Others are trying to modify the viruses so that they will make the cells more susceptible to traditional cancer treatments as well as kill them directly.

For example, at Massachusetts General Hospital in Boston, neurosurgeon Antonio Chiocca and his colleagues have added a rat gene for a protein called cytochrome P-450 to the genome of a herpesvirus. Cytochrome P-450 converts cyclophosphamide, a drug used for cancer chemotherapy, to its active form. Consequently, as this virus spreads through a tumor, it not only kills the cells directly but also makes them susceptible to cyclophosphamide. Chiocca's team is now evaluating this virus in animal studies. And there's talk of putting in genes for compounds that will make a tumor more sensitive to radiation. "That's the beauty of this viral technology: With one agent you can deliver an oncolytic effect, a pro–drug activating effect, even a radiation-sensitizing effect," Chiocca says.

Of course, early excitement about a potential cancer therapy often gives way to disappointment, or at least realism. "Caution must be exercised, since the long-term side effects are not really known," says Linke. But the concept of making tumors get sick and fade away has undeniable appeal, says Simons. "This is the kind of thinking we need in new cancer pharmacologies.

–ELIZABETH PENNISI

PALEONTOLOGY

Popular Interest Fuels a Dinosaur Research Boom

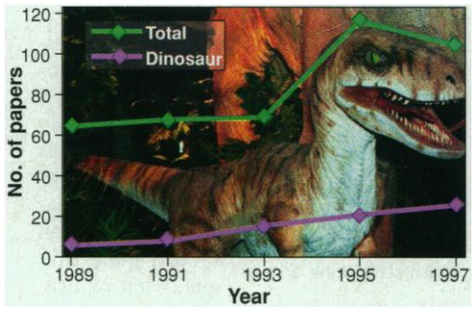
Paleontologists are learning to capitalize on the popularity of dinosaurs, and new discoveries, labs, and exhibits are the result

In 1994, paleontologist Cathleen May was running out of time and money. The University of California, Berkeley, graduate student had discovered an *Apatosaurus* skeleton in Curecanti National Recreation Area, near Gunnison, Colorado, but the bones were in danger of eroding away and her grant from the National Park Service was too small to excavate them. Many a similar skeleton has been left in the field for lack of funds, but May found an unexpected savior: Hollywood. She hooked up with an L.A. animation firm keen on creating a virtual dino dig for kids, gave interviews, let the company film the site, and wound up with $24,000 over 2 years. That was enough to finish the dig. The 20-meter-long *Apatosaurus*, one of the oldest known, is now headed for the Museum of Western Colorado in Grand Junction.

Hollywood isn't such an unlikely sponsor these days. After 65 million years of extinction, dinosaurs have conquered school yards, bookstores, and the video rental market. And the insatiable public appetite for the beasts is boosting research. Students are crowding into dinosaur paleontology classes, corporations and philanthropists are pledging support and donating specimens, and money is flowing into the field from movie and book spin-offs. Such nontraditional funding has its dangers, and despite all the activity, few researchers are flush with funds. But some say such sources are the key to survival for dinosaur paleontology.

Many researchers agree that popular enthusiasm and funding have combined with new discoveries to reanimate the field. A new analysis suggests that the number of dinosaur papers is on the rise, and new positions are appearing at a time when other areas of paleontology are barely holding steady. Spectacular fossil discoveries follow one upon another. This issue of *Science* reports the latest find: an African specimen with a fish-eating, crocodilelike skull, which paleontologist Paul Sereno of the University of Chicago and his colleagues describe on page 1298.

The field wasn't always so active. Dinosaurs have long been popular with the public, but scientifically they were a sleeper from the 1930s through the 1970s. Despite big dinosaur exhibits, most major museums had no Ph.D. dinosaur paleontologist. "Dinosaurs were considered gee-whiz things, good to show to the public but not particularly important from an evolutionary point of view," recalls Edwin Colbert, retired curator of dinosaurs at the American Museum of Natural History (AMNH) in New York City.



Hungry for more. Dinosaur money has helped fatten the pages of the *Journal of Vertebrate Paleontology*, allowing more papers to be published in all fields, including dinosaurs.

