

Chapter 17

Environmental Hazards and Human Health

Are Baby Bottles and Food Cans Safe To Use?

The BPA Controversy

- Some synthetic chemicals act as hormone mimics and disrupt the human endocrine system
- Excess estrogen effects on males: Feminization, Lower sperm counts, Presence of both male and female sex organs
- BPA (bisphenol A)
 - Estrogen mimic
 - In polycarbonates and other hardened plastics
 - Baby bottles and sipping cups
 - Reusable water bottles
 - Sports drink and juice bottles
 - Microwave dishes
 - Food storage containers
 - Liners of most food and soft drink cans

Are Baby Bottles and Food Cans Safe To Use?

The BPA Controversy

- BPA leaches into foods and drinks
 - Even when containers not heated
- 93% of Americans older than 6 have BPA levels above the threshold level set by the EPA
 - Higher in children and adolescents
- Risks for infants, children, adults

Malaria- The Spread of a Deadly Parasite

- Malaria
 - Caused by *Plasmodium* sp. carried by *Anopheles* mosquitoes
 - Tropical and subtropical regions
 - Spread
 - Symptoms
 - Malarial cycle
- Malaria on the rise since 1970
 - Drug resistant *Plasmodium*
 - Insecticide resistant mosquitoes
 - Clearing of tropical forests
 - AIDS patients particularly vulnerable
- Prevention of spread and current research

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

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

Some Chemicals May Affect Our Immune and Nervous Systems

- Some natural and synthetic chemicals in the environment can weaken and harm
 - Immune system
 - Nervous system
 - Neurotoxins: PCBs, arsenic, lead, mercury, some pesticides
 - Endocrine system

Endocrine disruptors are chemicals that, at certain doses, can interfere with the endocrine (or hormone) system in mammals.

These disruptions can cause cancerous tumors, birth defects, and other developmental disorders. Any system in the body controlled by hormones can be derailed by hormone disruptors.

Mercury's Toxic Effects

- 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
- How are humans exposed?
 1. Inhalation: vaporized Hg or particulates
 2. Eating fish with high levels of methylmercury
 3. Eating high-fructose corn syrup
- Effects of Hg on humans
 - Damage nervous system, kidneys, lungs
 - Harm fetuses and cause birth defects
- Who is most at risk?
 - Pregnant women
 - 75% of exposure comes from eating fish

Many Factors Determine the Harmful Health Effects of a Chemical (1)

- **Toxicology**
- **Toxicity** dependent on
 - **Dose**
 - Age
 - Genetic makeup
 - Multiple chemical sensitivity (MCS)
 - Solubility
 - Persistence
 - Biomagnification

