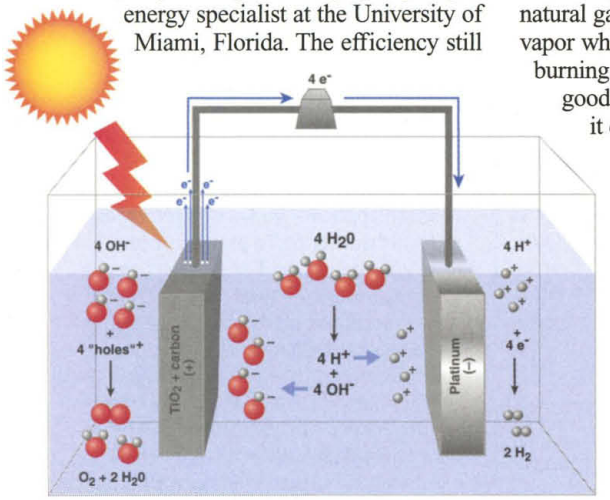
adding carbon to the well-known water-splitting catalyst titanium dioxide increased the material's ability to absorb visible light. The change boosted the catalyst's ability to convert the energy in sunlight more than eightfold, to 8.5%. "That's an excellent result," says T. Nejat Veziroglu, a hydrogen energy specialist at the University of Miami, Florida. The efficiency still falls just below the U.S. Department of Energy's 10% benchmark for a commercially viable catalyst, notes Eric Miller, an electrical engineer at the University of Hawaii, Manoa. But he says Khan's team has a real chance to clear the hurdle: "It's a good lead in a good direction."



Hydropower. In an electrolyte, water molecules (center) split into H^+ and OH^- ions, which sunlight and catalysts turn into oxygen and water (left) and hydrogen gas (right).

Researchers started experimenting with TiO_2 as a water-splitting catalyst in the early 1970s. Like other semiconductors, TiO_2 absorbs photons, which excite electrical charges in the material. These charges can then break apart water molecules to produce hydrogen gas (see diagram). TiO_2's big advantage is that it is stable under prolonged sunlight, and the material, which is added to everything from paint to sunscreen, is cheap. But TiO_2 also has a big drawback: It absorbs only ultraviolet light, a small fraction of the spectrum of sunlight that reaches Earth. That finickiness makes TiO_2 an inefficient hydrogen-gas generator, converting less than 1% of the energy in sunlight to chemical energy in hydrogen.

Researchers have developed much more efficient catalysts, including other inorganic semiconductors such as gallium arsenide and TiO_2 laced with dyes that absorb visible light. But crystalline semiconductors such as gallium arsenide are expensive, and the TiO_2 dyes are unstable in the charge-carrying electrolytes that must be added to working water-splitting systems.

Khan suspected that part of the problem was that the high-temperature process of turning titanium metal to TiO_2 created other types of compounds in the mix that do a poor job of absorbing light. He also knew that water vapor helps oxidize titanium metal to TiO_2. So Khan's group designed a precisely controlled furnace and placed a sheet of titanium metal in a flame of natural gas. Methane, the most abundant component of natural gas, breaks down into CO_2 and water vapor when it burns. Khan's team found that burning the titanium metal at 850°C did a good job of oxidizing the titanium. But it did something else as well: It added some carbon to the mix.

When Khan and colleagues tested their new material as a water-splitting catalyst, they got a pleasant surprise. Unmodified TiO_2 absorbs UV light with a wavelength below 400 nanometers. The carbon-containing TiO_2 catalyst, however, also absorbed longer wavelength photons in the violet, blue, and green regions of the spectrum, yielding the eightfold efficiency boost.