But in the 1970s, the field was rocked by the controversial idea that dinosaurs were warm-blooded and active like birds. The notion that the last dinosaurs were wiped out by an asteroid impact stirred even more interest. From then on, research seemed to take off: Since 1969, the number of dinosaur genera described has more than doubled, to about 350, notes Peter Dodson of the University of Pennsylvania School of Veterinary Medicine in Philadelphia. Papers have surged too. Back in the late 1980s, only about one in 10 papers in the *Journal of Vertebrate Paleontology* was on dinosaurs, according to a new analysis by Richard Cifelli, a mammal paleontologist at the University of Oklahoma, Norman, and former *JVP* editor. But by 1997, almost 25% of the articles in *JVP* were on dinosaurs (see figure).

Many paleontologists say that public interest bordering on mania has pumped specimens, students, and even jobs into the field. The movie *Jurassic Park*, for example, grossed nearly $900 million—vastly more money than all government agencies combined have ever spent on vertebrate paleontology. Although scientists don't share directly in these profits, the enthusiasm those figures reflect "doesn't hurt," admits Sereno, who has been featured in a half-dozen television documentaries and was listed as one of *People* magazine's 50 Most Beautiful People in 1997.

In 1986, paleontologist Timothy Rowe's first year at the University of Texas, Austin, his dino survey class had one of the largest enrollments in department history. "In some ways it's been my meal ticket here," he says. The next year, when he added labs to the course, he was able to fund six graduate students in paleontology as teaching assistants. Because many public universities distribute funding by the number of undergraduates taught, "a course that brings in 500 students really turns heads," says mammal expert Cifelli, who also teaches a dinosaur survey course.

And although many of the larger museums still haven't hired dinosaur specialists, popular interest has fueled the birth of regional museums that rely on dinosaurs as the main attraction, such as the Museum of the Rockies in Bozeman, Montana, and the Royal Tyrrell Museum of Paleontology in Drumheller, Alberta. "Where there used to be five museums where you could see dinosaur collections, now there's literally hundreds," says Sereno. Each one creates op-

SOURCE: R. CIFELLI/UNIVERSITY OF OKLAHOMA, NORMAN; PHOTO: MICHAEL SCHEMELLING STRINGER/AP

portunities for paleontologists.

When it comes to research money, private support can make a huge difference, because agencies give only moderate support to paleontology. Last year, the National Science Foundation gave out about $1 million worth of new grants in vertebrate paleontology; almost half went to three dinosaur projects. The National Geographic Society handed out almost $316,000 to vertebrate paleontologists. But the *JVP* has received $500,000 in private donations in the past 4 years for supporting fossil preparators and paying publishing charges in *JVP*.

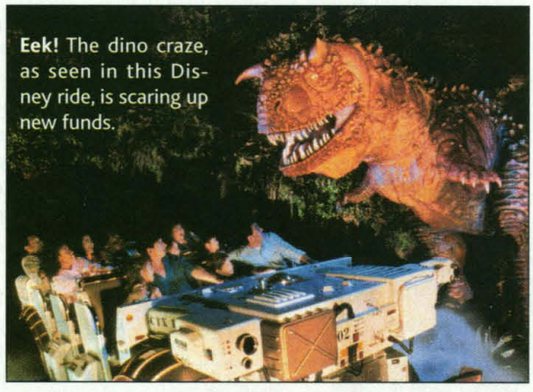
And more than 70 researchers got small grants from an organization called The Dinosaur Society, founded in 1991. Two years later, the society teamed up with Steven Spielberg and Universal Studios to put out a traveling exhibition based on *Jurassic Park*, showcasing casts of skeletons and eggs, as well as studio props and merchandise. Part of the proceeds went to the society, which began to give out peer-reviewed grants for dinosaur research, often supporting exploratory field trips that agencies won't fund. By 1997, when the exhibition was canceled, the society had handed out more than $980,000. "The Dinosaur Society was an experiment of science going into business, and it worked," says Steve Gittelman, president of a marketing firm who served as the society's second president. In addition, since May 1997, the Jurassic Foundation has amassed about $150,000 from *The Lost World* exhibit, which will be distributed as grants next year.

Other private foundations also dig deep for dinosaur research. Sereno has received substantial support from the Packard Foundation and Pritzker Foundation. Rowe thinks that dinosaur appeal helped him win a major grant from the Keck Foundation for a high-resolution computed tomography scanner.

