build our philosophical underpinnings about biological structure."

The results indicate that 72 copies of a virus protein and a look-alike protein that is one-third shorter act as prongs. One end of each prong fits into one of the 72 holes formed by the bundling of the coat protein into sets of five-sided units, says Caspar. The other end extends into the genetic material of the virus, but in a less well-defined manner.

The genetic material consists of 26 nucleosomes — the basic units of chromosomes — each with DNA folded tightly around eight histone molecules. Four nucleosomes crowd together and are surrounded by the other 22, making a compactly folded, circular minichromosome, says Caspar.

The exterior protein bundles do not need any guidance — or even any genetic material inside — to assemble into a coat, but the prongs may serve to direct the coat to assemble around the right piece of DNA, says Caspar.

While the Brandeis study sheds light on this particular virus, "the subtraction method for looking at disordered structures is a general one," says Caspar. Researchers could, as the Brandeis group did, subtract the ordered structural data from data about the whole material, or they could create a computer model of the structure, subtract the model from the experimental data and then focus on what is left over. *— E. Pennisi*

Glasnost offers oil-and-gas dividend

Russian physicists have designed and begun field testing a process for converting hydrogen sulfide — a noxious waste from petroleum refining and gas processing — into two marketable products. The process requires microwave generators of a size not yet available in the United States. But researchers at Argonne (Ill.) National Laboratory acknowledged last week that they are in the final stages of developing a pair of partnerships — involving the technology's Russian developers — to transfer this process to the U.S. market.

U.S. companies already market sulfur extracted from oil and gas tainted with high concentrations of hydrogen sulfide. However, the Russian process also recovers hydrogen, a valuable energy source. The new technology thus has the long-term potential to save U.S. oil refiners some 40 to 70 trillion Btus of energy — and up to $1 billion — per year, assert John B.L. Harkness and Richard D. Doctor of Argonne.

After learning about the new technology from a theoretical paper published in a Soviet journal, a team of Argonne engineers began a program four years ago to investigate the process. Last July, Harkness finally met with physicists at the I.V. Kurchatov Institute of Atomic Energy in Moscow to compare Argonne's progress with that of the Russian team. Soviet microwave technology proved so much more advanced than anything available in the United States, says Harkness, that Argonne decided to scrap plans for developing the process independently, opting instead to piggyback the U.S. efforts onto those of the Moscow group. Mikhail S. Gorbachev's policy of *glasnost*, or openness, made this possible, Harkness says.

In recent months, the Argonne researchers have verified the conceptual design of the Russian process, using a bench-scale model to treat a gas stream that emulates those exiting sulfur-scrubbing systems at U.S. refineries. Placing the inlet to the glass reaction chamber slightly off-center forces the entering gas to swirl at a velocity near the speed of sound. Waveguides direct the energy from a microwave generator into the center of the reaction chamber.

The microwaves electronically excite the gas into a plasma — in this case, a neutral mix of hydrogen and sulfur ions missing their outer electrons. Centrifugal force then separates the ions. The heavier sulfur, flung to the walls of the chamber, condenses to a liquid and collects beneath the chamber. The lighter hydrogen gas swirls on through the chamber, from which it can be collected as a nearly pure gas.

Last week, Harkness' team firmed up plans for several U.S. industrial partners to participate in two Cooperative Research and Development Agreements (CRADAs) with Argonne and the Kurchatov Institute. "We're looking to have our CRADAs in place by June 1," Doctor says.

The new technology "shows a lot of promise," says Barry Brunsman, a chemical engineer with the Chicago-based Gas Research Institute, one of the project's industrial partners. And the potential market for this process is "substantial," he says. Most oil refineries include a sulfur-removal step, and 25 to 30 percent of all natural gas in the United States requires hydrogen sulfide removal, Brunsman notes.

Over the past two years, Russian scientists have proved "quite open — even anxious — to share technology outside the country," says Raymond F. Decker of Wavemat, Inc., in Ann Arbor, Mich., another industrial partner. And "although it's quite shocking to many people in the United States . . . , we're finding many technologies where they [the former Soviets] are out ahead of us." *— J. Raloff*

Low-level radiation has delayed effects

A brief radiation blast composed of alpha particles can kill a person within months. Even a single alpha particle zinging through the nucleus of a cell can wreak enough genetic havoc to wipe out the cell. But what if the alpha particle passes through the body of a cell, skirting its nucleus? Does it leave in its wake irreparable damage that can lead to disease?

The answer is yes, according to a new study by researchers at the Medical Research Council Radiobiology Unit in Oxfordshire, England. The team, led by Eric G. Wright, found evidence suggesting that low levels of alpha particles cause the chromosomes of laboratory-grown cells to become unstable. This genetic instability shows up as broken, twisted chromosomes in successive generations of the cells, Wright's group reports in the Feb. 20 NATURE.

The researchers believe their finding may prompt radiation biologists to change the way they assess the dangers of exposure to alpha particles and other radiation that deposits large amounts of energy, such as the products of radon decay. At present, those assessments assume that if penetrating alpha particles do not directly damage a cell's genes, the cell emerges unscathed.

Wright and his team found evidence to the contrary after exposing bone marrow cells taken from mice to one of three dosages of alpha particles emitted from plutonium-238. To set up a control group, they exposed similar cells to a single, massive X-ray dose.

The researchers discovered that 18 percent of the bone marrow cells that received the highest dose of alpha radiation survived and went on to divide, even though the team's calculations indicated that most of those cells had been penetrated by an alpha particle. But nearly two-thirds of the survivors' "daughter cells" suffered varying chromosomal abnormalities, they found. In contrast, most of the control cells died; if they did live to produce progeny, all of their daughter cells bore the same abnormality.

Wright's group concludes that cells irradiated with alpha particles "transmit to their daughter cells some chromosomal instability that may result in one or more visible cytogenetic aberrations many cell cycles later." But they caution that they have not yet figured out how an alpha particle's glancing blow could bring about such delayed effects.

In an editorial accompanying the report, H. John Evans of the Medical Research Council Human Genetics Unit in Edinburgh, Scotland, says the new indications of risk "are likely to provoke something of a stir." *— C. Ezzell*

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