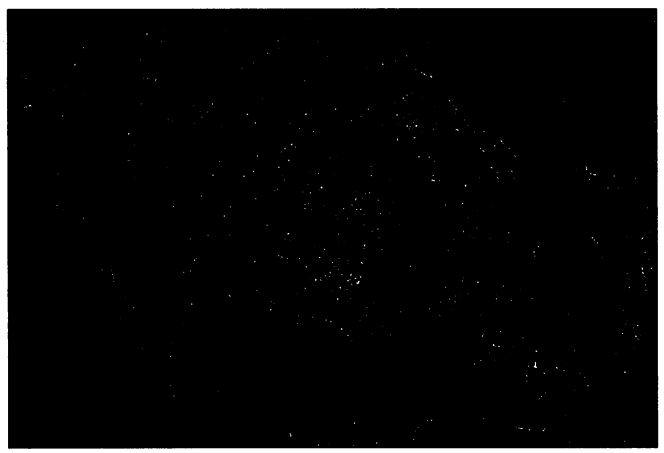
on the screen, the [cardiologists] were like little kids again," says Kuzmitz. "They couldn't believe what they were seeing."

The rare specimen—the first dinosaur heart known—was discovered inside the nearly complete skeleton of *Thescelosaurus*, a small, plant-eating dinosaur, as Kuzmitz and his co-authors report on page 503 of this issue. The heart's anatomy is more like that of birds and mammals than crocodiles or other reptiles, the team says. And a heart that beats like a bird's suggests that this dinosaur's metabolic rate would have been more like that of an endotherm (a warm-blooded animal) than an ectotherm (a cold-blooded animal), providing yet another feature shared by dinosaurs and their putative feathered relatives, the team asserts.



Heart of the matter. Stone concretion inside this dinosaur's ribcage turned out to be its heart.

"I'm afraid that this little dinosaur would have had an 'unreasonably' high metabolic rate, one approaching that of birds," says co-author Dale Russell of the North Carolina State Museum of Natural Sciences and North Carolina State University in Raleigh. Until now, Russell has been skeptical about the evidence suggesting that dinosaurs' metabolic rates reached those of birds.

Some researchers want to inspect the evidence personally before accepting that the concretion is a heart, and others are already challenging the anatomical interpretations, but most are impressed. "It is a fantastic discovery," says Jack Horner, a dinosaur paleontologist at Montana State University's Museum of the Rockies in Bozeman. "It just shows you what you can find if you keep your eyes and mind open."

Michael Hammer, a professional fossil preparator from Jacksonville, Oregon, chanced on the skeleton in South Dakota's Hell's Creek Formation in 1993. Tucked beneath the dinosaur's upper ribcage in its thoracic cavity was a rust-colored concretion, the kind of annoying rocky material that paleontologists typically chisel away when cleaning a specimen. Hammer, however, knew that such concretions sometimes carry a surprise; he has unearthed similar concretions along the Pacific Northwest coast and carefully broken them open to find entire fossilized crabs or the heads of seals. "I think of them like little treasure boxes," he says. "You never know what's going to be in them." But Hammer also knew that soft tissue preservation is unlikely in such sandstone sediments.

"That's not where you normally find these kinds of things," agrees Paul Sereno, a paleontologist at the University of Chicago. "It's not an anoxic environment. ... That, and the absence of any other traces of nonskeletal tissues, raises a major red flag for me. I'd need to examine this before I'd agree that it's a heart."

But the paper's authors suggest that chemical reactions between the blood- and iron-rich heart and minerals in the groundwater preserved the shape of the once-beating organ. And they think their CT scans will convince skeptics. "The CT scans basically sliced the heart up like a loaf of bread," explains Paul Fisher, director of the Biomedical Imaging Facility at North Carolina State University and the study's lead author.

To study the heart, the team realigned the "slices" with a special software program, turning the two-dimensional images into several three-dimensional ones that could be rotated and manipulated on a computer screen. The images revealed the heart's ventricles and a single, large blood vessel—the systemic aorta—leading from the heart toward the back of the chest. One image of the rib cage and heart is so clear, says Kuzmitz, that it looks like a "carcass that should be hanging from a meat hook."

Despite the detail, the scan does not show all of the expected blood vessels. The pulmonary vessels, carotid arteries, and both atria are not visible; they may have collapsed at death or simply are not resolved in this scan, the team says. But other researchers say that the missing pieces leave the heart's anatomy and physiology open to other interpretations. "There's no apparent trace of other major vessels that we know would have been there in life," says John Ruben, a physiologist at Oregon State University in Corvallis. "So they can't say that there wasn't a second major systemic vessel leading from the right side of the heart"—as seen in cold-blooded, ectothermic crocodiles and alligators, but not in birds or mammals. "I think it's premature for them to say this is a heart of an endotherm."