A few enterprising paleontologists have managed to tap public interest in other ways. Lou Jacobs, a mammal paleontologist at Southern Methodist University in Dallas, wrote two general-interest books about Texas dinosaurs. In the early 1990s, a chain called Half Price Books, headquartered in Dallas, agreed to donate their profits on the books—about $50,000 so far—to paleontology.

Sometimes the fossils themselves are sources of funds. When the most expensive fossil in the world, a *Tyrannosaurus rex* named Sue, was bought at auction in 1997 for $8.4 million, the Field Museum of Natural History in Chicago enlisted the support of McDonald's, Disney, and the California State University system. The deal will support a prep lab, two staff positions, six preparators, and a postdoc.

Indeed, corporations hold the big money, and they're often willing to spend some in exchange for a tax break and cheap advertising.



Eek! The dino craze, as seen in this Disney ride, is scaring up new funds.

Mercedes Benz supplied field vehicles for the recent AMNH expeditions to the Gobi desert, and American Airlines flew 6 tons of African dinosaur fossils and some of Sereno's crew back to the United States in 1993. "The possibilities are unlimited," says May, who is now director for Policy and Environmental Issues at the Geological Society of America.

But paleontologists are often uneasy with corporate funding. Potential donors must be catered to, says Gittelman. "These things irritate the psychology of the scientist," he says, "and most of them won't do it." Partly it's the worry of a stigma. "Nontraditional sources are still almost like dirty money," says May, "because they may be—and often are—generated not on the scientific importance of the endeavor but on spin-off benefits like education or career training or goodwill value." And the visibility sometimes gives the mistaken impression that dinosaur research is richly funded, says Sereno. In fact, he says his work is "a hand-to-mouth operation."

Yet other paleontologists don't seem to begrudge the popularity of dinosaurs. "This rise fuels a lot of the rest of the science, so those of us who don't work in dinosaurs are perfectly delighted with these trends," says Cifelli. "Dinosaurs are a vehicle for highlighting other specimens," says mammal paleontologist John Flynn of the Field Museum. "People love those extinct things that represent a different world. Dinosaurs are just one heightened example of that."

–ERIK STOKSTAD

CREDIT: (TOP) THE WALT DISNEY CO.

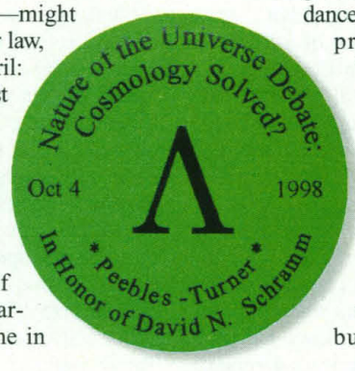
COSMOLOGY

Does Science Know the Vital Statistics of the Cosmos?

Cosmologists recently debated whether signs of a background energy in empty space point to a unified picture of the origins and makeup of the universe

Nelson Algren, the Chicago writer, said he lived by just three rules, two of which could be listed in polite company: Never play cards with any man named "Doc" and never eat at any place called "Mom's." Viewers of the face-off called "Great Debate III: Cosmology Solved?"—pitting the University of Chicago's Michael Turner against Princeton University's James Peebles in a crowded auditorium on 4 October—might have come up with another law, to be violated at great peril: Never debate a cosmologist whose viewgraphs are considered objets d'art.

The artful cosmologist is Turner, whose colorful creations were once the subject of a one-man exhibition. With the help of flamboyant graphics, he argued that for the first time in history, cosmologists have a credible handle on the origin, overall makeup, and ultimate fate of the universe.



Symbol of unity. The Greek letter lambda, representing the background energy called the cosmological constant, appeared on badges at the cosmologists' debate.

His case, made to an audience of several hundred astronomers, students, and interested nonspecialists at the National Museum of Natural History in Washington, D.C., drew heavily on this year's observations of distant, exploding stars called supernovae. In Turner's optimistic view, these cosmological beacons have helped bring previously conflicting evidence into an eerie concordance. As one of the viewgraphs proclaimed in fat letters, "Cosmology solved? Quite possibly!"

By showing that the universe is expanding at an accelerating rate rather than slowing from the force of gravity, the supernovae imply that the bulk of the universe consists not of matter but of a mysterious background energy called the cosmological constant. In Turner's picture, this energy acts as a cosmic deus ex