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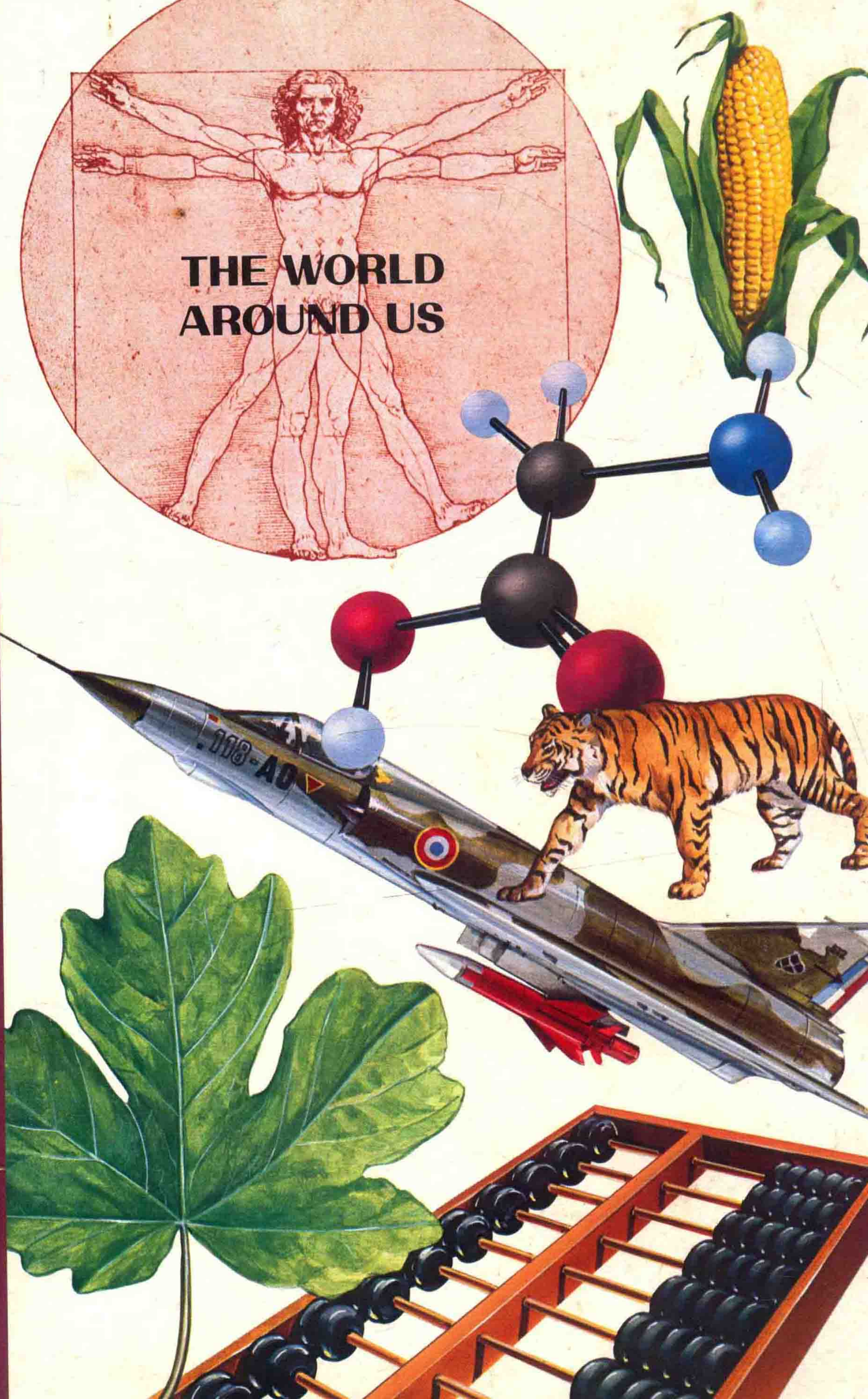
THE WORLD AROUND US



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The World Around Us

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Volume 24

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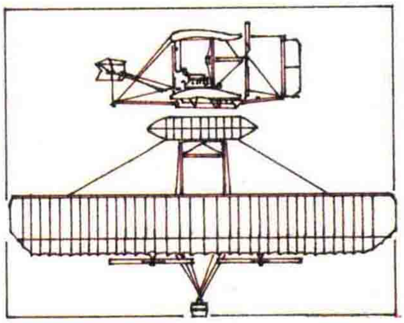

