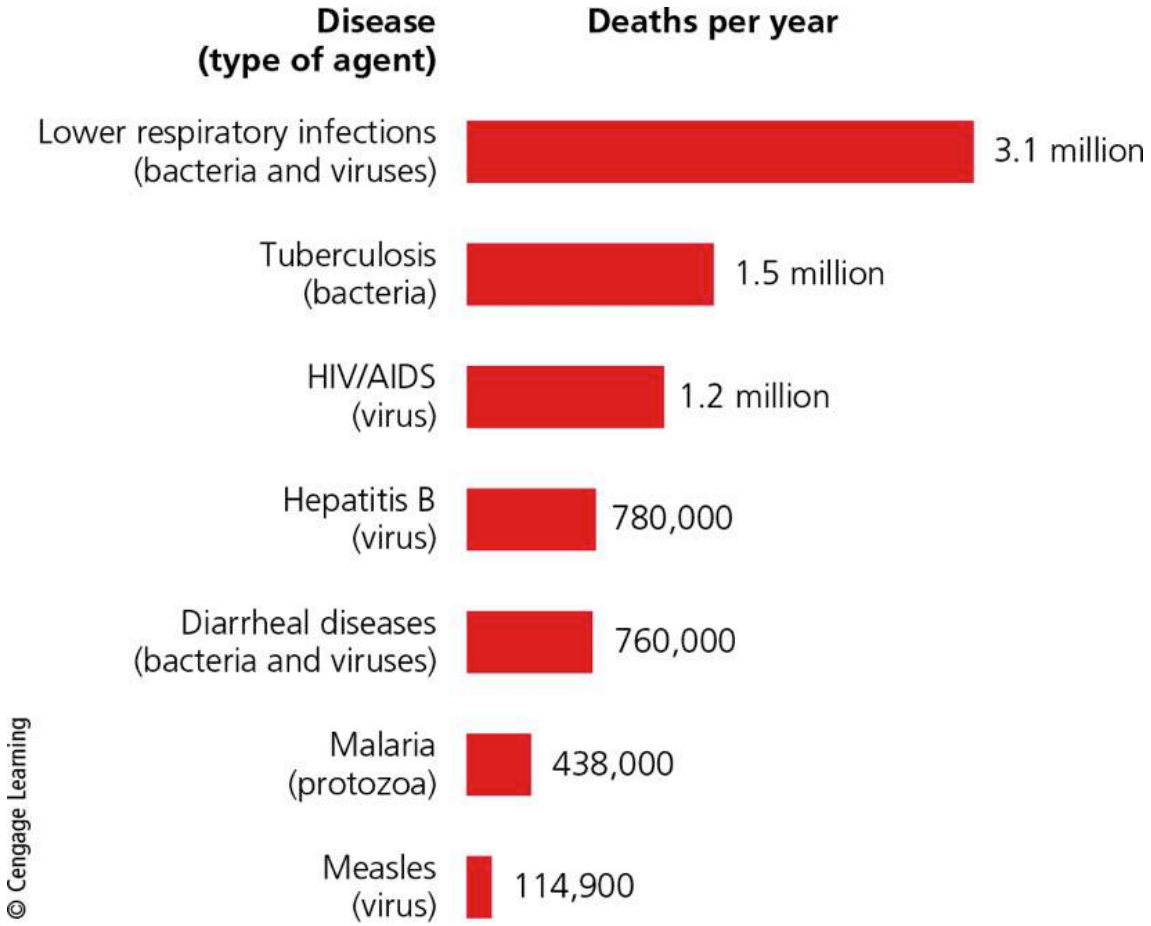
Some Diseases Can Spread from Person to Person (1 of 4)

- Infectious disease
  - Pathogen invades the body and multiplies
  - Viruses, bacteria, and parasites
- Transmissible disease
  - Contagious or communicable disease
  - Infectious disease transmitted between people
  - Examples: the common cold, tuberculosis, and gonorrhea

Some Diseases Can Spread from Person to Person (2 of 4)

- Nontransmissible disease
  - Not caused by living organisms
  - Examples: cardiovascular diseases, most cancers, asthma, and diabetes
- Epidemic
  - Large-scale outbreak of an infectious disease
  - Pandemic: global epidemic

Some Diseases Can Spread from Person to Person (3 of 4)