The team plans a finer CT scan to address this question. In the meantime, they argue that their interpretation is the "most logical and parsimonious," says Russell.

The find is certain to propel paleontologists to look for similarly preserved internal organs. "It's going to open up a field of research about how things like this get preserved, especially in a sandstone environment," says Thomas Holtz, a paleontologist at the University of Maryland, College Park. "And it's certainly going to change the way we prepare fossils." Indeed, Horner has a nearly complete dinosaur skeleton that will be getting an entirely different examination than it would have a week ago, he says: "We're only just beginning to learn what things can be preserved. I don't think this is the last dinosaur heart we're going to find."

–VIRGINIA MORELL

Dinosaur heart can be viewed at www.dinoheart.org

CREDIT: JIM PAGE/NC STATE MUSEUM OF NATURAL SCIENCES

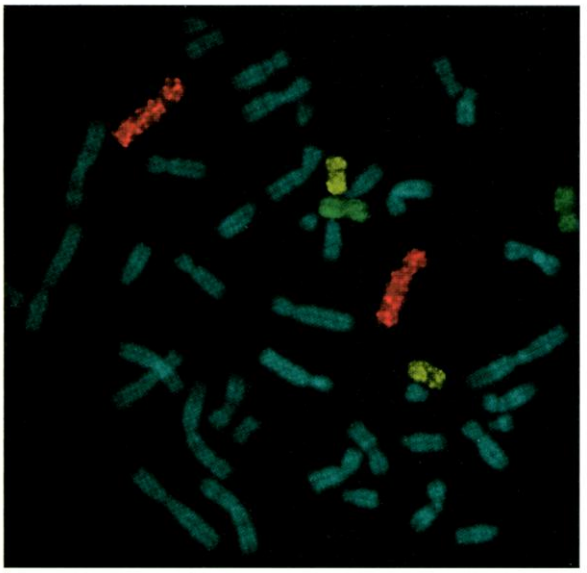
HUMAN GENOME

DOE Team Sequences Three Chromosomes

Last week, the U.S. Department of Energy (DOE) elbowed its way into the spotlight with other groups that have been getting attention for sequencing the human genome. Although the Human Genome Project originated in part in DOE laboratories in the 1980s, DOE's contributions have been overshadowed in recent years by giant sequencing operations supported by the Wellcome Trust in the United Kingdom and the National Human Genome Research Institute in the United States, and the private sequencing venture pursued by Celera Genomics of Rockville, Maryland. But DOE is back: On 13 April, DOE Secretary Bill Richardson announced that it has finished the working drafts of human chromosomes 5, 16, and 19. These chromosomes are the first to reach this stage since Britain's Sanger Centre and its partners finished chromosome 22 to finer accuracy in December.

The DOE's dedicated program, the Joint Genome Institute (JGI), is part of a 16-member consortium that is scrambling to complete a draft of the human genome's 3 billion DNA bases by June and produce a 99.99% complete version by 2003. Like other members of the consortium, DOE releases sequence data to the public daily with no restrictions. Later this year, Celera plans to release its human genome data through its own Web site, strictly for noncommercial use.

DOE's chromosomes, sequenced at least



Hat trick. DOE sequencers score with rough drafts of chromosomes 5 (red), 16 (green), and 19 (yellow).

three times each, contain 300 million bases and an estimated 12,000 genes, Richardson reported at the R&D Colloquium, a meeting in Washington, D.C., sponsored by the American Association for the Advancement of Science (*Science*'s publisher). "I'm very proud," Richardson said, noting that some of the genes are involved in diabetes, cancer, and other important diseases. "We're close to completing three chapters on the book of human life."

Those "chapters" are still in draft form, however, containing up to one mistake in every 100 bases and only about 90% of the gene-containing DNA in each chromosome. In contrast, chromosome 22 is 99.99% accurate (*Science*, 24 September 1999, p. 2038). Next in line for completion is chromosome 21, which the public consortium expects to have in final form in a few weeks. Meanwhile, JGI labs at Stanford University and the Los Alamos National Laboratory in New Mexico plan to produce a fully finished version of chromosome 19 by the end of 2000; they hope to complete chromosomes 5 and 16 a year later, says JGI sequencing chief Trevor Hawkins, in Walnut Creek, California. In addition, Hawkins says, JGI is working on stretches of DNA from the mouse that are equivalent to the three human chromosomes, to speed discoveries about the functions of the genes.

