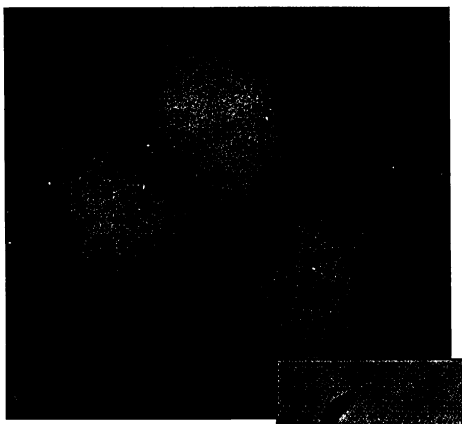
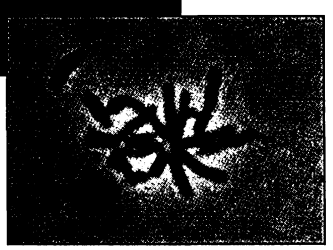




Genetic pack rats. *M. mazei* (*left*) and *R. palustris* both borrowed lots of genes from other organisms.

lution control, and better recycling of both natural and human-made products—which is why DOE funds microbial genetics in the first place.

One newly deciphered microbe is *Methanosarcina mazei*, a methane-generating archaea. Unlike most of its brethren that live in thermal vents and other hot environments, *M. mazei* thrives in freshwater sediments worldwide. Versatile in other ways as well, it can harvest the carbon it needs from acetate and so-called methylamines—and not just carbon dioxide. That makes *M. mazei* a "really major player" in the production of methane, a greenhouse gas, says Gerhard Gottschalk, a microbiologist at the University of Göttingen in Germany.

When Gottschalk and his colleagues started sequencing *M. mazei*'s genome 3 years ago, they expected it to be a tidy 3 million bases or less, as are the genomes of two other methanogens sequenced to date. Instead, Gottschalk reported at the meeting, *M. mazei*'s single circular chromosome proved to be 4.1 million bases long, about the size of the bacterium *Escherichia coli*. Its chromosome contains several sets of the same genes, apparently providing unanticipated redundancy for particular functions.

But it's the source of many of its genes that has researchers excited. "The amazing thing is that there were so many eubacterial genes," comments James Lake, an evolutionary biologist at the University of California, Los Angeles. Often microbial genomes reveal instances of horizontal gene transfer from one organism to another. "But it's never happened quite like this," says Lake. Of the 3300 predicted genes, about 1100 look like they used to belong to bacteria, Gottschalk reported. No one understands why this happened, but these numbers drive home "how little we understand about species' definitions," adds Judy Wall, a biochemist at the University of Missouri, Columbia.

The other microbe, *Rhodopseudomonas palustris*, a so-called purple nonsulfur bacterium, also comes with a panoply of unexpected genes. "The biggest surprise," says Lake, "is that it carries circadian rhythm genes." These genes were not thought to be part of the repertoire of bacteria or archaea, with the exception of an unusual group called the cyanobacteria, says Caroline Harwood, the microbiologist at the University of Iowa, Iowa City, who has been analyzing this microbe's gene content for the past year. Their presence suggests that these organisms are more sophisticated than microbiologists had suspected.

Another surprise is that this bacterium's genome more closely resembles the genomes of rhizobium bacteria that fix nitrogen for plants than those of other purple nonsulfur bacteria, Harwood reported. In particular, it has an unusual cluster of photosynthetic genes that are very similar to those in a rhizobium that infects soybean stems. Either this microbe borrowed a lot of genes from the rhizobium, or else the two are closely related. Finally, its genome revealed a plethora of genes that enable this microbe to break down complex organic matter—something other purple nonsulfur bacteria don't do—as well as fix nitrogen and produce hydrogen gas. "It's just an amazing collection of pathways," says Drell. But one would expect nothing less of a genetic pack rat. **–ELIZABETH PENNISI**

CREDITS: (TOP TO BOTTOM) SEBASTIAN BÄUMER; CAROLINE S. HARWOOD/UNIVERSITY OF IOWA

SELF-ASSEMBLING MATERIALS

Coated Nanofibers Copy What's Bred in the Bone

If imitation is flattery, Sam Stupp has just paid nature a high compliment. On page 1684, Stupp, a materials scientist at Northwestern University in Evanston, Illinois, and his postdocs Jeffrey Hartgerink and Elia Beniash report creating a self-assembling material, made from organic molecules with a mineral coat, that closely mimics bone. The feat opens the door to making a synthetic replacement for bone. And because the chemistry of the self-assembling molecules is simple to change, it also gives researchers a general strategy for forming a wide array of organic-inorganic fibers.