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

- **Response**

- Acute effect: immediate or rapid
- Chronic effect: permanent or long-lasting

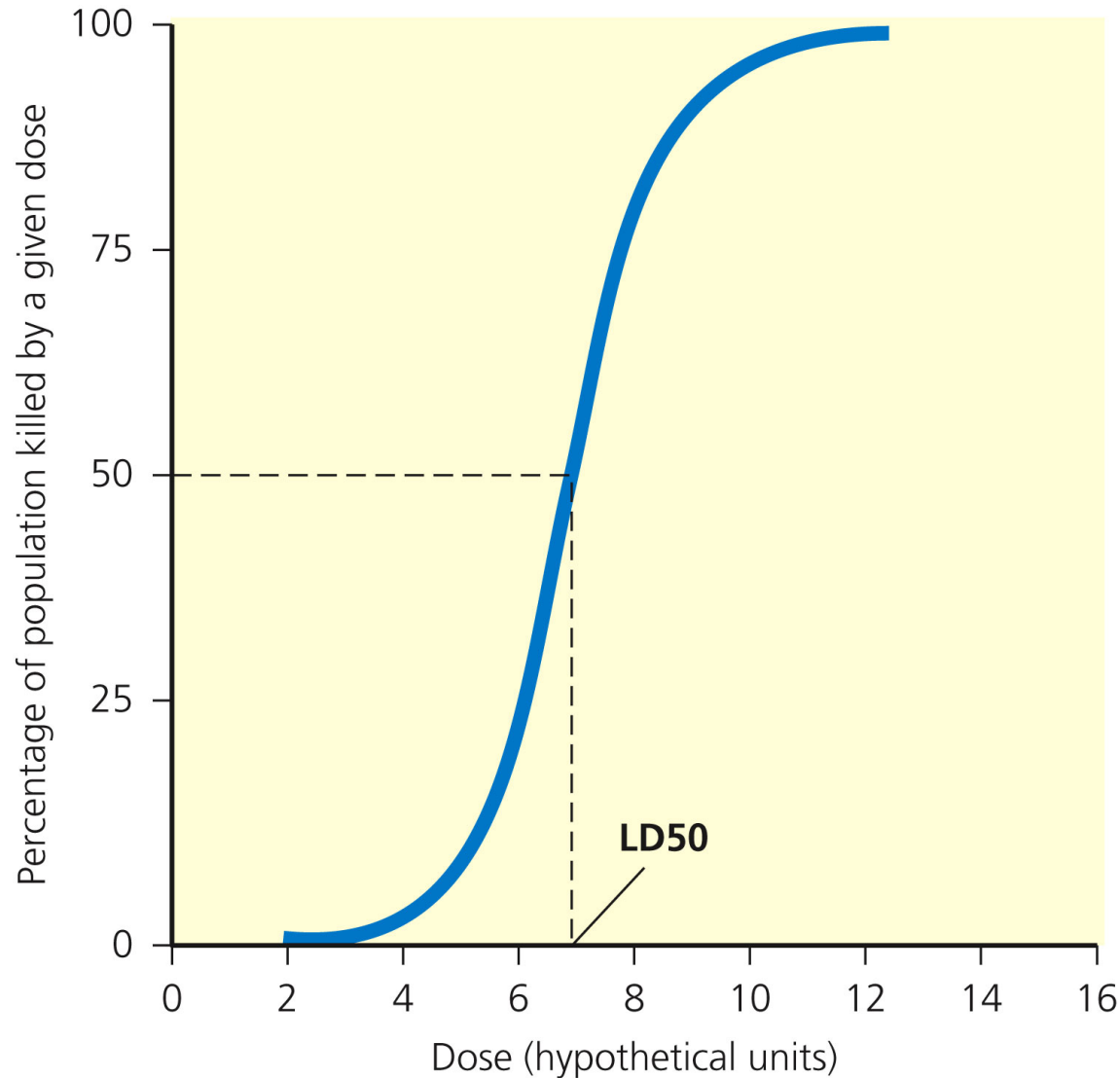
Scientists Use Live Lab Animals and Nonanimal Tests to Estimate Toxicity (1)

- Mice and rats
 - Systems are similar to humans
 - Small, and reproduce rapidly
 - Is extrapolation to humans valid?
- **Dose-response curve**: median lethal dose (LD50)
 - Nonthreshold dose-response model
 - Threshold dose-response model

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



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.