JGI's news represents a milestone for DOE management, which had invested in new technology and a slightly different approach to sequencing the genome. Unlike other labs, which use a bacterial phage called M-13 in the final step of sequencing, DOE chose to use bits of DNA called plasmids, which provide order and orientation even of draft sequence. Moreover, JGI decided not to rely on the popular Applied Biosystems capillary sequencing machines but to buy 84 machines made by a competitor, Amersham Pharmacia Biotech. Working out the kinks took a lot of dedication: One night, lab manager Susan Lucas was discovered in the lab in her pajamas. But the effort paid off, Hawkins notes: "We've had a 10-fold increase in throughput and efficiency in the last 8 months."

His colleagues are impressed: "Their performance has been remarkable," says Richard Gibbs, who heads the sequencing effort at Baylor College of Medicine in Houston. Leroy Hood, president of the Institute for Systems Biology in Seattle, goes further, saying that JGI's process improvements suggest that its performance has been "even better" than the labs funded by the National Institutes of Health. **–ELIZABETH PENNISI**

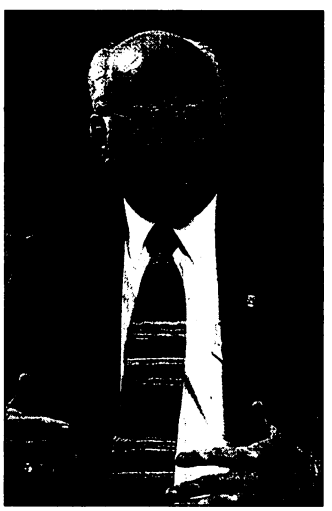
CREDITS: (TOP TO BOTTOM) E. HILGENFELD AND T. REID; SAM KITTNER

SCIENCE EDUCATION

Ehlers Offers Remedies For Ailing U.S. System

Joined by a fellow Republican and a Democrat, and with backing from scientific, professional, and educational societies, Representative Vern Ehlers (R–MI) last week unveiled three bills to improve science and math education in the nation's elementary and secondary schools.

The long-awaited proposals would create several programs at the National Science Foundation (NSF) and provide tax breaks and incentives for teachers to join and remain in the profession. The legislation tackles problems that Ehlers identified in his 1998 report on the state of U.S. science (*Science*, 31 July 1998, p. 635). But unlike that policy report, which was requested by the House leadership and sank without a trace, Ehlers says he will fight to get his education bills enacted.



Talk therapy. Representative Ehlers hopes his bills will stimulate interest in education reform.

Ehlers knows that he faces an uphill battle to win the support—or even the attention—of a majority of his colleagues in both houses of Congress, currently wrangling over a host of bills that would revise federal education policies. So he has assembled an impressive roster of supporters, including the American Chemical Society, the National Science Teachers Association, and Nobelist Leon Lederman, to lobby for his measures. "The formula for safe passage through the rapid technological change in our society is science education," says Lederman, the former director of the Fermi National Accelerator Laboratory. "We already know how to improve things, but we need leadership and a central strategy. I applaud Mr. Ehlers for taking the initiative."

The centerpiece of the reforms is the National Science Education Act (H.R. 4271). It directs NSF to create a variety of programs, including grants for schools to hire master teachers in math, science, and technology education, professional development in new technologies, and scholarships for teachers to carry out collaborative research. It would also set up an advisory panel to spread the word about exemplary curricula, an exercise that has already gotten the Department of Education into hot water with many conservative groups (*Science*, 11 February, p. 956). Companion bills would give a 10-year, $1000-a-year tuition tax credit to science and math teachers and beef up in-service and summer training institutes.

Ehlers pointedly refuses to put a price tag on his proposals, saying only that they would cost a tiny fraction of the current $20 billion federal investment. At a press conference last week, fellow House Science committee member Representative Sherwood Boehlert (R–NY) took a dig at his more fiscally conservative colleagues by urging them "to resist the temptation to cut taxes too much and instead put adequate resources into areas of need, including science education." Representative Eddie Johnson (D–TX) noted that a better trained workforce would cut down on the cost of remedial programs and reduce the need to hire foreign scientists and engineers.

NSF officials praise Ehlers's interest but express concern over whether they would receive additional funds to pay for the added responsibilities. The bills will be referred to the science, education, and tax committees. Even if passed, however, they would need the support of a separate set of spending panels before any of Ehlers's ideas could be implemented. **–JEFFREY MERVIS**