**The Greenhouse Effect and Climate Change**

During the 20th century, the great increase in our use of fossil fuels caused a significant rise in the concentration of carbon dioxide, CO2, in the atmosphere. Since 1750 (just before the Industrial Revolution), the concentration of atmospheric CO2 has increased by 37%. Since 2000, acceleration of the annual rate of CO2 production has increased to more than 3%, from 1.1% per year in the early 1990s. Scientists believe that atmospheric CO2 concentration could double, compared to 1750, by early in the 21st century.

Energy from the sun reaches the earth in the form of light. Neither CO2 nor H2O vapor absorbs the visible light in sunlight. The energy given off by the earth in the form of lower-energy infrared (heat) radiation, however, is readily absorbed by CO2 and H2O (as it is by the glass or plastic of greenhouses). Thus, some of the heat the earth must lose to maintain its temperature can become trapped in the atmosphere, causing the temperature to rise. This phenomenon, called the *greenhouse effect*, has been the subject of much discussion among scientists and the topic of many articles in the popular press.

The Intergovernmental Panel on Climate Change (IPCC) has summarized climate model predictions. The IPCC summary indicates that the average global surface temperature will likely rise an additional 1.1 to 6.4 ˚C during the 21st century. This may not seem like much. A change of even 4–5˚C, however, would be enough to cause a dramatic change in climate, transforming now productive land into desert and altering the habitats of many animals and plants beyond their ability to adapt. Another drastic consequence of even this small temperature rise would be the partial melting of the polar ice caps. The resulting rise in sea level, though only a few feet, would mean that water would inundate coastal cities such as Los Angeles, New York, and Houston, and low-lying coastal areas such as southern Florida and Louisiana. On a global scale, the effects would be devastating.

The earth’s forests and jungles play a crucial role in maintaining the balance of gases in the atmosphere, removing CO2 and supplying O2. The massive destruction, for economic reasons, of heavily forested areas such as the Amazon rain forest in South America is cited as another long-term contributor to global environmental problems. Worldwide, more than 3 million square miles of once-forested land is now barren for some reason; at least 60% of this land is now unused. Environmental scientists estimate that if even one quarter of this land could be reforested, the vegetation would absorb 1.1 billion tons of CO2 annually.

Some scientists are more skeptical than others about the role of human-produced CO2 in climate change and, indeed, about whether global warming is a significant phenomenon or simply another of the recognized warm–cold cycles that have occurred throughout the earth’s history. All but the most skeptical observers, however, seem to agree that responsible stewardship of the planet urgently requires that we do something in a reasoned fashion to reduce production of greenhouse gases, primarily CO2, and that this will involve decreasing our dependence on energy from fossil fuels and increasing reliance on renewable energy sources, solar energy, wind power, and geothermal energy. Despite the technical and political problems of waste disposal, increased use of electric energy based on nuclear power is one way of decreasing CO2 emissions. France, for example, gets 78% of its electricity from nuclear power. Improved ways to recycle the nuclear waste have been developed to minimize the amount needed for long-term storage.

Much CO2 is eventually absorbed by the vast amount of water in the oceans, where the carbonate–bicarbonate buffer system almost entirely counteracts any adverse effects of ocean water acidity. Ironically, there is also evidence to suggest that other types of air pollution in the form of particulate matter may partially counteract the greenhouse effect. The particles reflect visible radiation rather than absorbing it, blocking some light from entering the atmosphere. It seems foolish, however, to depend on one form of pollution to help rescue us from the effects of another! Real solutions to current environmental problems such as the greenhouse effect are not subject to quick fixes; they depend on long-term cooperative international efforts that must be based on the firm knowledge resulting from scientific research.

Tropical rain forests are important in maintaining the balance of CO2 and O2 in the earth’s atmosphere. In recent years a portion of the South American forests larger than France has been destroyed, either by flooding caused by hydroelectric dams or by clearing of forest land for agricultural or ranching use. Such destruction continues at a rate of more than 20,000 square kilometers per year. If current trends continue, many of the world’s rain forests will be severely reduced or even obliterated in the next few years. The fundamental question—“What are the long-term consequences of the destruction of tropical rain forests?”—remains unanswered.