"It's a major step forward" for the field of self-assembled materials, says Ulrich Wiesner, a chemist at Cornell University in Ithaca, New York. The new work, Wiesner says, distills the essential lessons that have been learned about how bone forms and incorporates them into a synthetic molecule that is simple to produce. "It connects the

ScienceScope

U.K. Cloning Controversy A legal ruling on a law governing embryo research might allow Italian fertility doctor Severino Antinori to attempt human reproductive cloning in Britain. On 15 November, Britain's High Court ruled that the Human Fertilisation and Embryology Act, passed in 1990 and amended last year, covers only embryos created by the union of sperm and egg and not those created by nuclear transfer procedures—i.e., cloning. A day later, Antinori told BBC television he planned to exploit the loophole by setting up a baby-cloning program in Britain, an idea the government opposes.

Some scientists, however, would like to create genetically matched pluripotent stem cells from cloned embryos, and last year Parliament voted to allow such limited cloning. Last week's ruling—in response to a lawsuit by British abortion opponents—apparently nullifies that vote and calls into question the government's ability to allow just certain types of cloning. After their victory, antiabortion groups called for quick legislation outlawing all forms of human cloning, but the government said it will appeal the decision.

The ruling does not end the government's ability to regulate stem cell research. Studies on cells derived from embryos not created by cloning are still overseen by the government.

Sound Bites It's pretty hard to argue with a commitment to research excellence. Or more interdisciplinary collaborations, or helping underserved populations. So the Canadian Institutes of Health Research (CIHR) won't need to spend much time defending its new suggestions for strengthening the country's health research.

But CIHR president Alan Bernstein warns scientists that these fuzzy generalities may take on a harder edge when used for judging funding proposals. "If someone puts forward a large initiative that doesn't fall into these [categories], they'll have to articulate a clear reason why it should be considered," Bernstein says.

In particular, Bernstein suggests that biomedical scientists figure out how to take advantage of hot areas such as bioinformatics and combinatorial chemistry. "This is, to some extent, my own view of where the action is going to be," he says. Whatever idea they pitch, he adds, researchers should spell out how it will "build Canada's international leadership through national excellence in health research."

Contributors: Mark Russell, Eliot Marshall, Gretchen Vogel and Aude Sonneville, Wayne Kondro

synthesis of artificial materials with lessons from biology. That interface is very, very exciting," Wiesner says.

Researchers at the frontier of materials science have long looked to nature for inspiration in synthesizing complex materials. Bone has been among the most enticing to emulate because of its strength and structure. At its simplest level, bone is a composite made when proteins in collagen fibers coax calcium, phosphate, and hydroxide ions in solution to condense atop the fibers and grow into a rigid structure of tiny crystallites of hydroxyapatite all aligned in the same direction. Hydroxyapatite gives bone its toughness.

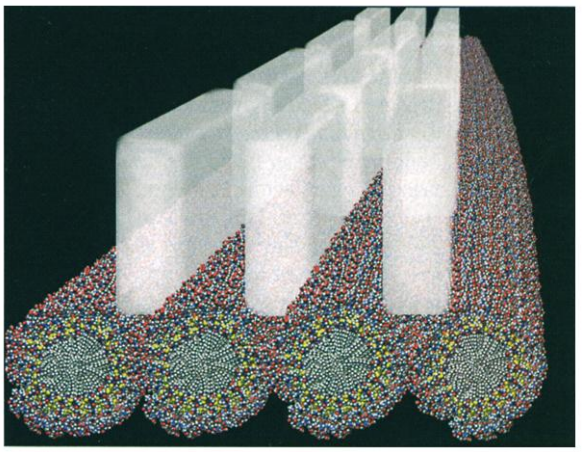
Over the years, several research teams have induced hydroxyapatite crystallites to grow atop other materials such as polymers. But they've never managed to align the crystallites with any material other than collagen, the protein fibers that nature picked for the job. So Stupp and his colleagues decided to see if they could design purely synthetic molecules to carry out the task.

From previous work in his own lab and others, Stupp knew that synthetic molecules could at least carry out the first task, assembling themselves into fibers. The trick was to make two-part molecules, with a water-friendly group at one end linked to an oily hydrocarbon at the other. When placed in water, these spontaneously assemble into loosely connected fibers called micelles as the hydrocarbon tails pack tightly together to avoid associating with water.

