that would fit: an 11-atom, paddle-wheel-like structure consisting of two "hub" atoms along an axle surrounded by three paddles, each containing an additional three atoms.

In the midst of the whisker work, Van Vechten realized that this structure could also be "a natural explanation for the strong prominence of 11-atom clusters in laser [vaporization]," since that process is as violent as sputtering. Support for the stability of the structure comes from the recent synthesis of similarly shaped molecules such as propellahexaene (SN: 6/6/87, p.357).

To explain the other carbon-cluster magic numbers, Van Vechten says each addition of four carbon atoms to the 11-atom molecule would allow a stable graphite six-member ring to form along the side of one paddle. The magic number series stops at 23, he believes, because there are only three paddles in the molecule. He also thinks this molecule—unlike the chain and ring structures proposed before to explain small clusters — can account for why 11, 15, 19 and 23 are observed to be magic numbers for neutral and positively charged clusters but not for negatively charged ones.

While Princeton (N.J.) University's Leland Allen says this work is "interesting and impressive," he and others caution that it is conjectural and that the chains and rings are still very much in the running. Moreover, says Richard E. Smalley at Rice University in Houston, Van Vechten's molecule is much more reactive than the other candidate structures. This property appears to be inconsistent with experiments indicating that the 11-atom clusters are not very reactive.

Van Vechten hopes to use the 11-atom structure as the basis for making a new low-density material that improves upon the properties of graphite. "Graphite is extremely strong, but there are difficulties using it as a structural material because it tends to fracture," he says.

Van Vechten would like to try to grow carbon crystals in which the 11-atom structure is stacked into a honeycomb pattern, interlocked by carbon chains. This interlocking would prevent the honeycomb planes from slipping past one another, which is at the root of graphite's brittleness. "It looks as though this material would have an order of magnitude higher tensile strength than titanium and about a third the density," he says.

"Also, the material is clearly a metal and it's nonmagnetic, so it ought to have a superconducting-transition temperature," says Van Vechten. "Its features lead one to think that it [the temperature] would be high." If so, then he says it would have vastly better structural properties than the high-temperature superconducting materials (see p.106) that are getting so much attention now, but that are difficult to form into wires because of their brittleness. *— S. Weisburd*

Hereditary highway map: Assessing the toll

Momentum is building among U.S. scientists to create a detailed road map of the entire human gene system, or genome. Last week, geneticists, molecular biologists and computer scientists convened in Washington, D.C., at the request of the Office of Technology Assessment (OTA) to help estimate the cost of such an undertaking — a biological mission so complex it has been likened to the 1960s effort to put a man on the moon. Congress is to consider funding for the project in the fall.

Scientists expect that human-gene mapping will lead to improved diagnosis of hereditary diseases, the development of new drugs and a host of unforeseen benefits. Enthusiasm for the project has grown in the past year with the mapping of genes responsible for muscular dystrophy and neurofibromatosis, and with the discovery that certain genetic sequences are related to manic depression (SN: 10/25/86, p.261; 6/6/87, p.359; 3/28/87, p.199). But a high-resolution map showing every human gene has only recently become feasible with the development of specialized automated technologies.

Recent advances in automation have made DNA sequencing both cheaper and faster. Until recently, according to scientists at the meeting, the cost has been $1 to $2 per nucleotide base; these bases spell out the genetic code. New technologies have lowered the costs to as little as 6¢ or 8¢ per base, says Leroy Hood of the California Institute of Technology in Pasadena. And within six months, he predicts, the cost could drop to a penny a base. Such differences are significant, he says, as there are approximately 3 billion bases in the human genome, and each base will have to be mapped at least two or three times to confirm its location.

Researchers at the meeting also noted progress in the number of genetic markers — key chromosomal reference points — that have been identified (SN: 8/31/85, p.140). To date, 300 to 400 "reasonably informative" markers have been identified, says Helen Donis-Keller, a senior research director at Collaborative Research Inc., a Bedford, Mass.-based biotech research laboratory. An additional 300 to 400 such markers will be needed to develop a genetic map that would have a marker every 5 million bases — a scale that would be very useful for locating the sites of disease-causing genes, Donis-Keller says. She predicts that such a map will be completed in the next two years. Detailed nucleotide sequencing, with its ability to determine exactly which proteins are coded for by defective genes, would take many more years.

Scientists say it will be necessary to develop highly sophisticated computer programs to make sense of the huge amount of genetic data that will be generated by the mapping project. It is not unreasonable to assume that a supercomputer may be needed, according to some scientists at the meeting. And millions of dollars may be needed to train specialists with combined skills in molecular biology and computer science.

How much would the gene mapping project cost? It will be some time before OTA analysts add up the numbers. But several scientists express surprise that while much of the mapping itself could be done for $100 million, the costs of simply freezing "signpost" cell lines for future use might amount to a quarter of a billion dollars or more. "At that price," says Harvard researcher and Nobel laureate Walter Gilbert, "it would be cheaper to make the stuff all over again instead of storing it."

If in fact every important cell line were to be cloned and stored, "it would take 12 of the largest liquid-nitrogen refrigerators now available," says Robert E. Stevenson, of the American Type Culture Collection, a cell-storage bank in Rockville, Md. "We're talking about a large [liquid-nitrogen] tank farm."

Total cost of the project will also hinge on the total number of human genomes mapped, says Paul Berg, Stanford biochemist and Nobel laureate: "Whose DNA are we going to sequence? Are you satisfied with one? Is that *the* human genome?" *— R. Weiss*

High-cadmium diet: Recipe for stress?

When laboratory rats consume a diet that includes relatively large doses of cadmium, a common metal and environmental pollutant, there is increasing evidence that they become more anxious and unable to deal with stress. The latest such study, conducted by psychologist Jack R. Nation and his colleagues at Texas A&M University in College Station, finds a link between exposure to cadmium and increased alcohol consumption.

Given a choice of drinking water or a 10-percent alcohol solution, rats put on a cadmium-laced diet preferred the liquor, whereas rats munching cadmium-free food favored the water. The former group may have turned to alcohol to ease cadmium-induced anxiety, says Nation. There are other indications of increased anxiety among rats who ingest cadmium, he notes, such as an exaggerated startle response and freezing in their tracks when a loud tone is presented.

But the connection between anxiety and alcohol use is tentative, say the researchers in the September NEUROTOXICOLOGY AND TERATOLOGY, since "there is