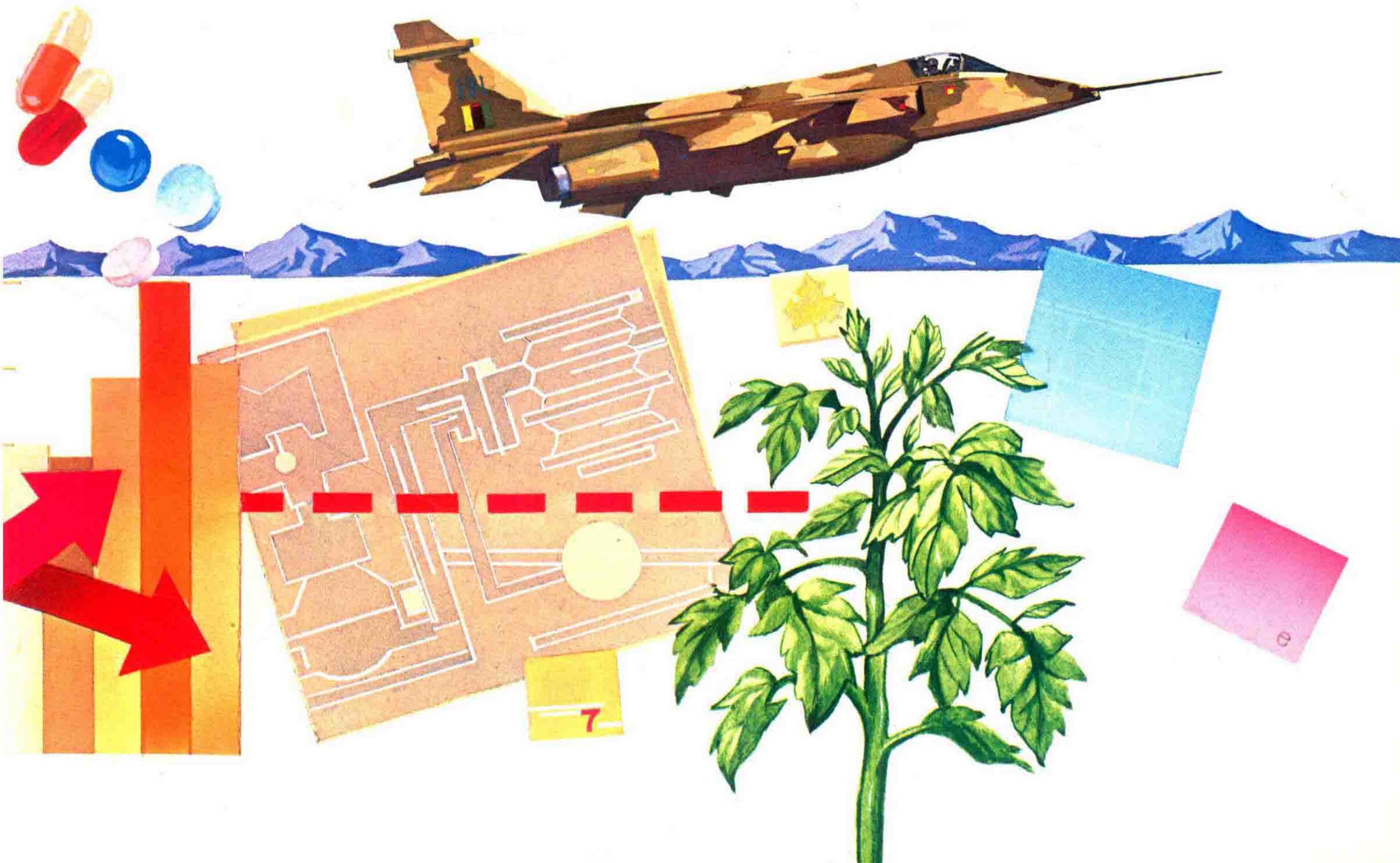

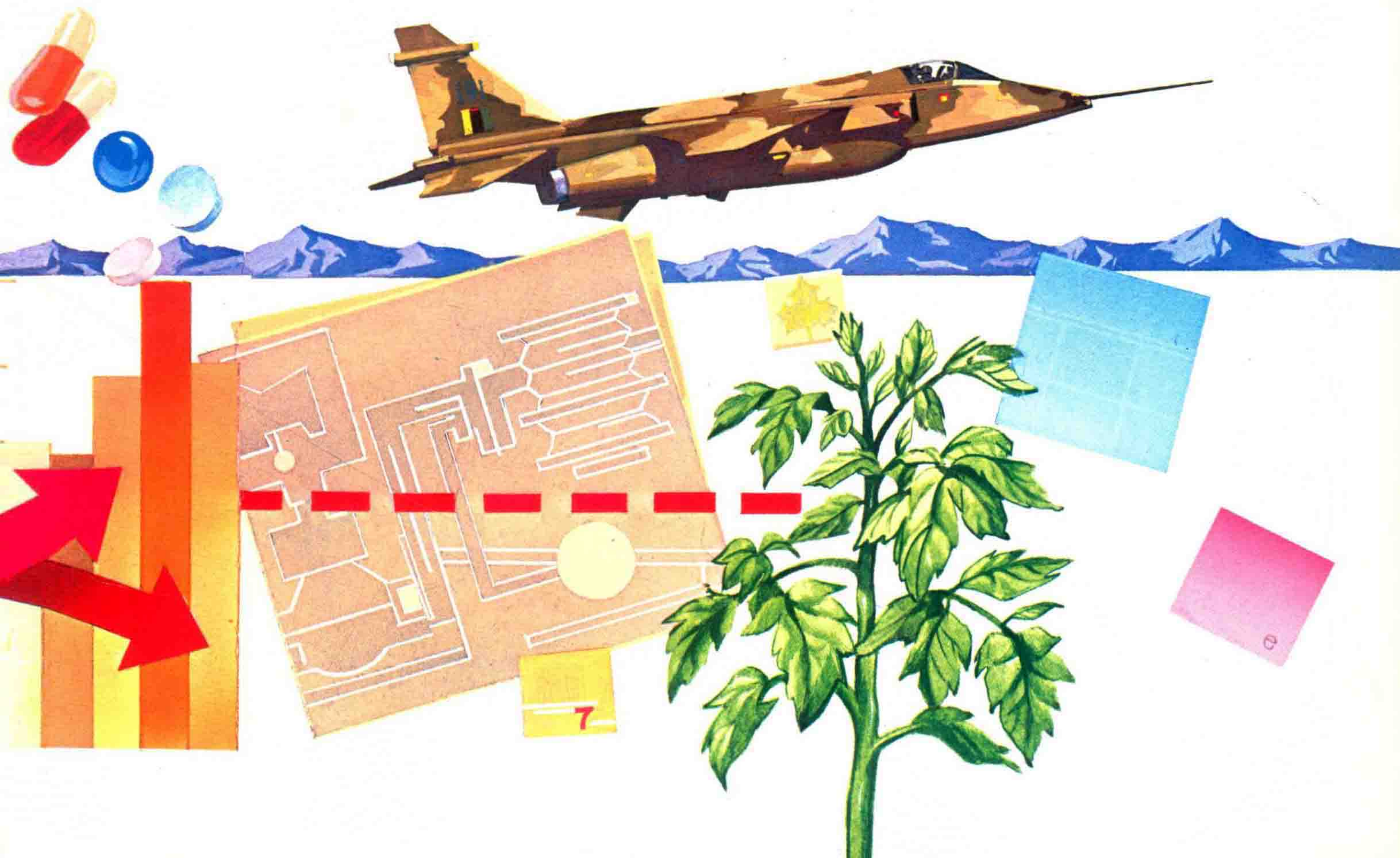
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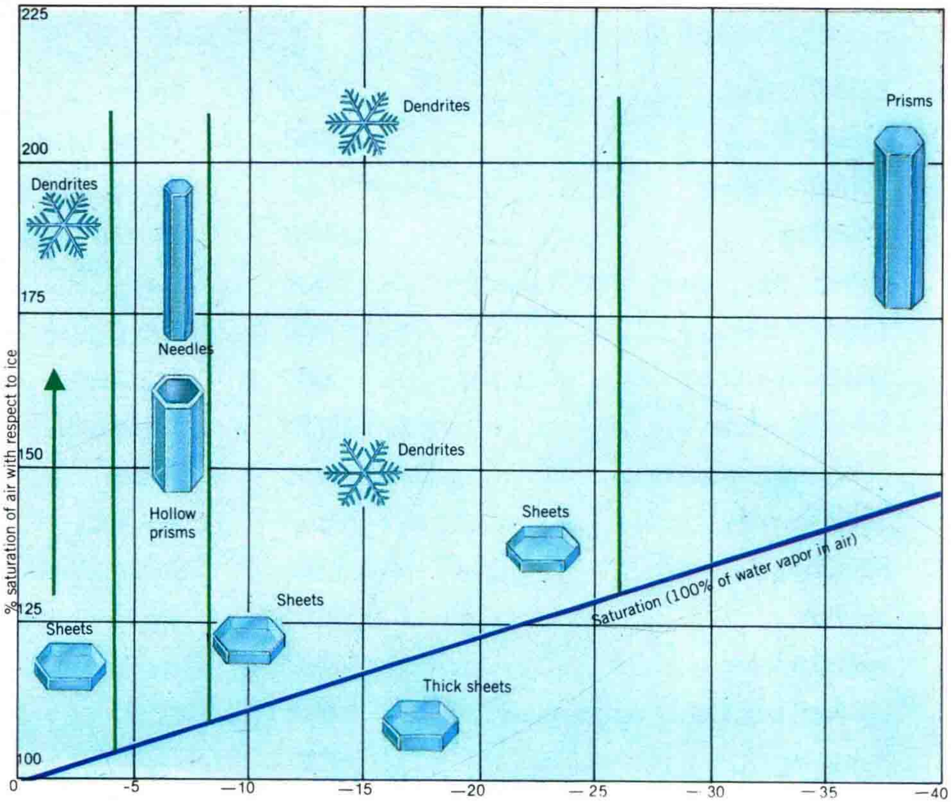
Poets frequently marvel that no two snowflakes are alike; meteorologists, on the other hand, set about classifying them according to structure. Snow is solid crystalline ice that originates in air and can either remain there, suspended in cloud formation, or fall to earth, covering the ground for months at a time or, in polar regions, forming a permanent ice cap.



