Chemistry

Making scads of molecular soccer balls

Give a technician a day and he or she now can make about 90 million trillion soccer-ball-shaped molecules, each tiny enough for virus-sized athletes, and collectively weighing about one-tenth of a gram. That should yield enough of the spherical structures to probe their physical properties and even to change the minds of skeptics — scientists who had likened most previous evidence for the wee carbon soccer balls to sightings of unicorns and UFOs.

In 1985, researchers in England and Houston suggested that vaporized carbon atoms from laser-blasted graphite might rearrange into exceptionally stable cage structures — most notably a 20-sided truncated icosahedron composed of exactly 60 carbon atoms (SN: 1/28/89, p.56). Researchers now refer to these and related hypothetical molecules as "fullerenes" for their resemblance to the geodesic structures popularized by the engineer and designer R. Buckminster Fuller. Many scientists have since published theories and some experimental data indicating that these carbon balls emerge in sooty combustion processes and even the clouds around stars.

However, because no one had corralled enough of the molecules to convincingly establish their structure with X-ray diffraction studies, skeptics argued that claims of the sooty sphere's existence relied more on theoretical and aesthetic pillars than on hard evidence.

Now Donald R. Huffman of the University of Arizona in Tucson and his co-workers at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, have developed a simple method for making and harvesting crystals and films made almost entirely of the 60-carbon balls. "A new form of pure, solid carbon has been synthesized," the researchers assert in the Sept. 27 NATURE. To make this material, christened "fullerite," they vaporize a bar of graphite within a helium-filled chamber maintained at about one-eighth atmospheric pressure. About 10 percent of the resulting, largely insoluble, soot consists of fullerenes — mostly the 60-carbon version with a touch of its 70-carbon cousin. These molecules dissolve in benzene, allowing the researchers to remove the insoluble soot particles that settle out. As the benzene evaporates from drops of the solution placed on microscope slides, fullerene crystals form. A battery of tests including X-ray diffraction studies indicate that the molecules in these crystals contain the chemical bonds and physical features expected from a 60-carbon fullerene.

Preparing large quantities of these fullerenes "opens the way to the examination of more properties and many technical possibilities," says crystallographer Alan L. Mackay of Birkbeck College in London. Writing in the same issue of NATURE, he speculates that fullerite might one day serve as new solid lubricants or as tiny bubbles to encapsulate smaller molecules.

Hints of a new superconductor champion

By combining thallium, strontium, vanadium and oxygen, Shin-Pei Matsuda and co-workers at the Superconductivity Research Group of Hitachi, Ltd., in Ibaraki, Japan, have cooked up a new ceramic material that they claim becomes superconducting at a record high temperature of 130 kelvins. The previous record holder for a high-temperature superconductor — a compound of thallium, barium, calcium, copper, and oxygen — shed all resistance at 122 K.

Though the Hitachi results are preliminary, "you have to take them seriously," notes physicist Mildred S. Dresselhaus at the Massachusetts Institute of Technology in Cambridge. Because copper has played prominent roles in previous high-temperature superconductors, she said its absence in the new compound may yield clues explaining these materials' tantalizing and still mysterious properties.

Food Sciences

Obesity: The role of fatty foods

Scientists continue to puzzle over why some people plump out and others remain thin. Clearly diet plays a role, but that role "may be more complicated than originally assumed," say researchers at Indiana University in Bloomington. Their latest work suggests it's the relative proportion of fat in the diet — far more than total calories consumed — that fosters obesity.

Wayne C. Miller and his co-workers surveyed diets and exercise among 107 men and 109 women. After instructing their volunteers on how to estimate dietary portions, the scientists asked them to recall food consumed over the past day, log consumption over another two days, and describe dietary preferences. In the September AMERICAN JOURNAL OF CLINICAL NUTRITION, Miller's team reports that "the only distinct difference" in eating behavior between lean and obese adults was the source of their calories. Lean men and women got about 29 percent of their calories from fat and 53 percent from carbohydrates. Obese subjects, by contrast, derived 35 percent of their energy from fat and only 46 percent from carbohydrates.

Per pound of body weight, fatter individuals ate fewer calories, the researchers found. And though svelter subjects exercised much more, Miller suspects this alone does not account for the major difference in body weights, and points to a pair of studies his team conducted in 1984 and '87. In those studies, rats receiving 40 percent of their calories from fat put on twice as much body fat as animals consuming the same calories — or even more — but receiving just 11 percent of their energy from fat. His new study now appears to extend this trend to humans: Among those eating the same number of calories, the more rotund proved to be those who routinely eat more fat.

Most U.S. diners cut back on fat

"Market basket" studies surveying what foods people buy in the United States suggest dietary-fat consumption "has changed little since the 1960s," and perhaps has increased, note Alison M. Stephen of the University of Saskatchewan in Saskatoon and Nicholas J. Wald of the Medical College of St. Bartholomew's Hospital in London, England. However, their new review of U.S. food-consumption studies portrays quite another picture — that fat intake has dropped steadily and significantly over that period. If confirmed, they said, this trend might help explain the 46.3 percent decline in U.S. coronary heart disease deaths since 1968.

Stephen and Wald analyzed 171 studies published since 1920, each involving from eight to 20,000 U.S. subjects. The pair weighted observed dietary patterns on the basis of how many people participated in each study.

U.S. fat consumption increased from an average of about 34 percent of calories in the 1930s to a high of between 40 and 42 percent in the late 1950s for men, and mid-1960s for women and children, they report in the September AMERICAN JOURNAL OF CLINICAL NUTRITION. Since the 1960s, however, fat consumption appears to have fallen "steadily," to about 36 percent in 1984.

Their review also identifies a major evolution in the consumer's choice of fats. Where saturated and monounsaturated fats accounted for 18 to 20 percent of calories in the early 1950s, they totaled just 12 to 13 percent in 1984. Over that same period, polyunsaturated fats increased from between 2 and 4 percent of calories to 7.5 percent.

If the trend toward declining fat consumption has continued since 1984, Stephen and Wald say, the average U.S. diet may already derive less than 35 percent of its calories from fat. This suggests a drop in average U.S. fat intake during the 1990s to 30 percent of calories is possible, they say — noting that even a few years ago most nutritionists considered this goal "desirable yet unrealistic for Western countries."