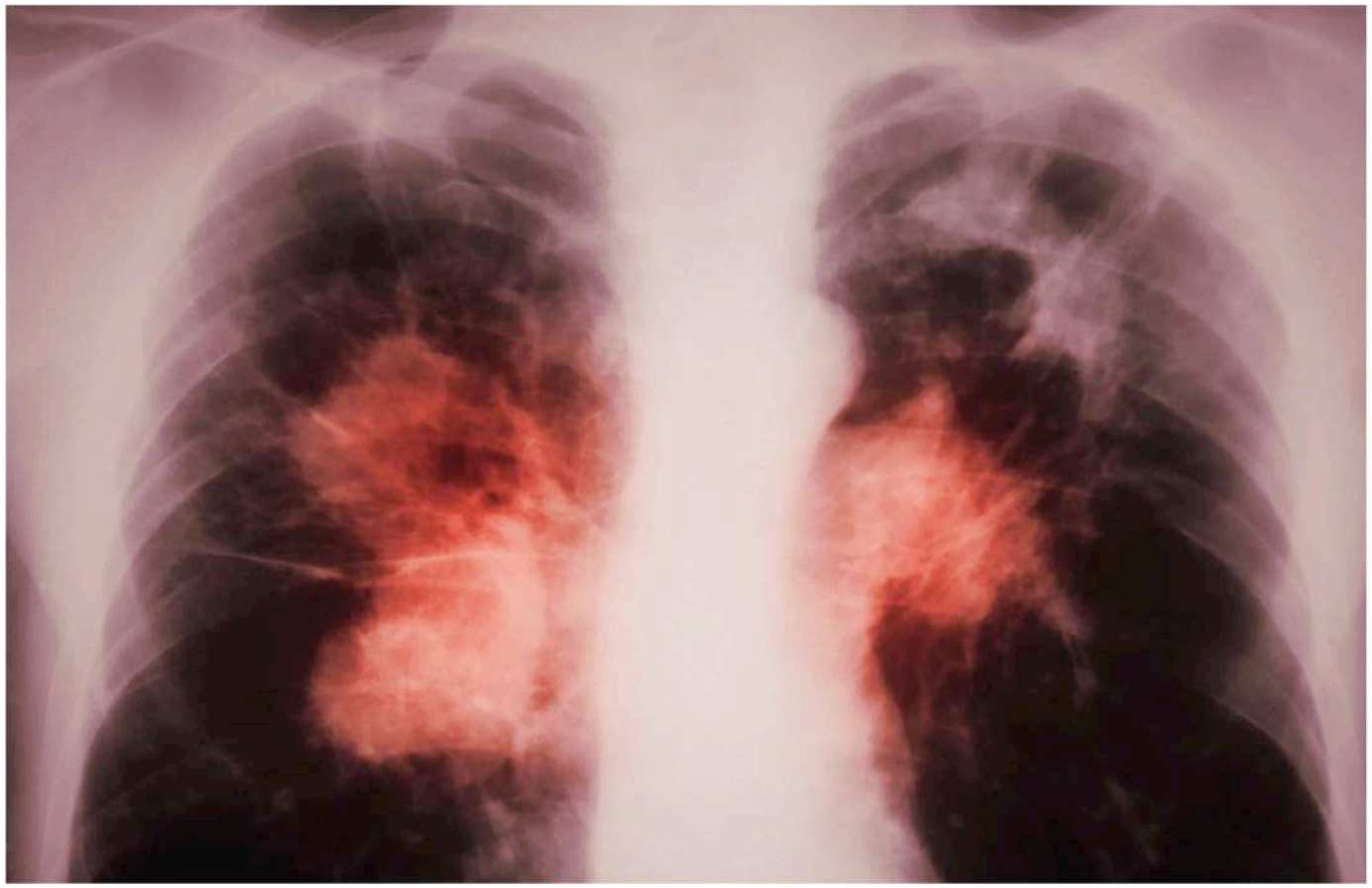
Some Diseases Can Spread from Person to Person (4 of 4)

- Infectious disease was the leading cause of death in the world in 1900
  - Incidence of infectious disease has dropped significantly since then
  - Still a problem, especially in less-developed countries
- Many disease-carrying bacteria have developed genetic immunity to widely used antibiotics
- Climate change allows disease vectors to increase their range

Case Study: The Global Threat from Tuberculosis (1 of 2)

- Tuberculosis (TB)
  - Highly contagious bacterial infection of the lungs
  - Spreading since 1990
- Why is tuberculosis on the rise?
  - Lack of screening and control programs
  - Genetic resistance to majority of effective antibiotics
  - Person-to-person contact has increased
  - Population growth, air travel, urbanization

Case Study: The Global Threat from Tuberculosis (2 of 2)



Michael Abbey/Visuals Unlimited/Corbis

Critical Concept: World Agencies

- United Nations
  - Promotes dialog between countries with goal of world peace
  - International health matters
- World Health Organization
  - Improvement of human health by monitoring and assessing health trends
- World Bank
  - Provides technical and financial assistance to developing countries

Viral Diseases and Parasites Are Killers (1 of 2)

- Influenza or flu virus
  - Kills the most worldwide
- Human immunodeficiency virus (HIV)
  - Infects about two million people yearly
- Hepatitis B virus (HBV)
- Ebola
- West Nile virus
- Zika virus