Chapter 21

Solid and Hazardous Waste

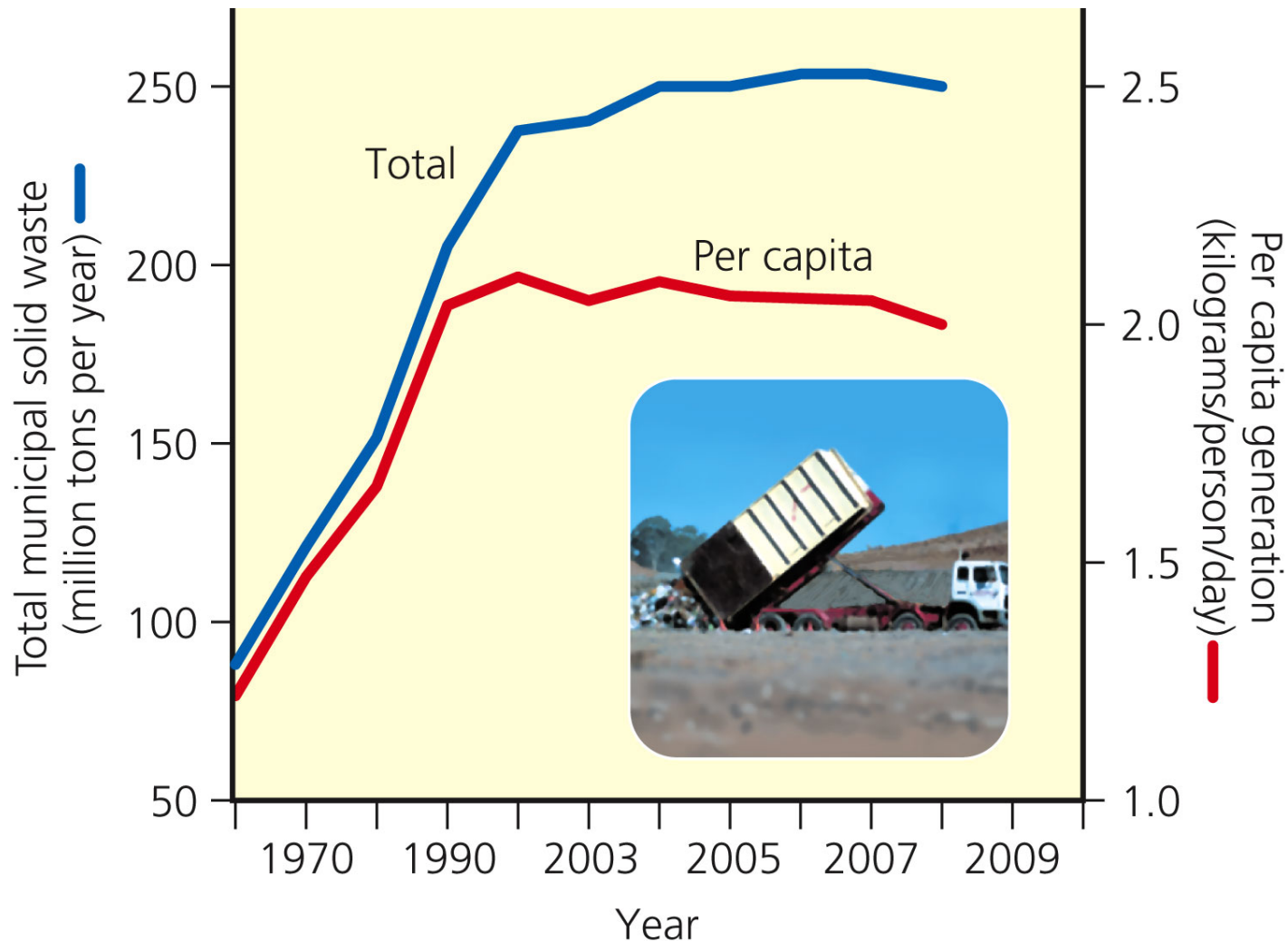
E-waste—An Exploding Problem

- Electronic waste, e-waste: fastest growing solid waste problem
- Most ends up in landfills and incinerators
- Composition includes
 - High-quality plastics
 - Valuable metals
 - Toxic and hazardous pollutants
- Shipped to other countries: What happens in China and India?
- **International Basel Convention:** Bans transferring hazardous wastes from developed countries to developing countries
- European Union: **Cradle-to-grave** approach
- What should be done?
 - Recycle
 - E-cycle
 - Reuse
 - Prevention approach: remove the toxic materials

We Throw Away Huge Amounts of Useful Things and Hazardous Materials (1)

- **Solid waste**
 - **Industrial solid waste**
 - Mines, farms, industries
 - **Municipal solid waste (MSW)**
 - Trash
 - **Hazardous waste (toxic waste)**
 - Threatens human health of the environment
 - Organic compounds
 - Toxic heavy metals
 - Radioactive waste

Total and Per Capita Production of Municipal Solid Waste in the U.S.



What Harmful Chemicals Are in Your Home?

Cleaning

- Disinfectants
- Drain, toilet, and window cleaners
- Spot removers
- Septic tank cleaners



Paint Products

- Paints, stains, varnishes, and lacquers
- Paint thinners, solvents, and strippers
- Wood preservatives
- Artist paints and inks



