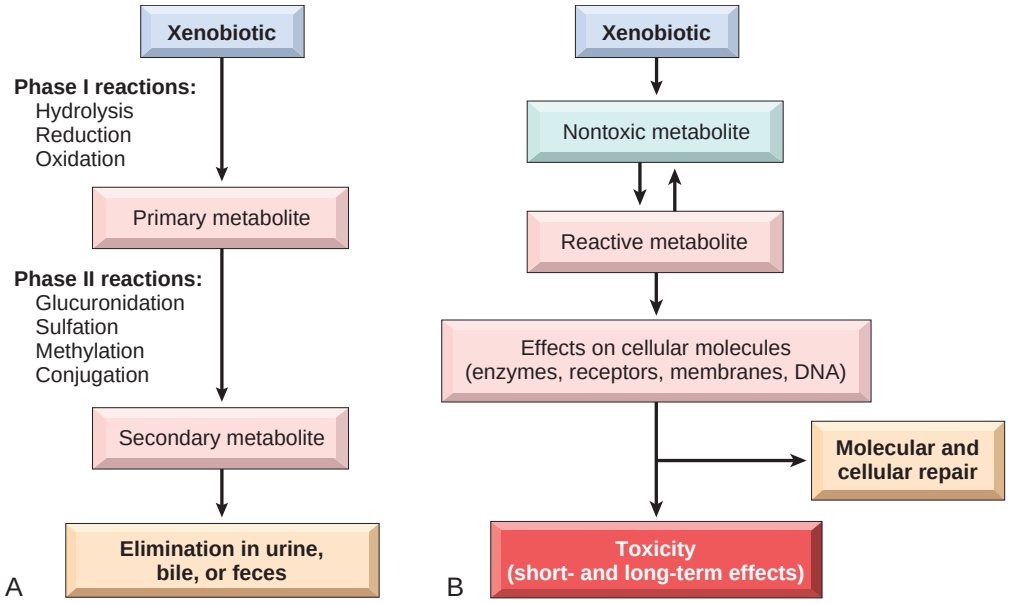

Figure 9-4 Xenobiotic metabolism. **A,** Xenobiotics can be metabolized to nontoxic metabolites and eliminated from the body (detoxification). **B,** Xenobiotic metabolism may also result in the formation of a reactive metabolite that is toxic to cellular components. If repair is not effective, short- and long-term effects develop. (Based on Hodgson E: A Textbook of Modern Toxicology, 3rd ed. Hoboken, NJ, Wiley, 2004.)

Angeles, Houston, Cairo, New Delhi, Mexico City, and São Paulo. It may seem that air pollution is a modern phenomenon, but this is hardly the case. John Evelyn wrote in 1661 that inhabitants of London suffered from "Catharrs, Phthisicks and Consumptions" (bronchitis, pneumonia, and tuberculosis) and breathed "nothing but an impure and thick mist, accompanied by a fuliginous and filthy vapour, which renders them obnoxious to a thousand inconveniences, corrupting the lungs, and disordering the entire habit of their bodies." The first environmental control law, proclaimed by Edward I in 1306, was straightforward in its simplicity: "whoever should be found guilty of burning coal shall suffer the loss of his head." What has changed in modern times is the nature and sources of air pollutants, and the types of regulations that control their emission.

Although the lungs bear the brunt of the adverse consequences, air pollutants can affect many organ systems. Except for some comments on smoking, pollutant-caused lung diseases are discussed in Chapter 15. Major health effects of outdoor pollutants are summarized in Table 9-1. Ozone, sulfur dioxide, particulates, and carbon monoxide are discussed here.

Ozone (O_3) is produced by interaction of ultraviolet (UV) radiation and oxygen (O_2) in the stratosphere and naturally accumulates in the so-called ozone layer 10 to 30 miles above the earth's surface. This layer protects life on earth by absorbing the most dangerous UV radiation emitted by the sun. During the past 35 years, the stratospheric ozone layer decreased in both thickness and extent due to the widespread use of chlorofluorocarbon gases in air conditioners and refrigerators and as aerosol propellents. When released into the atmosphere, these gases drift up into the stratosphere and participate in chemical reactions that destroy ozone. Due to prevailing stratospheric air currents, the resulting depletion has been most profound in polar regions, particularly over Antarctica during the winter months. Recognition of the problem led in 1987 to the Montreal Protocol, a series of international agreements that currently calls for a complete phase-out of chlorofluorocarbon use by 2020. Decreased use of chlorofluorocarbons over the past 25 years has reduced the size of the yearly ozone "hole" over Antarctica, suggesting that this global environmental challenge is being met successfully.

In contrast to the "good" ozone in the stratosphere, ozone that accumulates in the lower atmosphere *(ground-level ozone)* is one of the most pernicious air pollutants.

Table 9-1 Health Effects of Outdoor Air Pollutants

Pollutant	Populations at Risk	Effects
Ozone	Healthy adults and children	Decreased lung function Increased airway reactivity Lung inflammation
	Athletes, outdoor workers	Decreased exercise capacity
	Asthmatics	Increased hospitalizations
Nitrogen dioxide	Healthy adults	Increased airway reactivity
	Asthmatics	Decreased lung function
	Children	Increased respiratory infections
Sulfur dioxide	Healthy adults	Increased respiratory symptoms
	Individuals with chronic lung disease	Increased mortality
	Asthmatics	Increased hospitalization Decreased lung function
Acid aerosols	Healthy adults	Altered mucociliary clearance
	Children	Increased respiratory infections
	Asthmatics	Decreased lung function Increased hospitalizations
Particulates	Children	Increased respiratory infections
	Individuals with chronic lung or heart disease	Decreased lung function
	Asthmatics	Excess mortality Increased attacks

Data from Bascom R, et al: Health effects of outdoor air pollution. Am J Respir Crit Care Med 153:477, 1996.