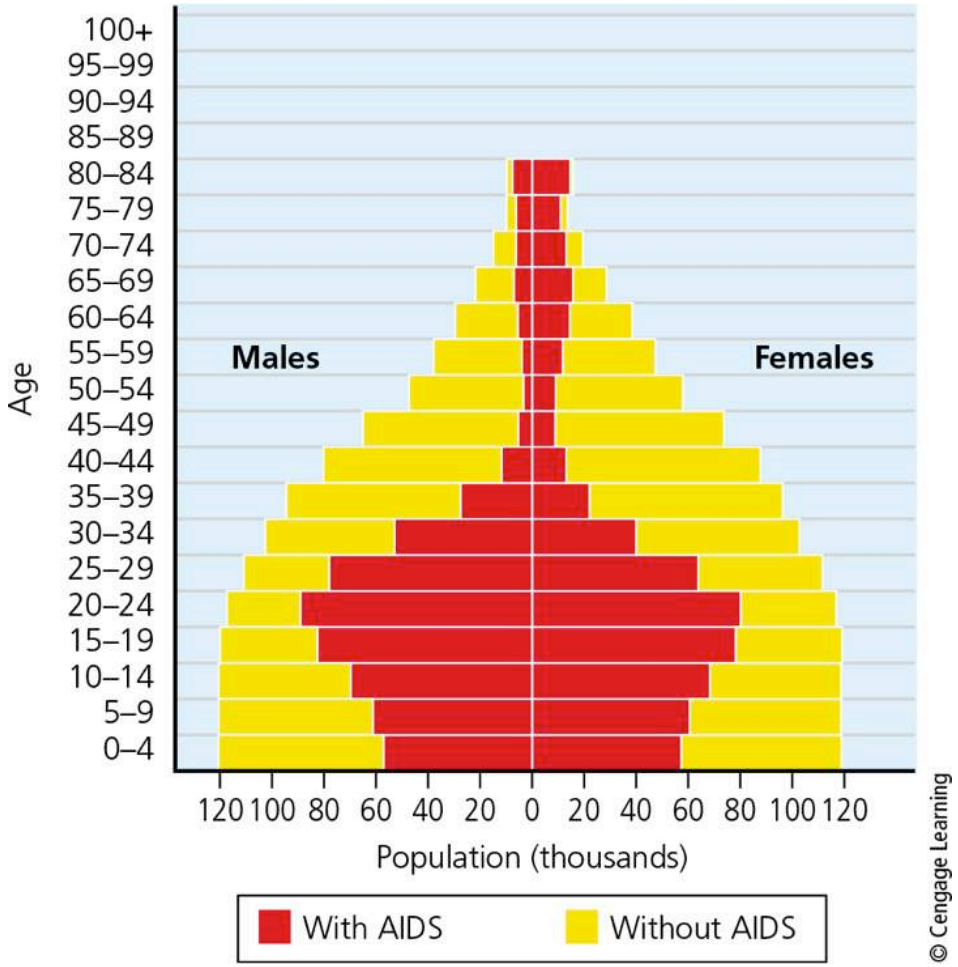
Viral Diseases and Parasites Are Killers (2 of 2)

- Viruses that move from animals to humans
  - New field: ecological medicine
- Good hygiene can reduce chances of infection
  - Wash your hands
  - Do not share razors or towels
  - Cover cuts and scrapes until healed
  - Avoid contact with people with viral diseases
  - Do not touch your eyes, nose, and mouth

Case Study: The Global HIV/AIDS Epidemic (1 of 2)

- AIDS
  - Caused by HIV
  - Leaves the body vulnerable to infections
  - Leading cause of death for people ages 15–49 worldwide
- No vaccine to prevent or cure AIDS
- Costly drugs can slow viral progress

Case Study: The Global HIV/AIDS Epidemic (2 of 2)



Case Study: Malaria–The Spread of a Deadly Parasite (1 of 3)

- Malaria
  - Caused by parasite carried by certain mosquitoes
  - Tropical and subtropical regions
  - Spread
    - Uninfected mosquito bites infected person, later bites an uninfected person
- Climate change–expected to spread malaria to warming temperate areas

Case Study: Malaria–The Spread of a Deadly Parasite (2 of 3)

- Malaria incidence increasing since 1970
  - Drug-resistant *Plasmodium* parasites
  - Insecticide-resistant mosquitoes
- No effective vaccine is available
- Insecticide-treated bed nets and window screens
  - Have saved 6.2 million lives between 2000 and 2014

Case Study: Malaria–The Spread of a Deadly Parasite (3 of 3)

Reducing the Incidence of Infectious Diseases (1 of 2)

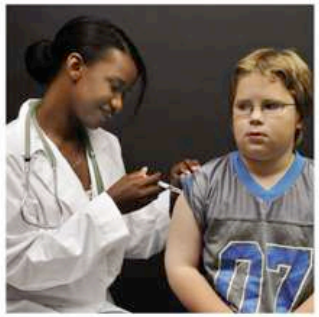
- Percentage of worldwide deaths from infectious diseases
  - Dropped from 35% to 16% from 1970 to 2015
  - More children being immunized
- Average annual deaths from infectious disease in children under age five:
  - Reduced from 12 million to 4.9 million between 1990 and 2015

Reducing the Incidence of Infectious Diseases (2 of 2)

Solutions

Infectious Diseases

- Increase research on tropical diseases and vaccines
- Reduce poverty and malnutrition
- Improve drinking water quality
- Reduce unnecessary use of antibiotics
- Sharply reduce use of antibiotics on livestock
- Immunize children against major viral diseases
- Provide oral rehydration for diarrhea victims
- Conduct global campaign to reduce HIV/AIDS



16.3 How Do Chemical Hazards Threaten Human Health?

- Certain chemicals in the environment:
  - Can cause cancers and birth defects
  - Can disrupt the human immune, nervous, and endocrine systems

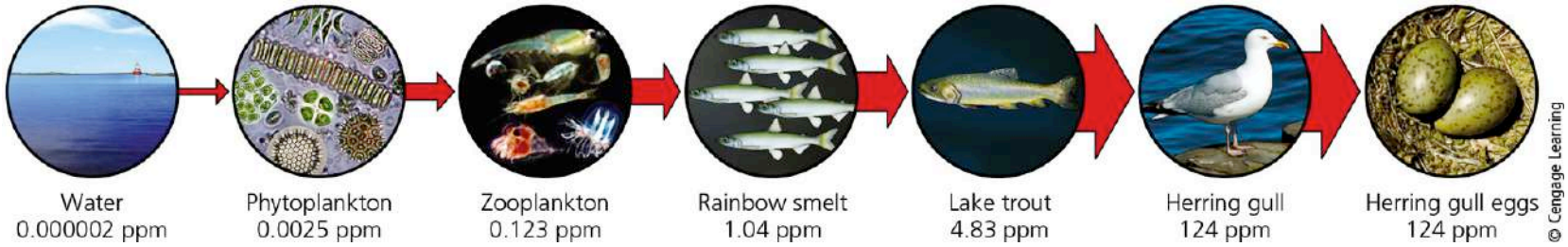
Some Chemicals Can Cause Cancers, Mutations, and Birth Defects