General

- Dry-cell batteries (mercury and cadmium)
- Glues and cements



Gardening

- Pesticides
- Weed killers
- Ant and rodent killers
- Flea powders

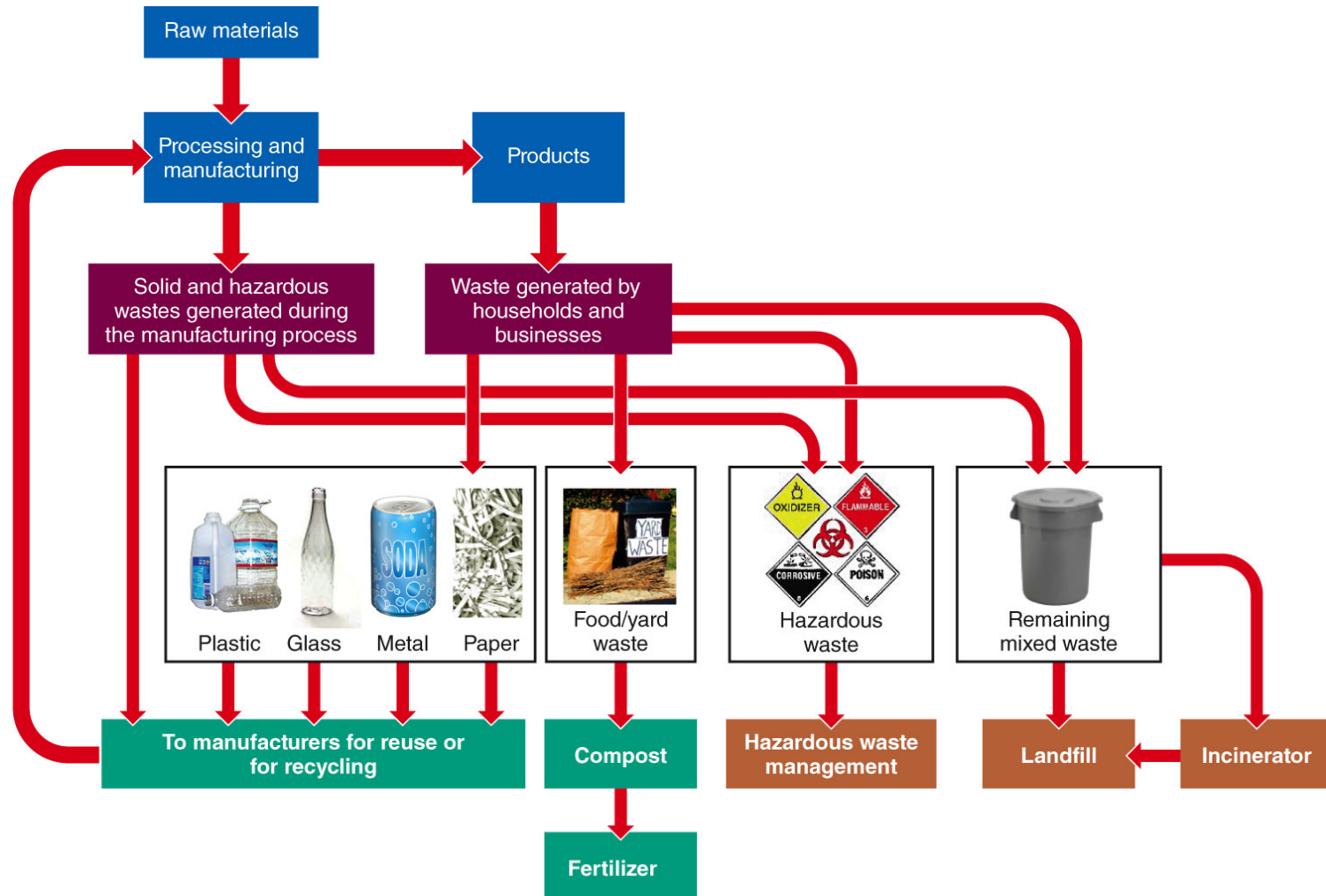
Automotive

- Gasoline
- Used motor oil
- Antifreeze
- Battery acid
- Brake and transmission fluid

We Can Burn or Bury Solid Waste or Produce Less of It

- **Waste Management**
 - Reduce harm, but not amounts
- **Waste Reduction**
 - Use less and focus on reuse, recycle, compost
- **Integrated waste management**
 - Uses a variety of strategies

Integrated Waste Management



Integrated Waste Management

First Priority

Primary Pollution and Waste Prevention

- Change industrial process to eliminate use of harmful chemicals
- Use less of a harmful product
- Reduce packaging and materials in products
- Make products that last longer and are recyclable, reusable, or easy to repair



Second Priority

Secondary Pollution and Waste Prevention

- Reuse
- Repair
- Recycle
- Compost
- Buy reusable and recyclable products



Last Priority

Waste Management

- Treat waste to reduce toxicity
- Incinerate waste
- Bury waste in landfills
- Release waste into environment for dispersal or dilution

We Can Cut Solid Wastes by Reducing, Reusing, and Recycling

- Waste reduction is based on
 - Reduce
 - Reuse
 - Recycle
- Six strategies:
 1. Redesign manufacturing processes and products to use less material and energy
 2. Develop products that are easy to repair, reuse, remanufacture, compost, or recycle
 3. Eliminate or reduce unnecessary packaging
 4. Use fee-per-bag waste collection systems
 5. Establish cradle-to grave responsibility
 6. Restructure urban transportation systems

Use of Refillable Containers

- Reuse and recycle
 - Refillable glass beverage bottles
 - Refillable soft drink bottles made of polyethylene terephthalate (PET) plastic
 - Bottle deposits create jobs and reduce litter and landfill amounts
- Paper, plastic, or **reusable cloth bags**

There Are Two Types of Recycling

- **Primary, closed-loop recycling**
 - Materials recycled into same type: aluminum cans
- **Secondary recycling**
 - Materials converted to other products: tires
- Types of wastes that can be recycled
 - Preconsumer: internal waste
 - Postconsumer: external waste

We Can Mix or Separate Household Solid Wastes for Recycling

- **Materials-recovery facilities (MRFs)**
 - Can encourage increased trash production
- Source separation
 - Pay-as-you-throw
 - Fee-per-bag