The Northwestern researchers designed two-part organic molecules called peptide-amphiphiles (PAs), in which the oily hydrocarbon chains were connected to a series of peptides, essentially short protein fragments. To carry out the second part of their task—growing the hydroxyapatite on top—the scientists had to design in a couple of other functions as well. First, they added peptides to their PAs that could form links with one another to lock the flimsy micelles into resilient fibers. Second, they added negatively charged peptides rich in phosphoserine groups, which previous biochemical studies had shown help collagen attract the positively charged ions that form hydroxyapatite crystallites.

Much to the team's surprise, the PAs not only formed fibers and slipped on a coat of hydroxyapatite crystallites, but also got the crystallites to adopt the same crystallographic organization as in bone. Stupp says the team is still trying to understand this bit of good fortune. "The bottom line is, we don't know the exact mechanism why our crystals end up aligned just as in bone," Stupp says. But it's clear the fibers play a vital role. "If we don't have the fibers [in solution], the crystals don't form," Stupp says. He suspects that the fibers are so small that they allow the crystals to grow in only one direction, along the length of the fibers.

Stupp says much more work is needed to understand the new bone-mimicking molecules. But his team is already looking beyond bone. In their paper, the researchers also describe how they added peptides with a trio of amino acids—arginine, glycine, and aspartic acid—which readily attract cells and encourage them to bind to a particular surface. Eventually, Stupp hopes, his team will be able to use PA fibers to repair damaged nerve tissue by coaxing neurons to attach and grow on the fibers. And by changing the peptides, Stupp believes, he and his colleagues will be able to assemble other types of crystals, metals, or even polymers to make everything from high-strength composites to nanowire circuitry for molecular-based computers. In that case, Stupp and his team may find themselves flattered with a little imitation of their own. –ROBERT F. SERVICE



Close copy. Synthetic molecules assemble into fibers that coax minerals into growing on top, a structure that mirrors bone.

CREDIT: J. HARTGERINK

ANIMAL WELFARE

Congress Clears Way For Rodent Rules

Animal rights groups have won the latest round in their long-running fight to force the U.S. government to more tightly regulate the use of mice, rats, and birds in scientific research. Congress last week approved an agriculture spending bill that allows the U.S. Department of Agriculture (USDA) to start developing the new rules, which biomedical groups blocked last year in an 11th-hour lobbying victory.

"Finally, we can get started [on regulations] that will be good for animals and for science," says lobbyist Nancy Blaney of the Working Group to Preserve the Animal Welfare Act, a coalition of animal rights groups. But Tony Mazzaschi of the Association of American Medical Colleges, which opposes the idea, says the decision is "disappointing; all this would do is create costly paperwork for research institutions."

The controversy stems from a 30-year-old USDA policy that exempts mice, rats, and birds—which account for 95% of all experimental animals—from regulation under the Animal Welfare Act (AWA). Last year, after several court battles, USDA signed a pact with animal rights groups and agreed to draft caging and care rules. The deal outraged biomedical groups, which argued that USDA regulation would duplicate existing government and voluntary rules and drain millions of dollars from research accounts. They quickly convinced Senator Thad Cochran (R–MS) to block USDA action by adding a ban to the 2001 agricultural appropriations bill (*Science*, 13 October 2000, p. 243).

This year, Congress seemed ready to continue the freeze after the House included the ban in its version of the agriculture measure. But the Senate balked after Democrats took control this spring. As a result of the switch, Senator Herb Kohl (D–MI) took over the subcommittee that oversees agriculture spending from Cochran. Lobbyists say Kohl—who is considered friendlier to animal rights groups—was instrumental in hammering out the compromise language included in this year's bill. It allows USDA to begin writing the regulations and seek public comment, but it bars the agency from finalizing any rules before 30 September 2002, when the annual measure expires. The open deadline gives lawmakers a chance to revisit the issue next year.

The lack of closure "won't have an effect on the process," however, because getting new regulations approved routinely takes years, says John McArdle of the Alternatives Research and Development Foundation in Eden Prairie, Minnesota. He has long pushed for AWA regulation because the law requires researchers to consider alternatives before using animals for experiments.

It's not clear how rapidly the USDA will push ahead, however. USDA officials were not available to comment, and Mazzaschi says the Bush Administration "isn't anxious to move forward." But Blaney expects the agency to "start work as soon as the president's signature is dry" on the funding bill, which could be this week. If it doesn't, both sides agree, the matter could end up back in court.

–DAVID MALAKOFF