- Toxic chemicals
  - Carcinogens
    - Chemicals, types of radiation, or certain viruses that cause or promote cancer
  - Mutagens
    - Chemicals or radiation that cause mutations or increase their frequency
  - Teratogens
    - Chemicals that cause harm or birth defects to a fetus or embryo

Case Study: PCBs Are Everywhere–A Legacy from the Past (1 of 2)

- Class of chlorine-containing compounds
  - Very stable
  - Nonflammable
  - Break down slowly in the environment
  - Travel long distances in the air
  - Fat soluble
  - Biologically magnified in food chains and food webs
- Now banned, but found everywhere

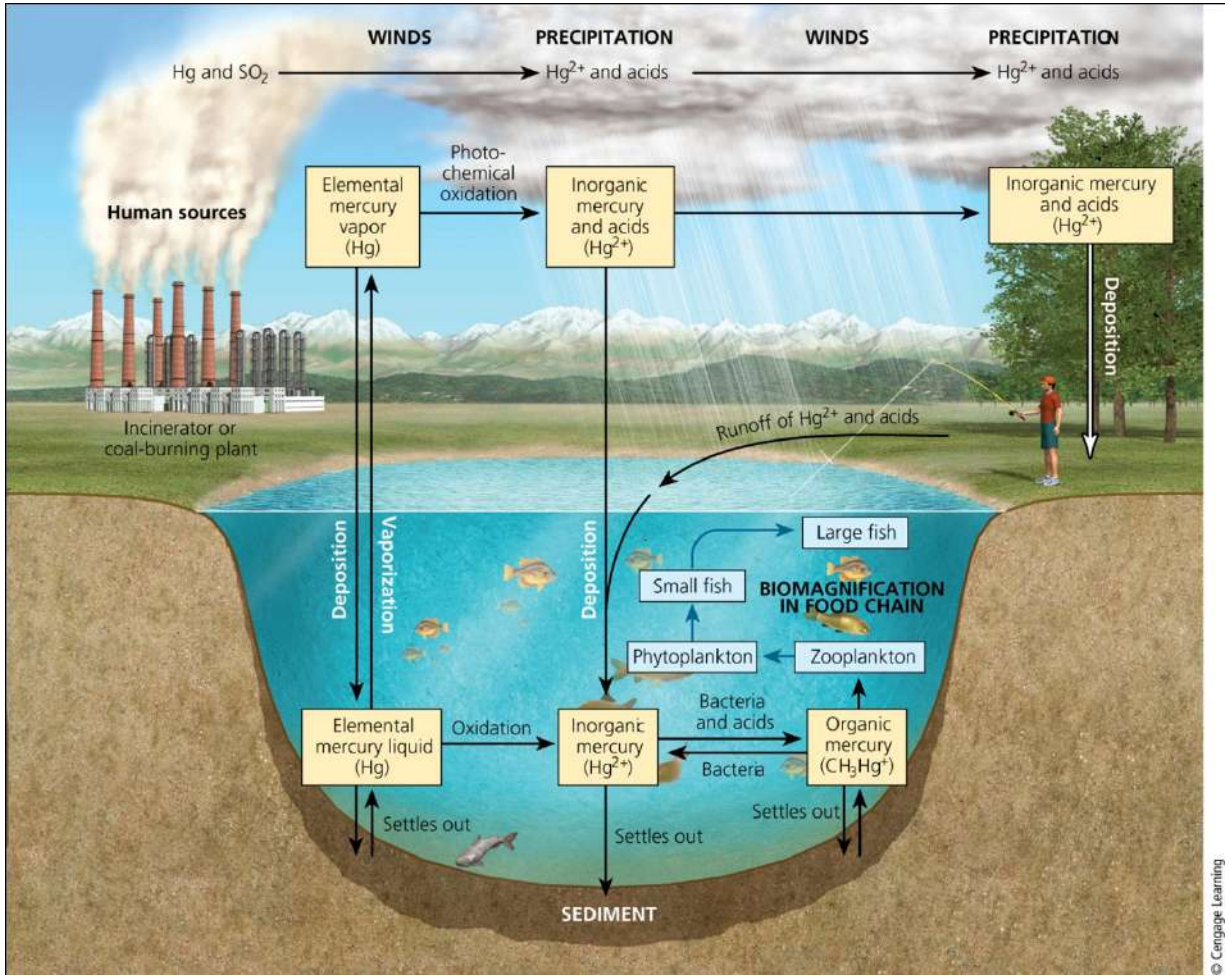
Case Study: PCBs Are Everywhere–A Legacy from the Past (2 of 2)



Some Chemicals Can Affect Our Immune and Nervous Systems (1 of 2)

- Immune system
  - Protects human body against disease
  - Arsenic, methylmercury, and dioxins can weaken
- Neurotoxins can harm human nervous system
  - Examples: PCBs, arsenic, lead, and certain pesticides
  - Methylmercury especially dangerous

Some Chemicals Can Affect Our Immune and Nervous Systems (2 of 2)



Some Chemicals Affect the Endocrine System (1 of 5)

- Endocrine system
  - Glands that release hormones that regulate bodily systems
    - Control sexual reproduction, growth, development, learning ability, and behavior
- Hormonally active agents (HAA)
  - Also called endocrine disruptors
  - Have similar shapes and bind to hormone receptors

Some Chemicals Affect the Endocrine System (2 of 5)