Composting

- Composting
 - Individual



Backyard Composter Drum: Bacteria Convert Kitchen Waste into Compost

- Municipal
 - San Francisco, 2009
 - Edmonton, Alberta, Canada

Recycling Paper & Plastic

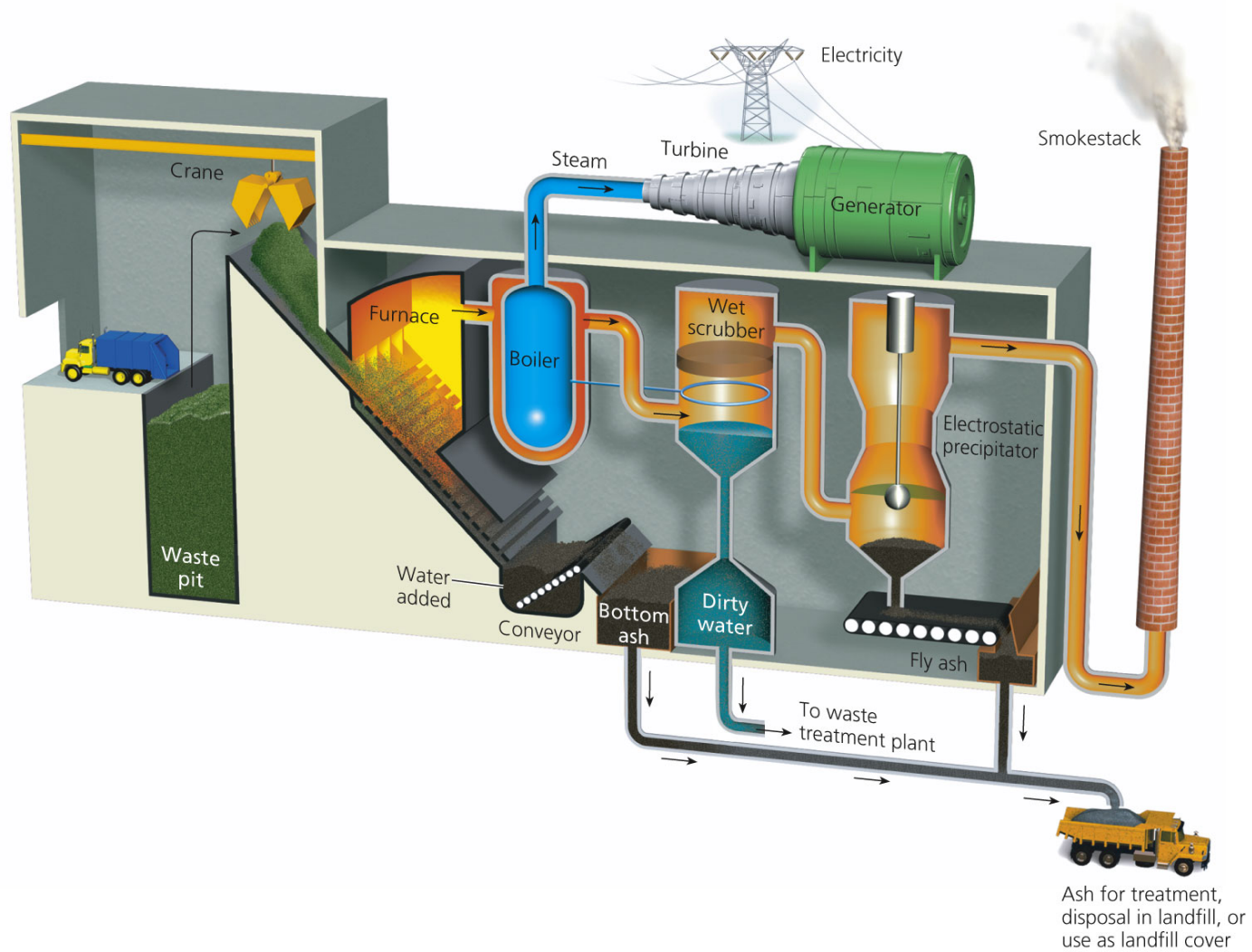
- Production of paper versus recycled paper
 - Energy use: world's fifth largest consumer
 - Water use
 - Pollution
 - Countries that lead recycling efforts
 - Replacement of chlorine-based bleaching chemicals with H_2O_2 or O_2
-
- Plastics: composed of resins created from oil and natural gas
 - Most containers discarded: 4% recycled
 - Litter: beaches, oceans
 - Kills wildlife
 - Gets into food chain and seafood

Bioplastics

- Plastics from soybeans: not a new concept
- Key to bioplastics: catalysts that speed reactions
- Sources
 - Corn
 - Soy
 - Switchgrass
 - Chicken feathers
 - Some garbage
 - CO₂ from coal-burning plant emissions
- Benefits: lighter, stronger, cheaper, and biodegradable