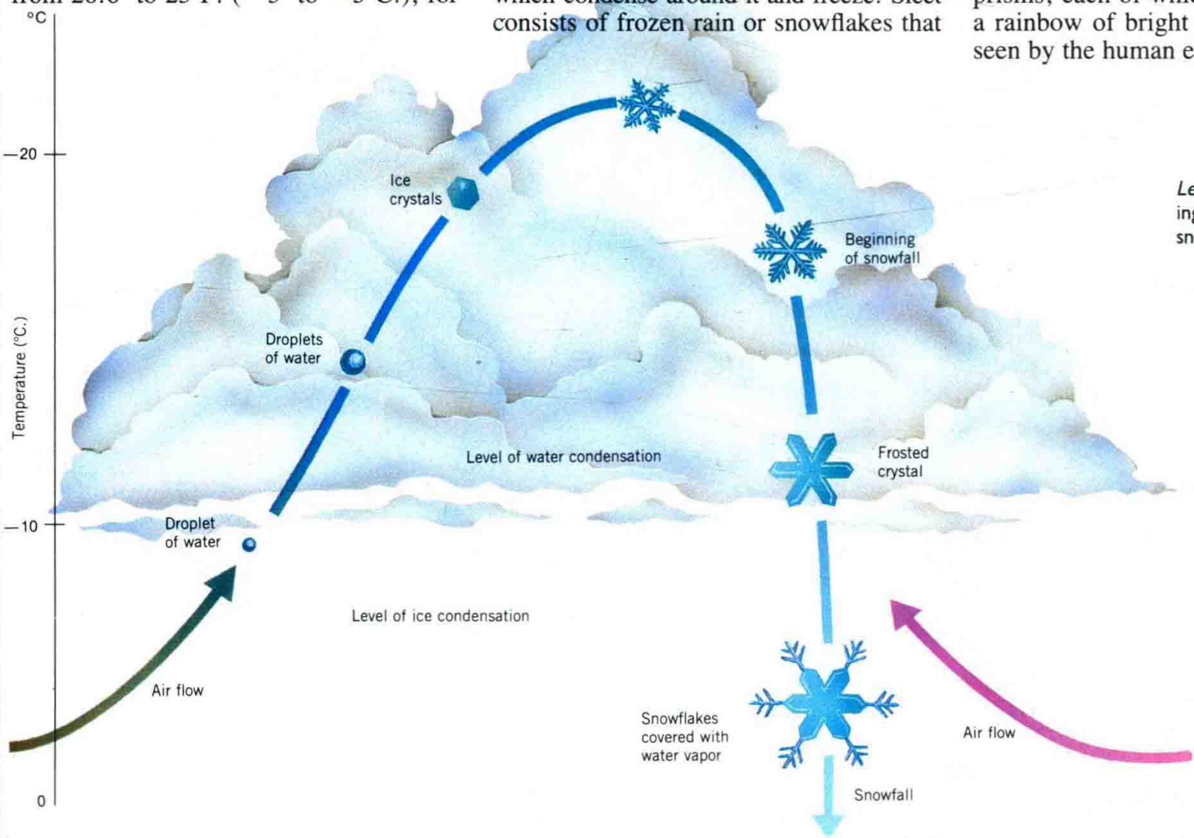
Formation and Varieties of Snow

Snowflakes are collections of up to 100 ice crystals. Ice crystals, which are usually of a breathtaking symmetry, can be formed in either of two ways. In some cases, as the water vapor in the atmosphere is cooled slightly below freezing, it can collect directly on a seed known as a nucleus, which is either a speck of clay or sand with a crystalline arrangement similar to that of ice. In others, water at temperatures well below freezing condenses directly into ice crystals.

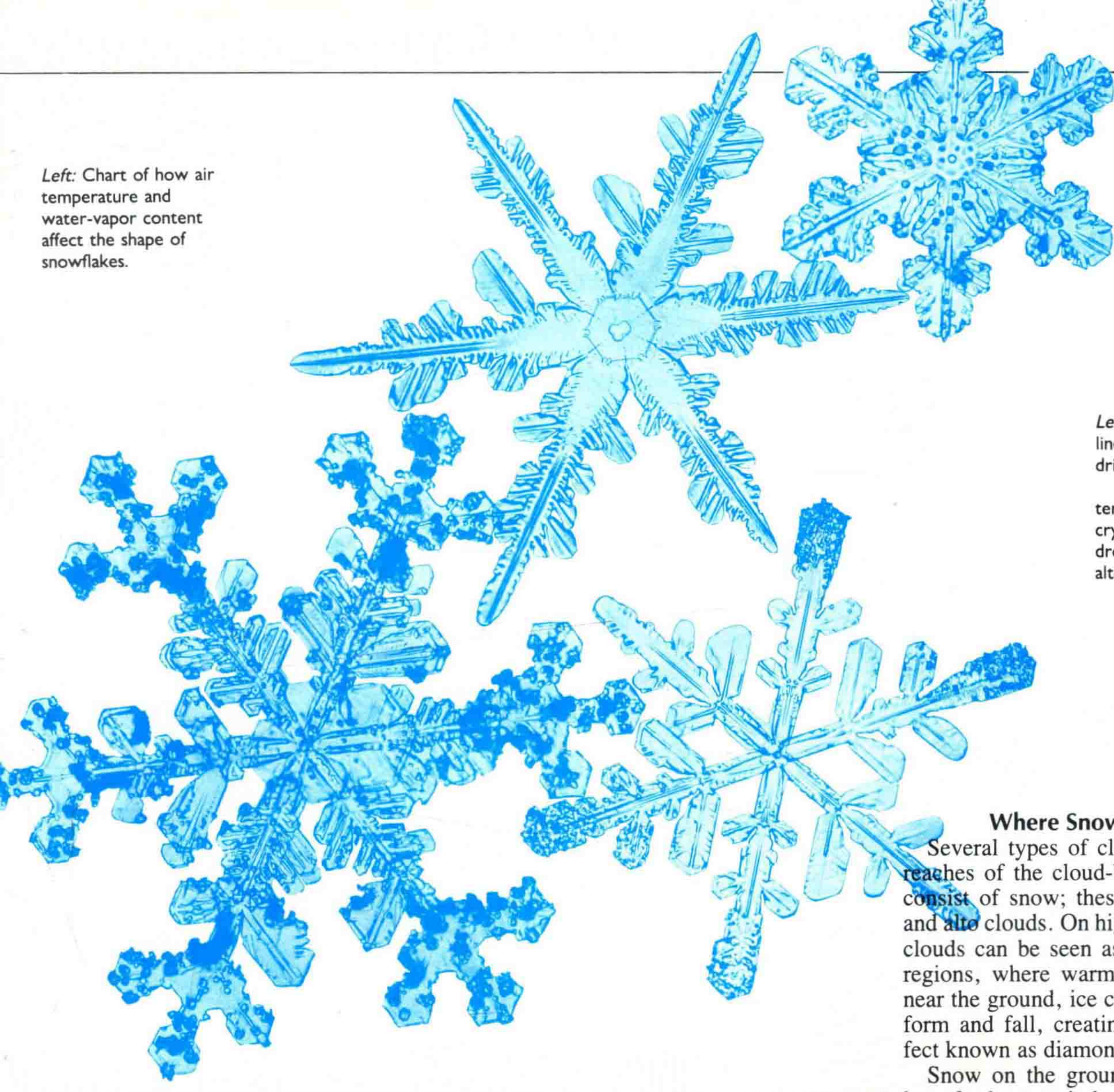
In both cases, the ice forms into a hexagonal structure because of the natural arrangement of oxygen and hydrogen atoms in the crystal (H_2O). Depending on the temperature and the amount of water vapor, any of seven different main types of ice crystal can be formed. What makes snow crystals truly fascinating to contemplate is that each of them, by shape and size, tells us the temperature and humidity conditions of the cloud from which it has fallen. A needle type of flake is the result when the cloud's temperature ranges from 26.6° to 23°F. (−3° to −5°C.), for example, while a dendrite, or stellar flake, is produced when the cloud ranges from 10.4° to 3.2°F. (−12° to −16°C.).