- Hormone mimics
  - Bisphenol A (BPA) mimics estrogen
- Hormone blockers
- Thyroid disruptors
  - Perfluorinated chemicals (PFOAs) used to make nonstick cookware linked to thyroid disease, cancer, and birth defects
  - Polybrominated diphenyl ethers (PBDEs)
    - In fabrics, furniture, mattresses, and plastics

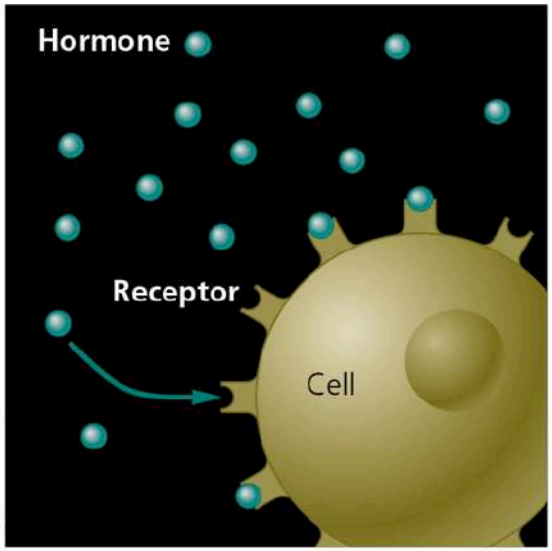
Some Chemicals Affect the Endocrine System (3 of 5)

Solutions

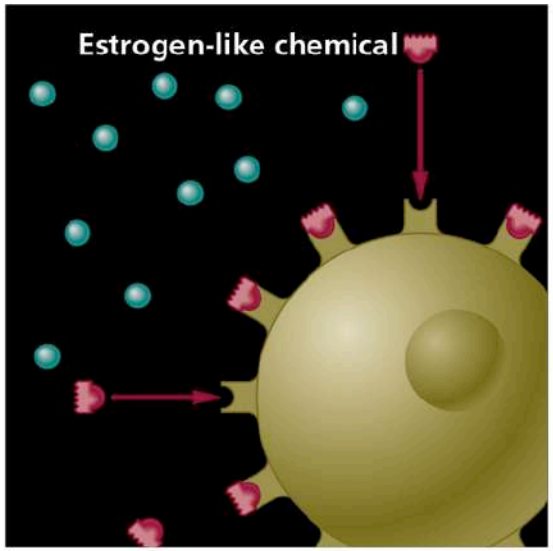
Mercury Pollution

Prevention		Control
Phase out waste incineration		Sharply reduce mercury emissions from coal-burning plants and incinerators
Remove mercury from coal before it is burned		Label all products containing mercury
Switch from coal to natural gas and renewable energy resources		Collect and recycle batteries and other products containing mercury

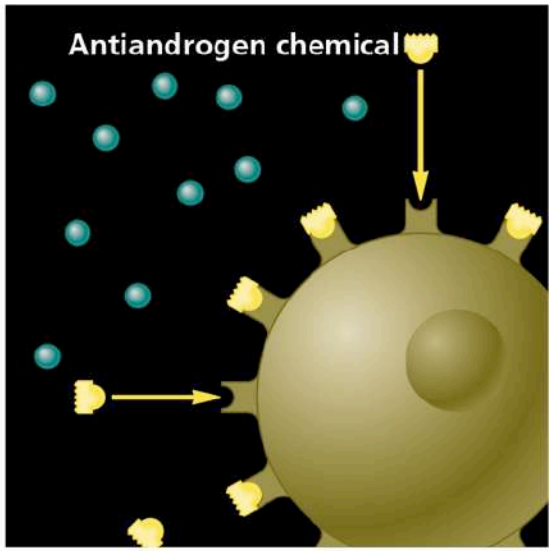
Some Chemicals Affect the Endocrine System (4 of 5)



Normal Hormone Process



Hormone Mimic



Hormone Blocker

Some Chemicals Affect the Endocrine System (5 of 5)

What Can You Do?

Exposure to Hormone Disrupters

- Eat certified organic produce and meats
- Avoid processed, prepackaged, and canned foods
- Use glass and ceramic cookware
- Store food and drinks in glass containers
- Use only natural cleaning and personal care products
- Use natural fabric shower curtains, not vinyl
- Avoid artificial air fresheners, fabric softeners, and dryer sheets
- Use only glass baby bottles and BPA-free, phthalate-free sipping cups, pacifiers, and toys

16.4 How Can We Evaluate Risks from Chemical Hazards?

- Methods to estimate chemical toxicity
  - Live laboratory animals
  - Case reports of poisonings
  - Epidemiological studies
- Many health scientists call for much greater emphasis on pollution prevention
  - To reduce our exposure to potentially harmful chemicals

Many Factors Determine the Toxicity of Chemicals (1 of 2)

- Toxicology: study of harmful effects
  - Dose
  - Age
  - Genetic makeup
  - Multiple chemical sensitivity (MCS)
  - Solubility
  - Persistence
  - Biological magnification

Many Factors Determine the Toxicity of Chemicals (2 of 2)

- Synergistic interaction
  - Effect of two or more agents interacting is greater than the sum of the agents
- Response
  - Acute effect–immediate or rapid
  - Chronic effect–permanent or long-lasting