Burning Solid Waste

- Waste-to-energy incinerators
- 600 globally - Most in Great Britain



Burying Solid Waste

- Open dumps
 - Widely used in less-developed countries
 - Rare in developed countries
- Sanitary landfills
 - Leachate: water that has percolated through a solid and leached out some of the constituents.
 - Ex. Cadmium from batteries

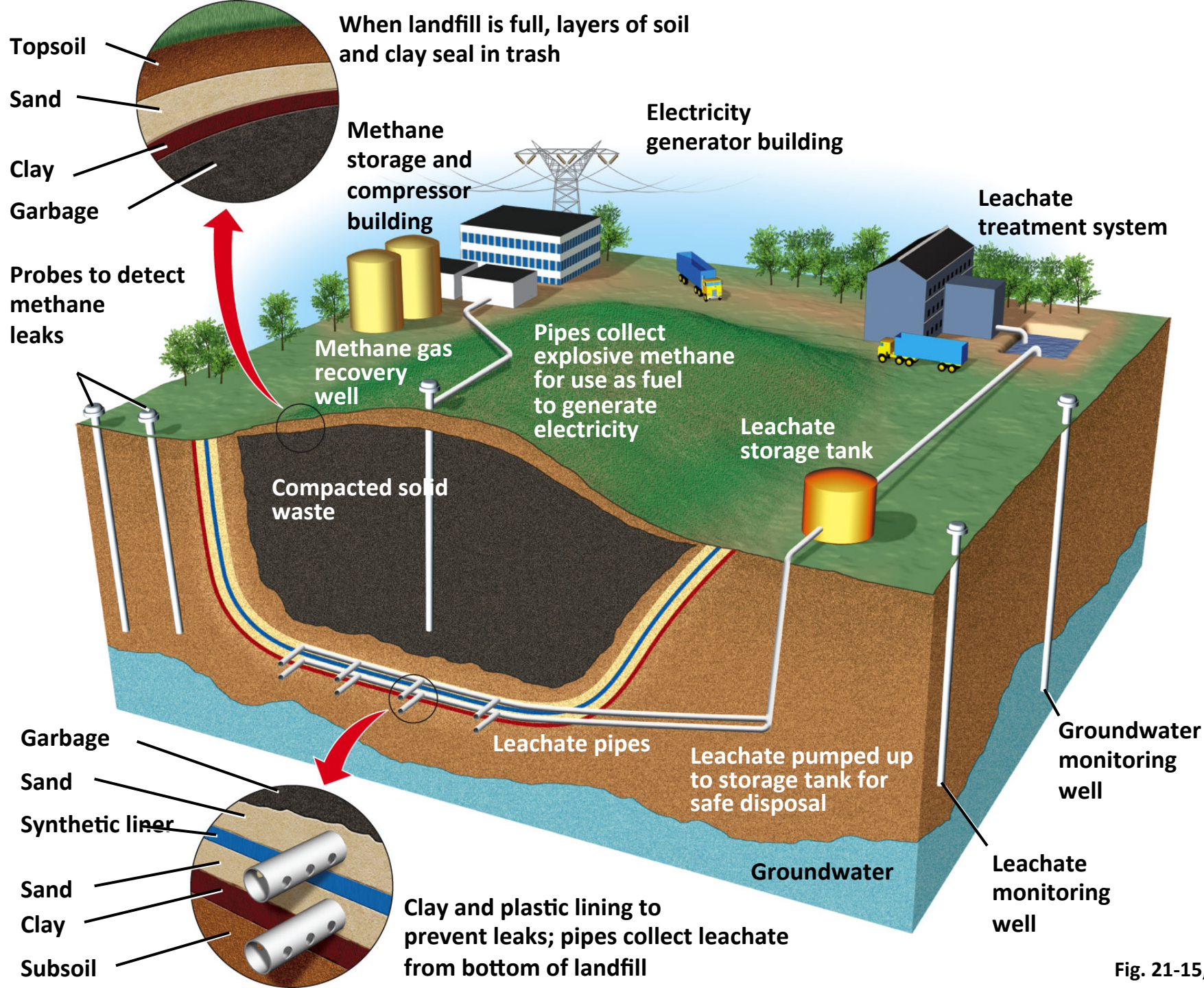


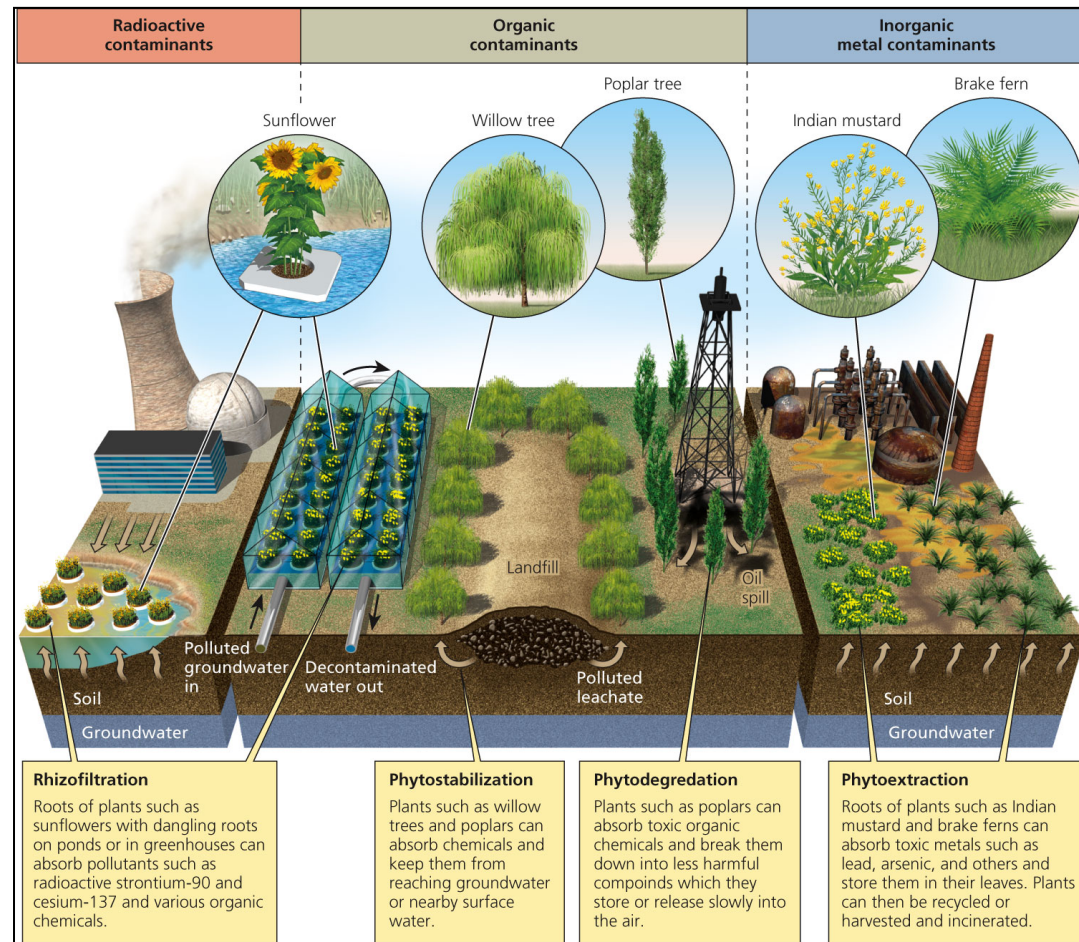
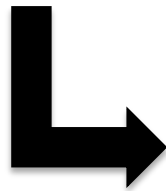
Fig. 21-15, p. 572

We Can Use Integrated Management of Hazardous Waste

- Integrated management of hazardous wastes
 - Produce less
 - Convert to less hazardous substances
 - Rest in long-term safe storage
- Increased use for postconsumer hazardous waste

We Can Detoxify Hazardous Wastes

- Incineration
- Collect and then detoxify
 - Physical methods
 - Chemical methods
 - Use nanomagnets
 - Bioremediation
 - Phytoremediation



We Can Store Some Forms of Hazardous Waste

- Burial on land or long-term storage
 - Last resort only
- Deep-well disposal
 - 64% of hazardous liquid wastes in the U.S.
- Surface impoundments
 - Lined ponds or pits
- Secure hazardous landfills