Still, Khan thinks his team can do better. He believes that the amount of carbon incorporated into the TiO_2 varies as the titanium sheet is burned and that the higher carbon regions do a better job of absorbing longer wavelength visible-light photons. Khan says his team plans to look for ways to pack more carbon into the TiO_2 throughout the firing process. If that works, he says, "it would definitely increase the efficiency to above 10%." –ROBERT F. SERVICE

UNDERGRADUATE EDUCATION

Million-Dollar Plums For Teaching Biology

Research grants have always been the main source of prestige and money for academic scientists. Now one of the biggest funding sources for biologists, the Howard Hughes Medical Institute (HHMI) in Chevy Chase, Maryland, is hoping to add luster to researchers who are devoted to teaching. Last week, the philanthropic giant announced fellowships that will give each of 20 top U.S. biologists $1 million over 4 years to enhance undergraduate education.

The new awards are meant to improve science curricula at major research universities, where courses are often outdated, boring, and impersonal, says Peter Bruns, HHMI's vice president for grants and special programs. To rev up interest in the classroom, which frequently plays second fiddle to research, HHMI asked 84 research universities to nominate faculty members who are committed to working with students.

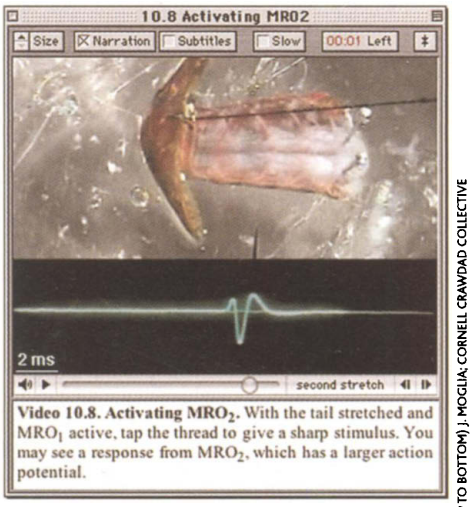
Many of the 20 winners* will use the money to give more undergraduates research experiences. Jo Handelsman, a microbiologist at the University of Wisconsin, Madison, will bring 15 undergrads into her lab. Although the undergraduates will require extra attention, Handelsman expects them to nourish her research. "I have always found undergraduates to be productive and creative scientists," she says. "They ask good questions and aren't as bound by dogma as the rest of us."

Providing those opportunities isn't cheap, though. Neurobiologist Ronald Hoy of Cornell University in Ithaca, New York, estimates that it will cost upward of $65,000 for a single setup of software and high-speed video cameras to enable undergrads to study behavior in mutant flies. He's also planning multimedia lab materials, akin to an earlier project involving crayfish (see figure). The award, Hoy says, "lets you make a very ambitious plan from the get-go."

Other winners will create programs to mentor prospective scientists, especially minorities. Hilary Godwin, a chemist at Northwestern University in Evanston, Illinois, is planning a summer workshop for incoming minority first-year students. They will learn chemistry skills by mapping lead levels in soil and correlating them with lead-poisoning rates. Afterward, they'll be eligible for further research stipends and training as student mentors.

The sterling research reputations of the new fellows should help leverage the program, Bruns says. "We wanted to pick people who could influence their colleagues" and promote more interest in improving education, he says. Geneticist Elizabeth Jones of Carnegie Mellon University in Pittsburgh, Pennsylvania, plans to reserve adver-

* Complete list at www.hhmi.org/news/091802.html



Video 10.8. Activating MRO_2. With the tail stretched and MRO_1 active, tap the thread to give a sharp stimulus. You may see a response from MRO_2, which has a larger action potential.

Stimulating. HHMI hopes that new lab materials, such as this multimedia crayfish experiment, will make undergraduate biology more exciting.

CREDITS: (TOP TO BOTTOM) J. MOGLIA; CORNELL CRAWDAD COLLECTIVE

tising space in *Genetics*, the journal she edits, to plug her tutoring software. "I wouldn't have that bully pulpit if I had just taught," she says. Jones and the other fellows will have a chance to convert other high-powered researchers at meetings with Hughes investigators. The institute will assess the program before deciding whether to repeat it in 2006.