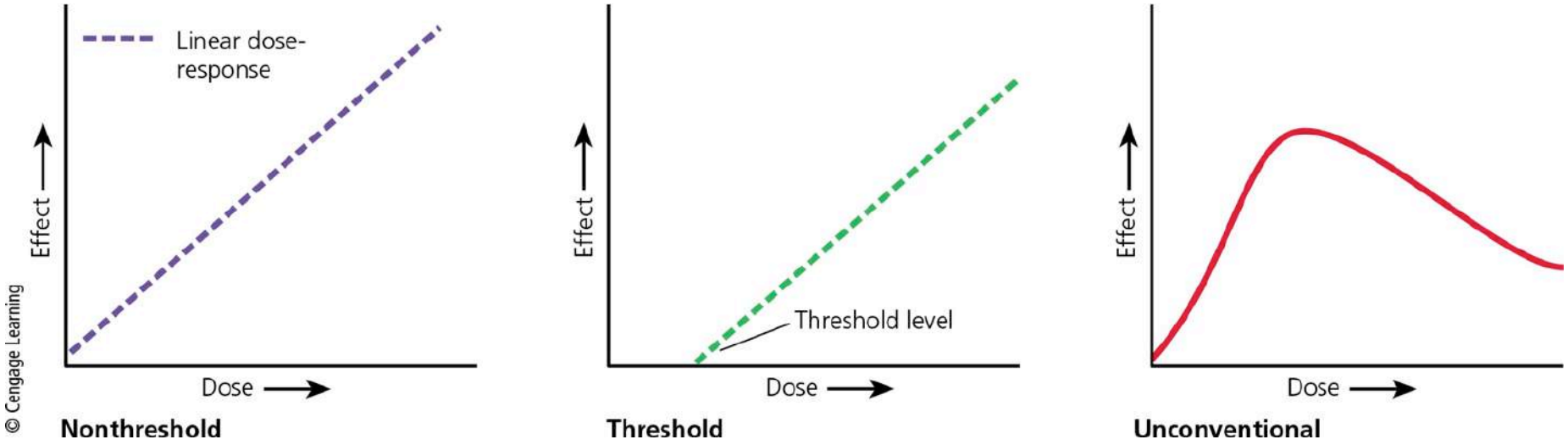
Case Study: Protecting Children from Toxic Chemicals

- Analysis of umbilical cord blood
  - 180 chemicals found that cause cancers in humans or animals
- Infants and children more susceptible
  - Eat, drink, and breathe more air per unit of body weight than adults
  - Exposed to toxins in dust and soil when they put objects in their mouths
  - Less well-developed immune systems

Scientists Use Live Various Tests to Estimate Toxicity (1 of 3)

- Studies usually involve mice and rats
  - Systems similar to human systems
  - Small, and reproduce rapidly
- Dose-response curve–median lethal dose (LD50)
  - Nonthreshold dose-response model
  - Threshold dose-response model

Scientists Use Live Various Tests to Estimate Toxicity (2 of 3)



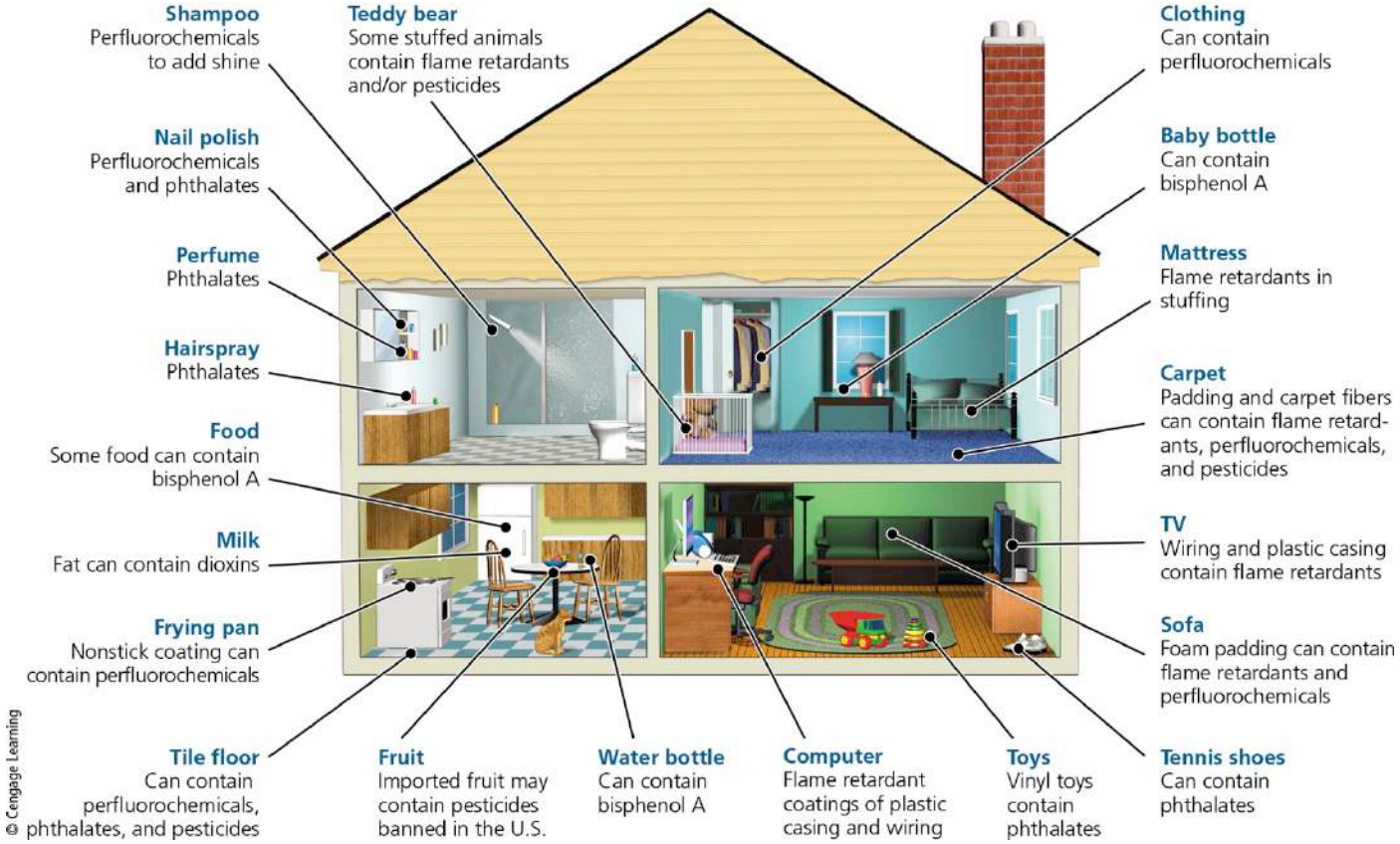
Scientists Use Various Tests to Estimate Toxicity (3 of 3)