Surface Impoundment in Niagara Falls, New York

Solutions: Secure Hazardous Waste Landfill

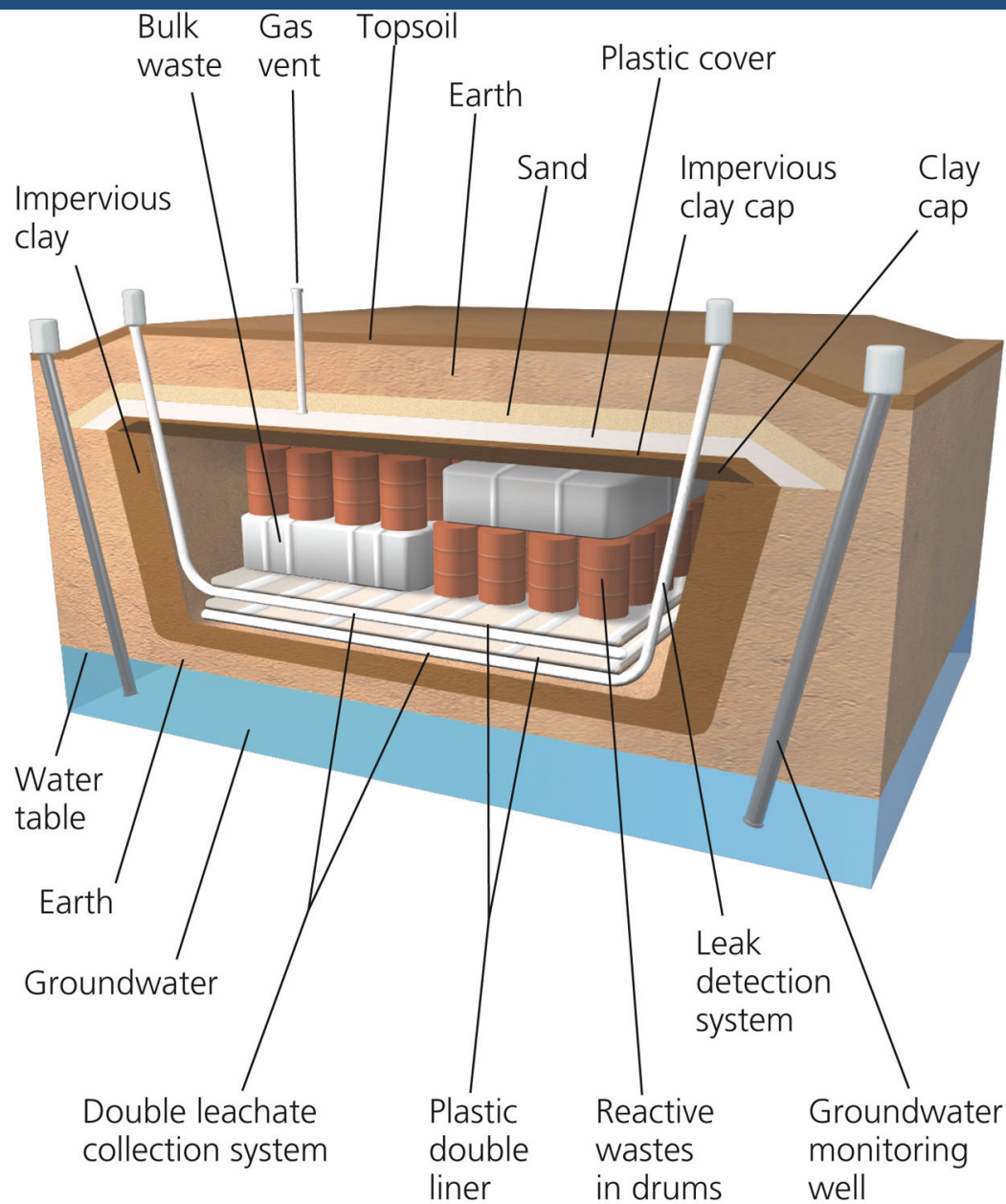


Fig. 21-23, p. 577

Case Study: Hazardous Waste Regulation in the United States (1)

- 1976: Resource Conservation and Recovery Act (RCRA)
 - EPA sets standards and gives permits
 - Cradle to grave
 - Covers only 5% of hazardous wastes

Case Study: Hazardous Waste Regulation in the United States (2)

- 1980: Comprehensive Environmental, Compensation, and Liability Act (CERCLA)
 - National Priorities List
 - 2010: 1300 sites, 340 sites cleaned so far
 - Pace of cleanup has slowed
 - Superfund is broke
- Laws encouraging the cleanup of brownfields

Providing Environmental Justice for Everyone Is an Important Goal

- **Environmental Justice**
 - Everyone is entitled to protection from environmental hazards
- Which communities in the U.S. have the largest share of hazardous waste dumps?
- Environmental discrimination

International Treaties Have Reduced Hazardous Waste (1)

- Basel Convention
 - 1992: in effect
 - 1995 amendment: bans all transfers of hazardous wastes from industrialized countries to less-developed countries
 - 2009: Ratified by 195 countries, but not the United States

International Treaties Have Reduced Hazardous Waste (2)

- 2000: Delegates from 122 countries completed a global treaty
 - **Control 12 persistent organic pollutants (POPs)**
 - **“Dirty dozen”**
 - **DDT, PCBs, dioxins**
 - **Everyone on earth has POPs in blood**
- 2000: Swedish Parliament law
 - By 2020 ban all chemicals that are persistent and can accumulate in living tissue