AIR

Air seems so thin and insubstantial that we cannot intuitively grasp its role as a global circulator of the essential nutrients CARBON, NITROGEN, and SULFUR as well as of that universal medium of life, WATER. How can something so light, invisible, even odorless, be so critical to life? We know that the air holds up birds and airplanes in flight. We can recall the delicious caress of a summer breeze on our skin, or the bite of subzero winter air in our noses. Yet, looking across a room, we're conscious only of the people or objects in the room, not of the air that fills it. Indeed, we ordinarily ignore air—unless it blows down our houses or fills our lungs with smoke or smog. We forget that without air, we couldn't even hear each other, since it transmits sound.

Take a deep breath, and pay close attention to what happens in your body. We say that we "take in" air, as if our wills were in control. But in fact the diaphragm muscle expands your chest. Then air, which surrounds us at a pressure of almost 15 pounds per square inch, rushes in. Deprived of this air, we could live only a few minutes; astronauts on space walks must carry air with them in their space suits.

Air is one of our fundamental connections to other life on

A term in SMALL CAPITALS is discussed in an alphabetical entry of its own, which you may wish to turn to, now or later. A term in **boldface** is also crucial in ecological thinking but does not have an entry of its own. All terms used anywhere in the book can be located through the index.

Earth. When you took that big breath, your lungs absorbed millions of oxygen molecules from the air. Each one of those molecules was contributed to the air by green plants, ALGAE, or BACTERIA. Without these living organisms that produce oxygen, your body could not "burn" its food to provide you with energy. (Some MICROBES live by breathing sulfate or nitrate. Others do not breathe at all; they ferment their food. There are also many microbes for whom oxygen is a fatal poison; they live primarily in mud or in intestines, where almost no oxygen is present.)

In ecology, all relationships are in some way reciprocal. Without the carbon dioxide that we and other animals breathe out, plants, bacteria, and algae could not get carbon dioxide from the air to build their cells and provide nourishment for themselves and for other forms of life—including you. Plants also draw water from the SOIL, but most of plants' nonwater weight is built up from carbon taken from the air and nitrogen compounds taken from the soil. Thus the simple, unconscious act of breathing links us totally and inescapably, every moment, to the rest of the BIOSPHERE. Air is the essential currency for life's most basic transactions, and almost all life exists at the boundaries between air and land or water.

Yet the air surrounding Earth—its "atmosphere"—is a skimpy layer compared to the planet's 8,000-mile diameter. Air thins out rapidly as the distance from the earth's surface increases, and about 15 miles above sea level there is nothing but airless space. Earth's atmosphere is a mixture of about four-fifths nitrogen and one-fifth oxygen, together with small quantities of many other gases, including carbon dioxide, water vapor, and methane. This atmospheric balance is not only essential to life; it is maintained by life. The nearby planets Mars and Venus have atmospheres too, but, quite unlike Earth's atmosphere, they are mostly carbon dioxide. Only their argon is similar to Earth's—an inert gas not linked to life. On those planets, purely physical and chemical processes operate, and in the absence of plants, algae, and bacteria capable of PHOTOSYNTHESIS, there is no oxygen gas.

According to the GAIA theory, the amount of oxygen, hydrogen, carbon dioxide, and other gases in the air, the temperature of the air, and other global requirements of life are maintained by the growth and metabolism of living beings. If oxygen was much less available than it is, animal (including human) life would be under severe stress—as you can judge by how hard it is to do vigorous physical exercise at high altitudes, where oxygen molecules are scarcer than at sea level. But if oxygen was even slightly more available, FIRES would start easily, even spontaneously, and burn more vigorously; they would consume most substances on the Earth's surface. The slow "fires" that burn oxygen in our muscles would be too intense to produce the controlled release of energy we need.

Gaian mechanisms regulate carbon dioxide levels, too. Carbon dioxide in the atmosphere, though present only in low concentration, is essential to life. Taking different forms, the element carbon cycles through the atmosphere, living beings, and even rocks. For more than a century, however, humans have been transferring to the atmosphere huge amounts of carbon dioxide through our use of underground deposits of oil, natural gas, and coal. When we burn fossil fuels in our cars or industrial machinery, we liberate carbon that has been deposited by life over hundreds of millions of years.

This practice has ominous consequences for our future. Carbon dioxide, along with water vapor and methane (which is largely produced by bacteria, either free-living or inhabiting the guts of animals, including cows and termites), is a major "greenhouse gas." Greenhouse gases in the atmosphere prevent some incoming solar energy from being radiated out again into space. An increase in any greenhouse gas thus tends to increase average planetary temperatures—causing GLOBAL WARMING.

However, life can cool as well as warm, and it has succeeded in regulating the atmosphere within tolerable limits for at least three billion years so far. Oceanic algae produce SULFUR compounds that directly or indirectly cool the Earth. Moreover, carbon is withdrawn from the atmosphere by microbes and plants. These processes may slow or moderate global warming, though present trends suggest that human releases of carbon will overwhelm natural counterforces and lead to severe disruption of life on the planet, with catastrophic effects on humans.

Another way in which the atmosphere is connected to life is through a thin layer of **ozone** (a form of oxygen) at very high altitudes. First formed two billion years ago by sunlight hitting oxygen emitted by bacteria, ozone filters incoming sunlight and greatly reduces its ultraviolet radiation, which is dangerous to life. Leaked refrigerants and solvents called chlorofluorocarbons (CFCs) float up to the ozone layer, where they destroy ozone molecules. This reduces the ozone layer's protectiveness, most dramatically in the polar regions but also in heavily populated areas distant from the poles. Worldwide alarm at the potentially lethal effects of greater ultraviolet exposure led to international agreements to phase out most CFC production, including novel subsidies to help developing nations adopt less damaging refrigerants and solvents. However, the phaseout has been slow. China and India continue to release large quantities of CFCs despite the agreements, and the United States and Canada still account for 15 percent of world CFC production. Less-damaging related compounds called HCFCs are still permitted—and used in enormous quantities in Chinese-made air conditioners. In addition, a compound 30 to 60 times more damaging to the ozone layer than CFCs, highly toxic methyl bromide, is widely used in the United States and elsewhere to fumigate timber and also soil for strawberries, flowers, grapes, and almonds. Its phasing out has been repeatedly prolonged.

Thus chemicals in the atmosphere will go on attacking the ozone layer for many decades—everywhere, not just in the "ozone hole" above the Antarctic. Meanwhile, we do not know all the effects increased ultraviolet exposure will have. It reduces the population of plankton—tiny beings that drift in the sea and provide food for fish and whales—and cuts outputs of rice and soybeans, the basic foods of billions of people. It's already causing increased skin cancers and cataracts in humans and other animals, and markedly higher rates are expected. Greater exposure to ultraviolet rays may also damage our immune and reproductive systems.

The air circulates carbon to all oxygen producers and brings their oxygen to us. We should not continue human activities that cause it to bring death and disease.