In addition to snow, there are three other types of frozen precipitation. Graupel (snow pellets) form when a falling crystal passes through a cloud of water droplets, which condense around it and freeze. Sleet consists of frozen rain or snowflakes that have melted and refrozen, and hail is layered ice crystals.

Because of its crystalline structure, clean snow reflects as much as 87 percent of the sunlight that shines on it. The lacy pattern of each snowflake is actually an intricate arrangement of tiny crystal prisms, each of which reflects sunlight in a rainbow of bright colors too fine to be seen by the human eye.



Left: Diagram illustrating formation and fall of snowflake.



Left: Chart of how air temperature and water-vapor content affect the shape of snowflakes.

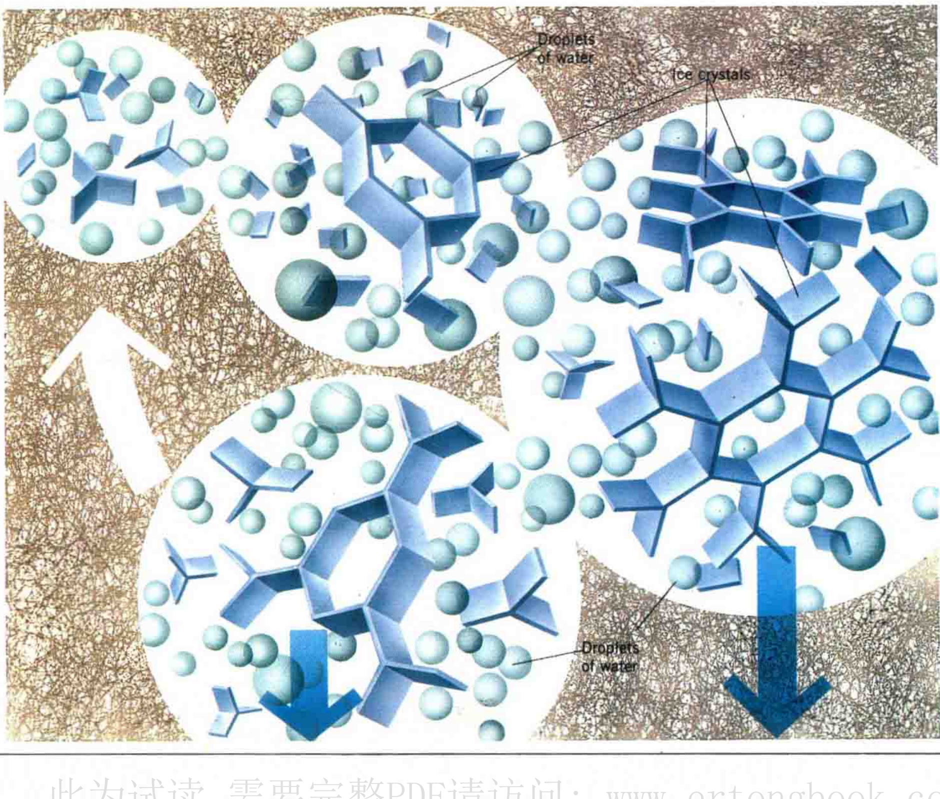
Left: Intricate crystalline structure of dendrite snowflakes.
Below: Cyclic pattern of formation of ice crystals from water droplets in cirrhus and alto clouds.

Where Snow Is Found

Several types of clouds in the highest reaches of the cloud-bearing atmosphere consist of snow; these are mainly cirrus and alto clouds. On high mountains, these clouds can be seen as ice fogs. In polar regions, where warm air meets cold air near the ground, ice columns and needles form and fall, creating a spectacular effect known as diamond dust.

Snow on the ground, or snow cover, lasts for long periods only at low temperatures—in the depths of winter, for example, or in mountain regions. Because snow absorbs less than half as many of the Sun's rays as the earth and ocean, and because it is a poor conductor of the Sun's radiation, allowing little of the heat lost from the earth's surface at night to be replaced during the day, its surface tends to be very cold. Nonetheless, this same snow cover, if it is thick enough, can protect vegetation from severe frost.

The thickness and duration of snow cover is determined by a variety of factors, including the amount of precipitation, wind, air temperature, and heat from the Sun. Snow on the ground is constantly rearranged by a variety of factors, including wind, temperature, melting, evaporation, and its own weight. In many parts of the world, winter snowfalls are a major source of water. When the deep snows melt in the springtime, they run down the mountainsides in springs, which can be diverted into reservoirs and irrigation canals and used as needed.



Soap

In ancient times, when people wanted to get clean, they reputedly washed themselves with water and wood ashes and then applied oils to soothe their irritated skin. When someone figured out how to leach wood ashes with water, a crude method of soapmaking was begun. From a soap factory excavated among the ruins of Pompeii we know that the Romans knew how to manufacture it. But it took two French inventions to put soapmaking on a modern, scientific footing: Nicolas LeBlanc's discovery in 1791 of how to obtain soda ash cheaply from common salt, and Michel Chevreul's discovery in 1823 of the structure and nature of fatty acids, which include soaps.

Saponification—the chemical reaction that produces soap—occurs when oils, fats, greases or tallow, and bases (compounds containing hydroxide [OH-] molecules), such as caustic soda (sodium hydroxide), are boiled in water until they form a smooth, semisolid metal salt (the soap) and a liquid that contains glycerol. The main sources of fatty acids are tallow, derived from sheep and cattle fat, and coconut oil (in the United States), or palm oil (in Europe). A blend of 80 percent tallow fat and 20 percent coconut oil is considered best; most commonly known soaps are made with this mixture. Sodium hydroxide is the most commonly used alkaline for saponification, but it produces a hard soap. For softer soaps that go into shampoos, for example, potassium or ammonium hydroxides are used instead.

Much soap manufacture still takes place in large kettles, where the fats are boiled with various alkalies until they blend. When salt is added (a process called graining), the soap curd separates from the lye, which is drained and further distilled for the valuable glycerol. This and a process called closing (adding steam and water) is repeated several times until the mass separates into three layers—neat soap, the purest soap layer, on top; a lower-quality soap (called nigre) below; and lye at the bottom. Neat soap, which contains about 30 percent water and can be pumped away, is further processed (perfume and dye are usually added) before final cooling, cutting, stamping, and final wrapping in paper or plastic. Some soaps are "superfatted" by the addition of small amounts of (unneutralized) fatty acids, which results in special mildness toward the skin.