- More humane methods than using animals
  - Replace animals with other models
    - Computer simulations
    - Tissue culture and individual animal cells
- Effects of mixtures of potentially toxic chemicals difficult to determine

Are Trace Levels of Toxic Chemicals Harmful? (1 of 2)

- Insufficient data for most chemicals
  - More research needed
- We are all exposed to toxic chemicals
  - Trace amounts

Are Trace Levels of Toxic Chemicals Harmful? (2 of 2)



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

- There are severe limitations in estimating toxicity levels and risks
- Only 10% of over 85,000 registered synthetic chemicals have been thoroughly screened for toxicity
- 99.5% of chemicals used in the United States are not supervised by government

Pollution Prevention and the Precautionary Principle (1 of 2)

- Precautionary principle
  - Those introducing a new chemical or new technology need to follow new strategies
    - A new product is considered harmful until proven safe
    - Existing chemicals and technologies that appear to cause significant harm must be removed
- 2000: international agreement to ban or phase out the dirty dozen persistent organic pollutants (POPs)

Pollution Prevention and the Precautionary Principle (2 of 2)

- 2007: European Union enacted REACH
  - Requires registration of untested substances
  - Most hazardous substances not approved for use if safer alternatives exist
- 2011: EPA issued new pollution prevention standards
  - Mercury emissions from coal-burning plants
- Minamata Convention
  - Goal: reduce global mercury emissions

Case Study: Pollution Prevention Pays

- The 3M Company
  - 1975 to 2015, prevented more than 2 million tons of pollutants from reaching the environment
    - Saved company $1.9 billion
  - Employee reward program for projects that eliminate or reduce a pollutant

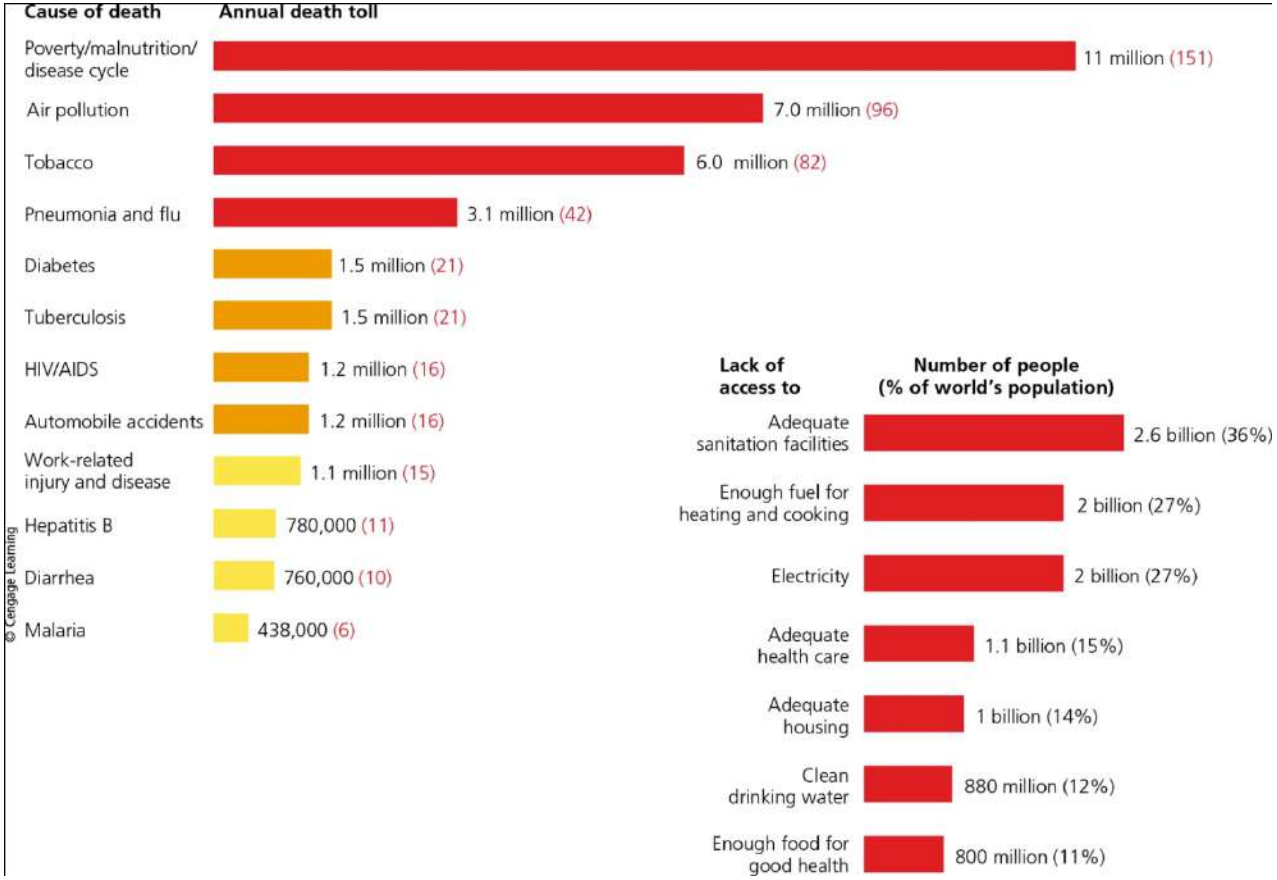
16.5 How Do We Perceive and Avoid Risks?