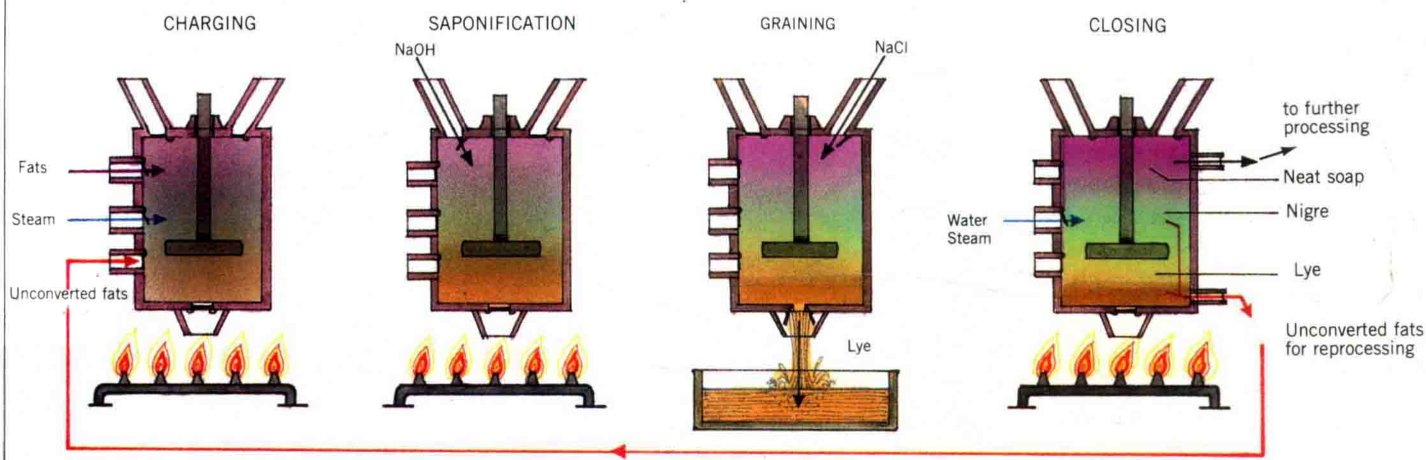
How Soap Cleans

The cleaning action of soaps comes from their unusual molecular makeup, which consists of a "water-loving" (hydrophilic) portion at the end of a long hydrocarbon chain, which is water-repellant (hydrophobic). As a result, these molecules concentrate at the areas of contact (interfaces) between water and the surface to be cleaned, one end seeking the water, the other end seeking oil or air. At water/oil interfaces, they emulsify grease (mixing it into the soap liquid the way fat is dispersed in milk); at water/air interfaces, they trap air molecules to produce foam. Dirt particles that cannot be dissolved are prevented from reattaching to the surfaces and are absorbed into the foam until they can be rinsed away.

Uses of Soap

Water-soluble soaps, made from salts of sodium, potassium, and amines (ammonia derivatives) are used widely in shaving creams, shampoos, and bar soap for personal bathing. Amine soaps also form the basis for many creams in the cosmetic industry and can be used to clean metals, dry-clean textiles, and prevent rust. Metallic soaps, based on ions of aluminum, magnesium, zinc, lead, and copper, can be dissolved in organic liquids rather than water; they are utilized as paint driers, lubricating greases, gelling agents, in waterproofing, and for mildew-proofing of leather.

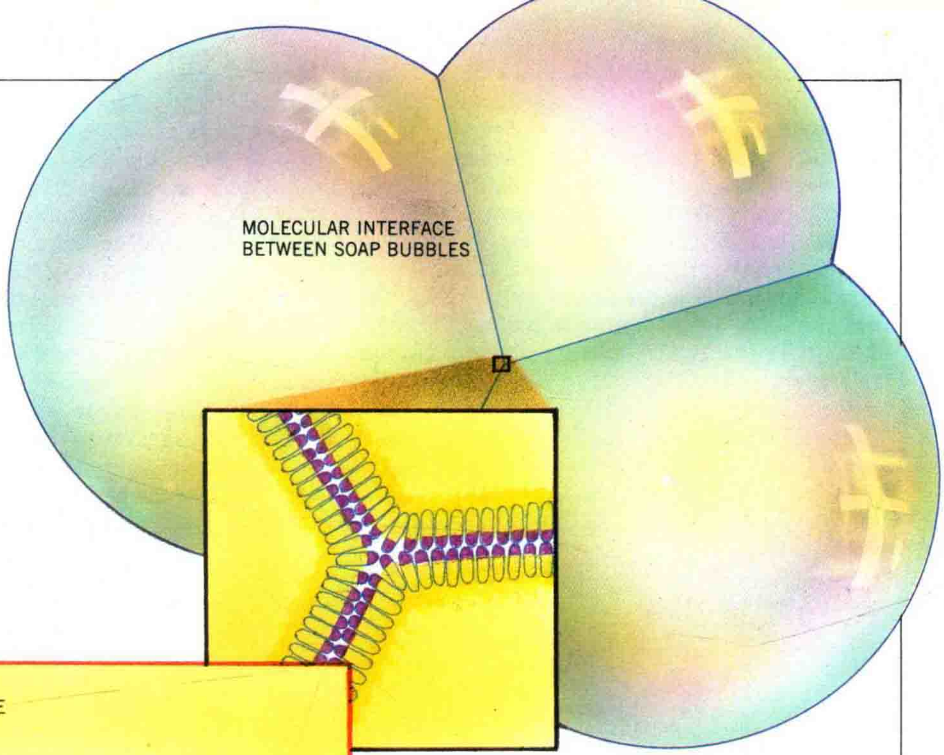
Because of sensitivity to hard water, the use of soap in laundry has virtually disappeared over the past several decades. When the hydrophilic portion of the soap reacts with the calcium and magnesium in the water, it forms an insoluble soap—the floating curds in washbowls and bathtub rings—and causes fabrics to become gray and stiff. As a result, synthetic detergents, which do not react with the calcium and magnesium ions in hard water, have taken over the laundry functions; however, they have failed to replace bar soap for personal use.