- Ways to reduce risks
  - Becoming informed
  - Thinking critically about risks
  - Making careful choices

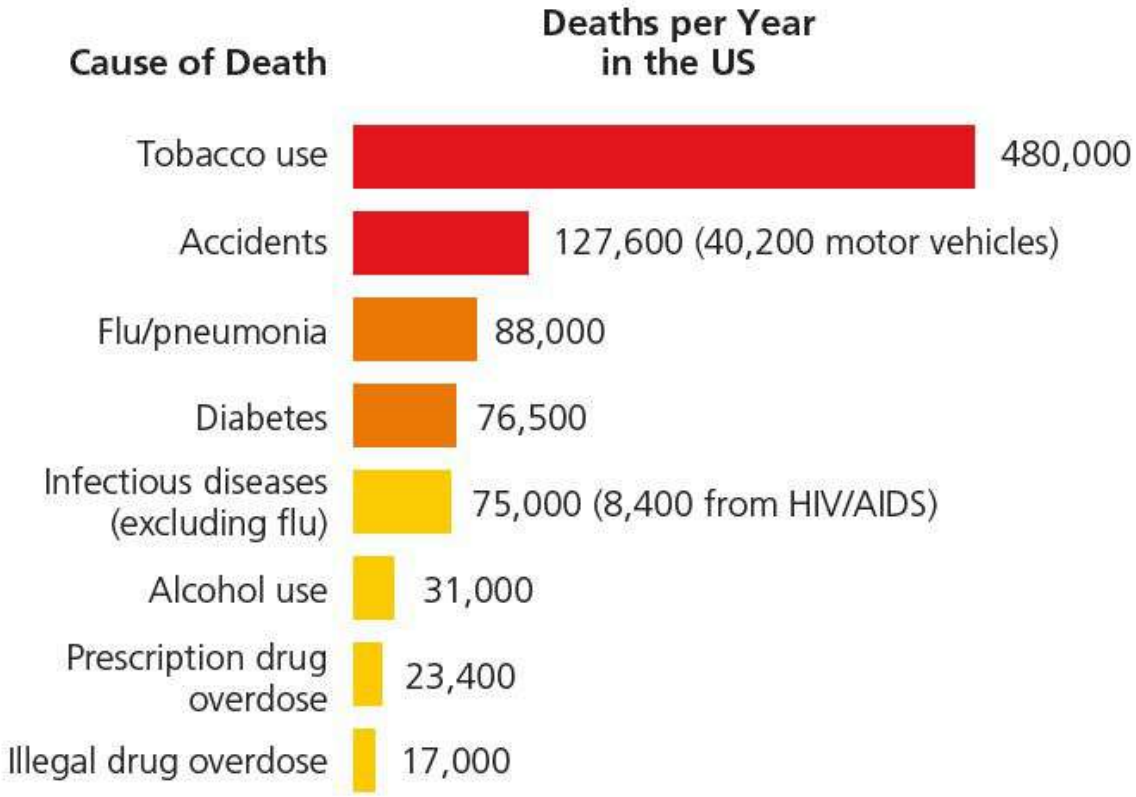
The Greatest Health Risks Come from Poverty, Gender, and Lifestyle Choices (1 of 3)

- Poverty
  - Greatest health risk by far
  - Malnutrition, increased infectious diseases, and unsafe drinking water
- Gender
  - Being born male
- Lifestyle choices
  - Examples: overeating and smoking

The Greatest Health Risks Come from Poverty, Gender, and Lifestyle Choices (2 of 3)



The Greatest Health Risks Come from Poverty, Gender, and Lifestyle Choices (3 of 3)



Leading causes of death in the United States. Some result from lifestyle choices and are preventable.

Case Study: Cigarettes and E-Cigarettes (1 of 2)

- Cigarette smoking
  - Most preventable major cause of suffering and premature death among adults
  - Killed 100 million people during the 20th century
  - Study linked to increased dementia and Alzheimer's disease
- Nicotine: highly additive
- Secondhand smoke poses health hazards

Case Study: Cigarettes and E-Cigarettes (2 of 2)

- Smoking decline in the United States
  - From more than 50% of adults in the 1950s to 18% in 2013
- E-cigarettes
  - Substitute for tobacco cigarettes
  - Vapors contain toxic metals
  - Used by more than 13% of high school students in 2014
  - European Union banned sales to minors

Estimating Risks from Technologies

- Reliability
  - System reliability (%) = Technological reliability (%) x Human reliability (%)
- Human reliability is much lower than technological reliability
  - Much harder to predict

Most People Do a Poor Job of Evaluating Risks

- Factors causing misjudgments in risk
  - Fear
  - Degree of control
  - Whether a risk is catastrophic or chronic
  - Optimism bias
  - Instant gratification

Guidelines for Evaluating and Reducing Risk

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