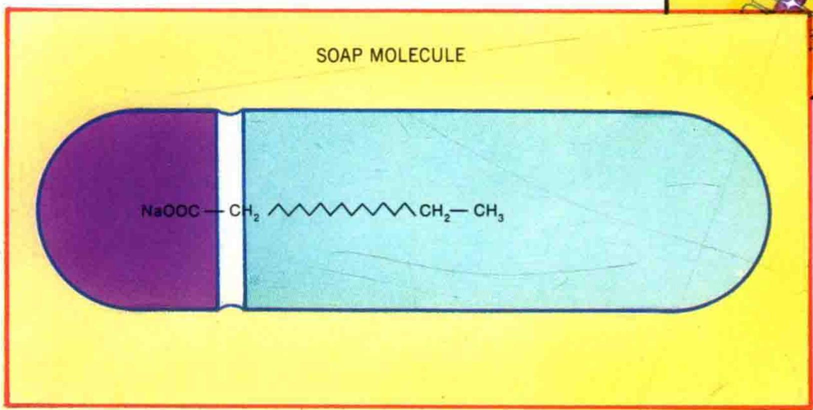


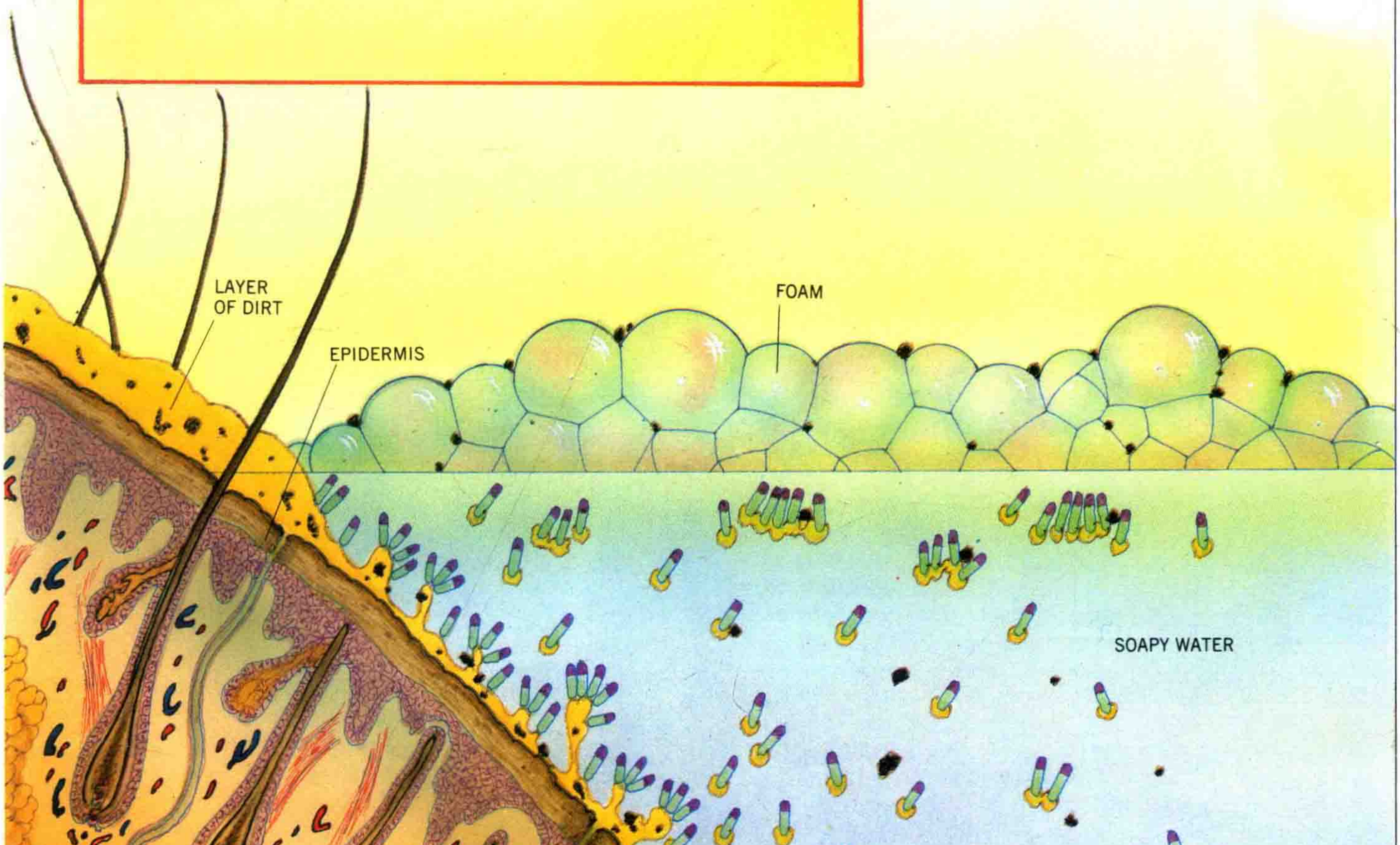
Above: Illustration shows, in simplified form, steps in the manufacture of soap. Neat soap removed from the reactor at the end of the process will normally go on to further finishing, including the addition of perfumes and coloring agents, before being formed into soap bars and other products. Unconverted fats left behind will pass through the cycle again for reprocessing.

Below: The cleaning effect of soap is a result of the assymmetric structure of its molecules. One end of the molecule is attracted by water, the other by fats and oils.

Right: Illustration shows how these molecules align at the interface between different soap bubbles. At bottom of the page, soap molecules link molecules of oily dirt to molecules of water, so that when the water is rinsed away, the skin is cleansed.







Sociobiology

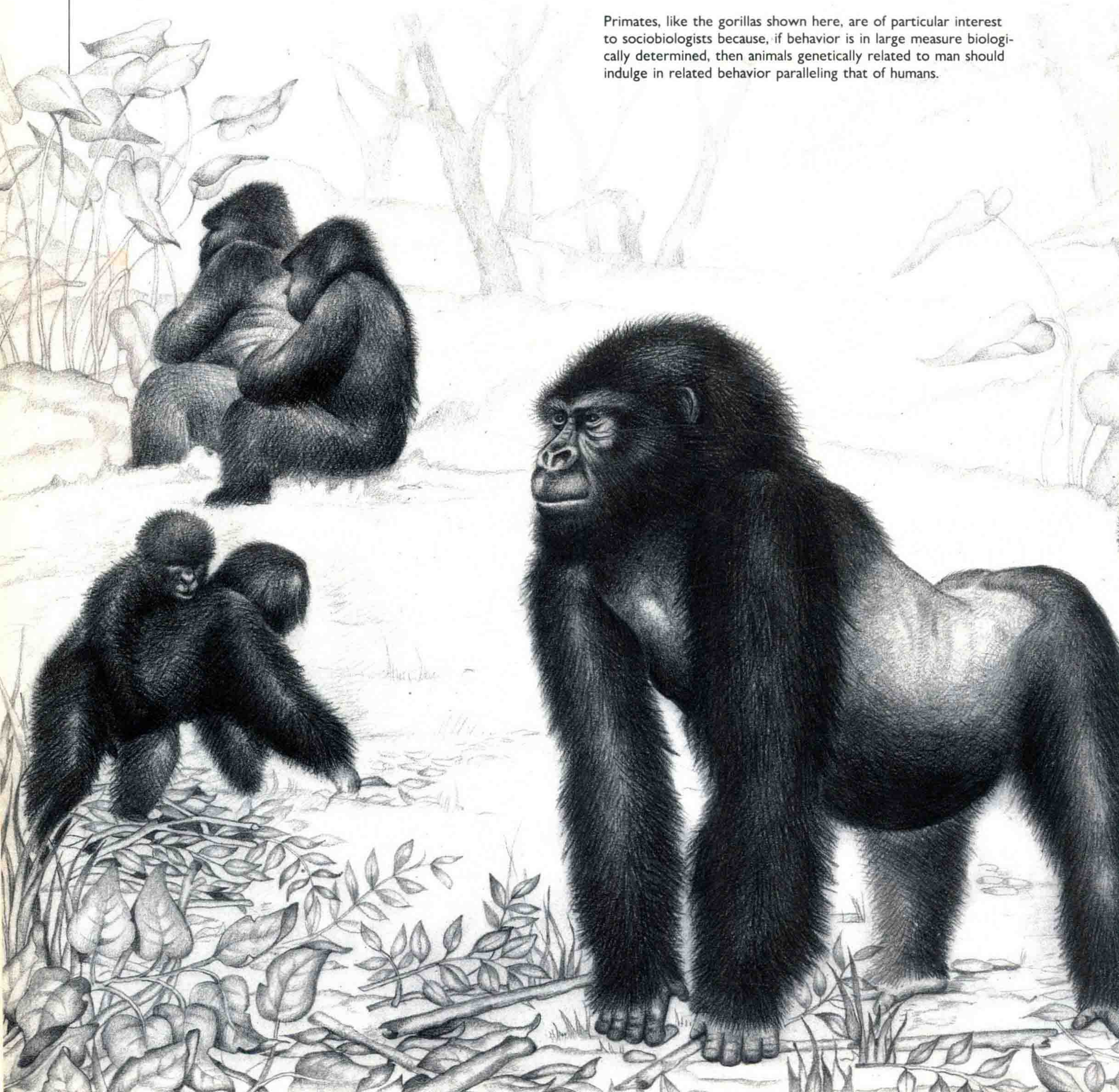
Whether denounced as a pseudoscience, with fascist and racist overtones, or celebrated as the most important advance in biology since Darwin, the new field of sociobiology is one of the most controversial intellectual endeavors of the last quarter-century. About the only area of general agreement is the definition of the field. Sociobiology is defined as the study of the biological basis of behavior—from the wagging of a dog's tail to the elaborate hand signals of a traffic policeman.

Scientists have recognized that there is a biological component in the origin of some human and animal actions. Even Sigmund Freud, who pioneered many purely psychological explanations of behavior, argued that "instincts" toward food, sleep, and sex were somehow embedded in our very cells. Modern biologists have discovered the mechanism by which the elaborate patterns of heredity are passed from generation to generation, through the genes in our chromosomes. Made from a complex and now-famous molecule called deoxyribonucleic acid (DNA), the genes in plants and animals wholly or partly determine the characteristics of living things, from eye color to the shape of leaves to the length of toes.

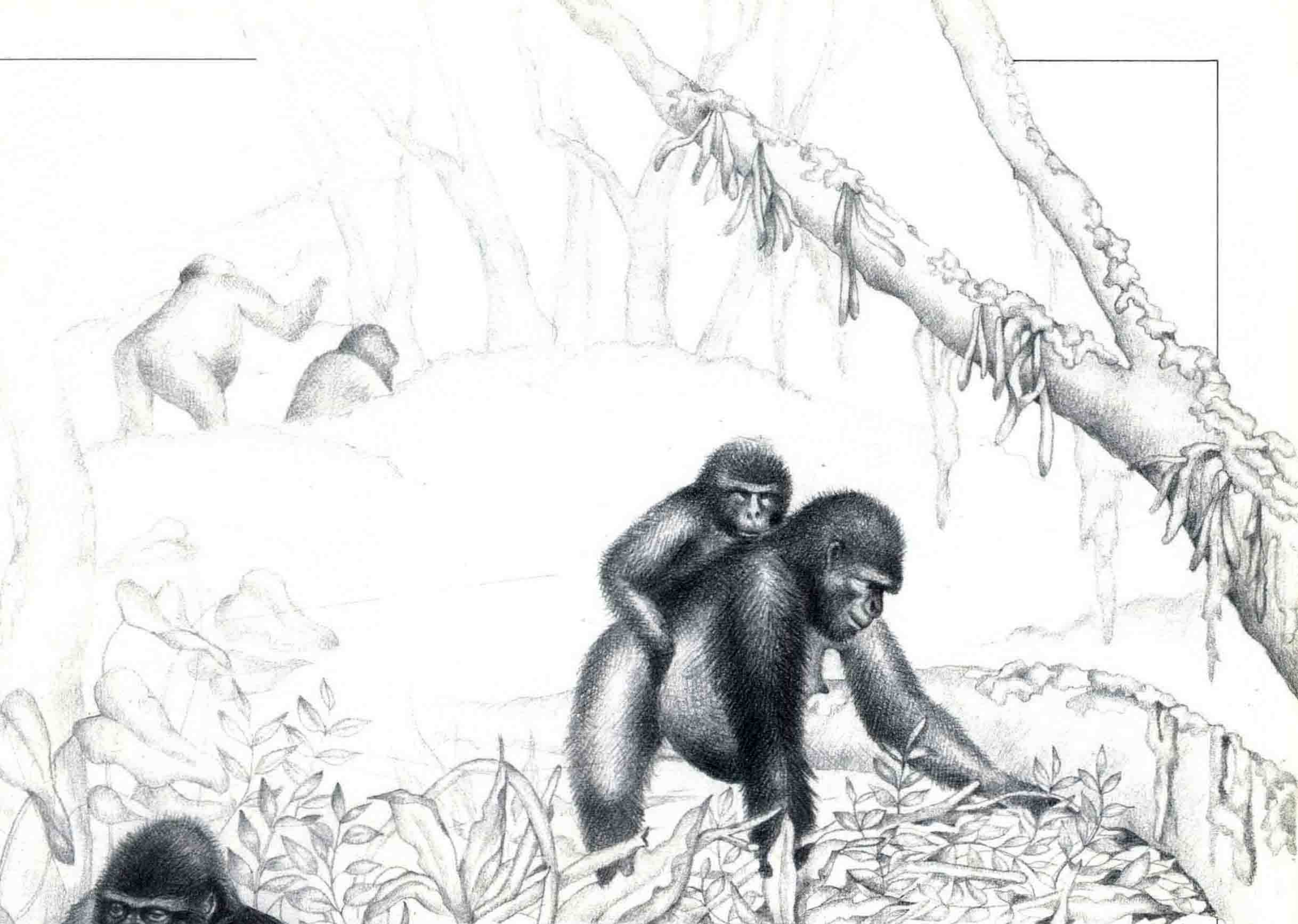
Even the most deterministic biologists, however, have not argued that genes control much in human behavior beyond vaguely defined "instincts." Sociobiologists have achieved their present notoriety by declaring, sometimes in advance of the evidence, that many human actions may be genetically programmed. Running into a burning house to save a neighbor, they say, may be dictated by heredity.

Selection

To understand sociobiological theory, it is necessary first to discuss the notion of natural selection, which is the mecha-



Primates, like the gorillas shown here, are of particular interest to sociobiologists because, if behavior is in large measure biologically determined, then animals genetically related to man should indulge in related behavior paralleling that of humans.



nism driving evolution. Natural selection occurs when particular genes, producing particular effects, increase their representation in the population at a greater rate than other genes, determining different effects. For example, take the eye color of cats. This trait is entirely determined by genes. Suppose that for some imaginary reason, blue-eyed cats live longer and are healthier, in general, than yellow-eyed cats. Over a long period of time, blue-eyed cats will have more kittens than will yellow-eyed cats, because more blue-eyed cats will survive. In time, the percentage of blue-eyed cats—and hence the proportion of genes for blue eyes—in the total pool of cats will rise. Biologists would say that the genes for blue eyes were selected for, while those for yellow eyes were selected against.

Inclusive Fitness

Sociobiology is based on the premise that genes for behavior can be selected for, just as were the genes for blue eyes. Even seemingly self-destructive behavior, such as running into a burning house to save a neighbor, can be selected for. This might seem to be nonsensical because risking your life obviously lowers the chances that you would be able to pass on your genes.

This seeming paradox is resolved by the concept of inclusive fitness. Described by William D. Hamilton in the 1960s, inclusive fitness is an expansion of the idea of genetic fitness—that is, the contribution of one individual's genes to the next generation of a population, relative to the contributions of other individuals' genes. By definition, natural selection leads eventually to the prevalence of individuals whose genetic makeup has the highest fitness. (The term "fitness" has no moral implications. It simply means the degree to which an individual organism can pass on its genes.) Hamilton's inclusive fitness is the sum of an individual's own fitness plus its influence on fitness in relatives other than direct descendants. This encompasses your fitness plus the fitnesses of your siblings, cousins, and parents, but not the fitness of your children.

According to Hamilton, rushing into that burning house would be favored genetically—in other words, selected for—if it increased the rescuer's inclusive fitness. For instance, suppose the Good Samaritan is a woman and the person inside the flaming home is her sister. Because of their common descent, the woman and her sister each have half the other's genetic endowment. A genetically based altruistic act will be selected for, if the rescuer's loss of fitness is surpassed by the increase in fitness of the sibling she saves.

Imagine there was a gene, or a complex of genes, that prompted the woman to rush into the flames. Now, further suppose that her sister in the house had this same gene and that they were the only two people in the world with it. If the woman dies but manages to save her sister, the saved sibling can have more children. If the sibling has, say four children, three of whom have this altruistic gene, the number of people with the gene has risen from two to three, and it has been selected for.

The example is oversimplified—among other reasons, because there are no specific genes coding for highly specific actions like running into a dangerous environment. But the point, sociobiologists say, is clear. Genes that involve sacrificial behavior can increase the fitness of an organism, even if the organism perishes because of them.

Spiteful Behavior

Something of the same reasoning can apply to the opposite extreme, spiteful behavior. In sociobiology, spiteful behavior is defined as lowering the fitness of a competitor at some cost to your own (or at least not improving it). The classic example, of course, is cutting the nose off one's face to dismay other people. If this action in some way causes a relative to do well, the action may actually raise the noseless person's inclusive fitness. (In addition, their genes don't care whether he has one.)

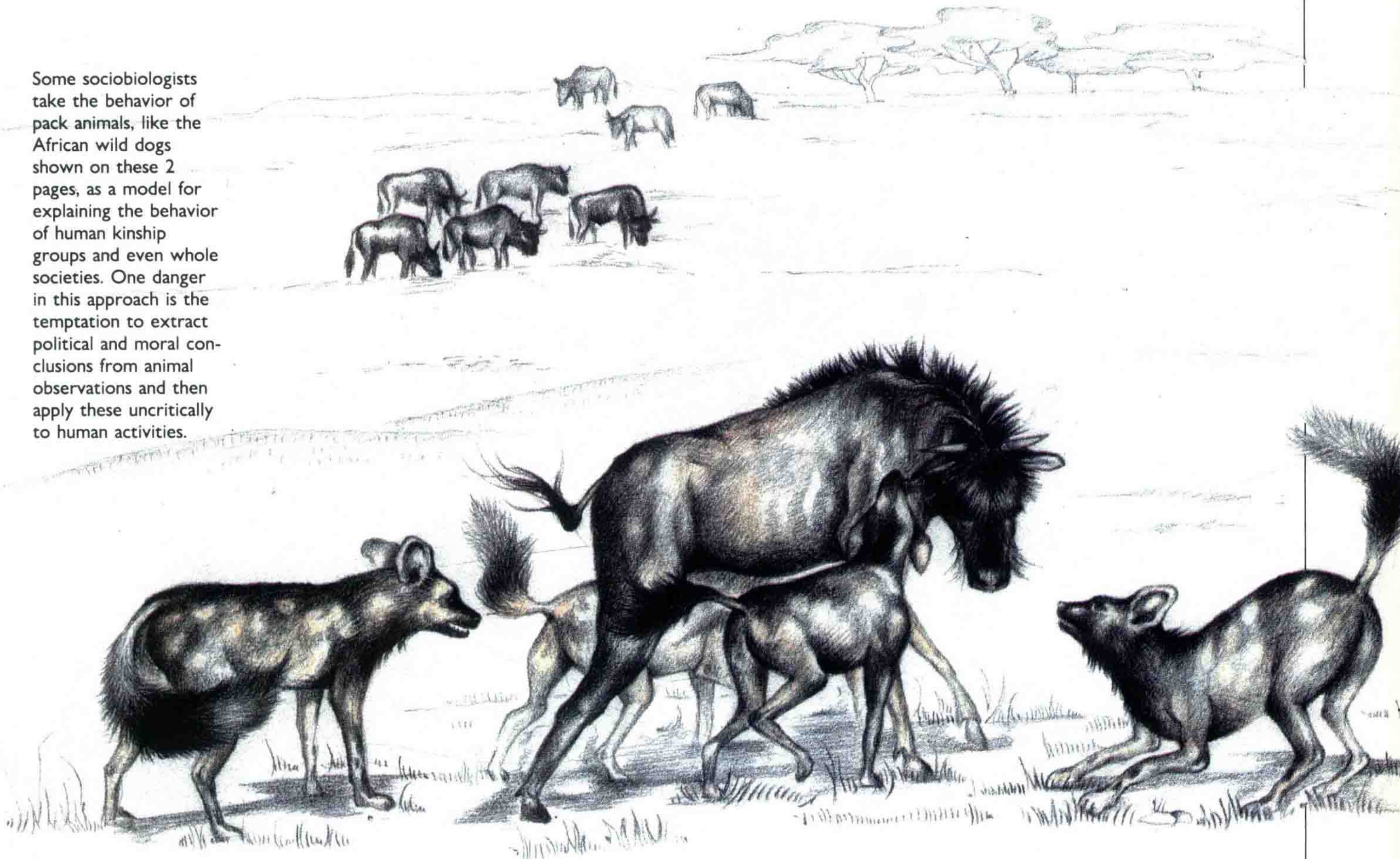
This kind of spite is all too frequent in human societies. To help their relatives, people will often attack outsiders at some risk to themselves. An example is the officeworker who fabricates rumors about somebody in order to get his daughter a job—even though being caught would cause him to lose his own. Spite in animal groups is rare. As Hamilton put it, in one of the rare jokes of sociobiology, "By our lofty standards, animals are poor liars."

Reciprocal Altruism

The theory of sociobiology was carried a step farther by Robert L. Trivers, who came up with the idea of reciprocal altruism in 1971. In a sense, reciprocal altruism extends the notion of inclusive fitness to unrelated individuals. It is the sociobiologist's answer to, "Why do Good Samaritans rescue total strangers?"

Trivers argued that unselfish people may actually benefit from their own actions. Suppose, in the case of a burning house, the person inside has a 50-percent chance of dying if left unaided, whereas the rescuer has a 10-percent chance of burning to death in the blaze. Also, for the sake of simplicity, imagine that when the rescuer perishes, the victim dies as well, but when the Samaritan lives, the other also survives. Looked at in isolation, it is hard to see why this action could benefit the

Some sociobiologists take the behavior of pack animals, like the African wild dogs shown on these 2 pages, as a model for explaining the behavior of human kinship groups and even whole societies. One danger in this approach is the temptation to extract political and moral conclusions from animal observations and then apply these uncritically to human activities.



rescuer (aside from the personal satisfaction). But if house fires are common, as they were until this century, and the victim may have to rescue the Samaritan at another time, there is the strong suggestion that each will benefit by helping the other. Each will have traded a 50-percent chance of death for a 10-percent chance of death.

This tradeoff works only if there is no cheating, if the rescuees do not turn their backs on rescuers when the next fire starts. However, in complex societies, such as those formed by such higher animals as humans, selection will discriminate against individuals if their cheating has later adverse effects on their lives—if, in short, they acquire a bad name and are themselves not rescued. If rescuing, as an idea, weakens, everyone's fitness decreases.

Ethics

This reasoning brings us very close to the field of ethics. It is here the sociobiologists have made the boldest claims and stirred up the strongest controversies. Although many scientists believe that many features of animal behavior—the schooling of birds and fish, the mating combats of deer, and almost everything done by bees—can be explained sociobiologically, they balk at the assertions made for human beings. In E. O. Wilson's *Sociobiology* (1975), the opening shot in the critical fray, the distinguished Harvard entomologist wrote, "A science of sociobiology, if coupled with neurophysiology, might transform the insights of ancient religions into a precise account of the evolutionary origin of ethics and hence explain the reasons why we make certain moral choices instead of others at particular times."

Following this, Wilson suggested hypothetical genetic roles in such human behavior as barter, the family, social class, and even sexuality. In the case of homosexuality, for example, Wilson and Trivers have argued that homosexual members of early societies may have worked as helpers, either in the home or in the hunt. Even though homosexuals generally have fewer children, thus implying lower genetic fitness, their helper role may have added to their inclusive fitness—especially if they substantially assisted close relatives, therefore ensuring more children in the family.

Other writers took off from Wilson's speculations, and a lively scientific debate now rages. Critics have termed sociobiology nothing more than a house of cards because, in fact, no concrete evidence of an "altruistic" or "spiteful" gene has been found. On the other hand, genetic techniques are still at the level where it might be difficult to discern them even if their location were known. In a sense, this ignorance may be bliss, for, if sociobiologists are right, it will give us some time to get used to the idea that our moral faculties reside in our cells.

See also GENE.