–ERIK STOKSTAD

U.S. ENVIRONMENT

Report Takes Stock of Knowns and Unknowns

The United States spends more than $120 billion a year on protecting ecosystems, but the information used to evaluate such efforts is often inadequate or of questionable relevance, say ecologists and policy experts. According to one environmentalist, it's like monitoring a sick patient by measuring fingernail length. A new report—*The State of the Nation's Ecosystems*, published 24 September by the nonpartisan Heinz Center in Washington, D.C.—tries to provide the missing data and point out where better measures are needed.

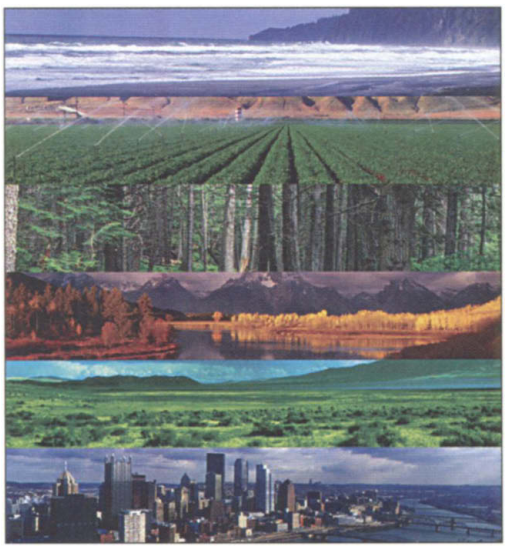
The Heinz report (www.heinzctr.org/ecosystems) aspires to be the Dow Jones Industrial Average of the environment. But don't expect to see it published next to the latest stock prices; half of its "ecosystem indicators" can't be measured yet. And for those that can be measured, the center is not saying whether the results represent good or bad news, because it wants to steer away from opinion.

Some environmentalists say such rigid neutrality masks the dire straits of certain ecosystems. But the report's authors insist that their approach is an essential starting point for protecting the environment. The authors also worked to build consensus among people with a range of viewpoints. As with economic indicators, they say, the goal is to start with widely accepted data, which can lead to a debate on policies to change the status quo.

The $3.7 million report was conceived in 1995 by the White House Office of Science and Technology Policy, which asked the Heinz Center to complete it. Its funders run the ideological gamut from International Paper to Defenders of Wildlife, and its 150 authors come from universities, environmental groups, industry, and government. About 100 reviewers of a prototype report in 1999 (*Science*, 10 December 1999, p. 2071) helped the team's seven committees compile government data into 10 national indicators plus 93 other indicators tailored to fit six broad ecosystem types.

Despite all the number crunching, the 270-page report is most striking for what it lacks. "Half the report is empty," admits William Clark, chair of the report's design committee and a professor of international science policy at Harvard University's John F. Kennedy School of Government in Cambridge, Massachusetts. Missing data are marked by bleak gray boxes that say, "Data Not Adequate," meant to prod monitoring programs to fill the gaps. For example, participants agreed that the degree of human alteration is an important ecosystem indicator but say there is no widely accepted way to measure it.

The available indicators organize and add precision to a welter of existing data. For example, the report points out that the four major U.S. rivers carry three times as much nitrate per year as in 1955. A fifth of native animal species are faced with serious decline. Three-fifths of estuaries are contaminated. On the other hand, 85% of streams meet human health standards. Moreover, agricultural production has doubled since the 1950s, and land threatened by erosion has declined by a third since 1985.



Sea to shining sea. A new report identifies environmental health indicators for six broad ecosystem types.

CREDIT: THE H. JOHN HEINZ III CENTER FOR SCIENCE, ECONOMICS AND THE ENVIRONMENT

"Anyone could do a list that would make everything look good or everything look bad," Clark says. The report's authors sought to avoid the criticism, often heaped on past assessments, that their measures are biased. The Heinz report's indicators are accepted by all participants.

But some environmentalists say the focus on consensus is the report's greatest weakness. "Because the emphasis was on producing a report that was consensus-driven, they had to focus on the margins of what most scientists would have looked at," says Dominick DellaSala of the World Wildlife Fund. He quit one of the report committees, claiming that its indicator of forest fragmentation downplays the extent to which forests are broken up by roads, power lines, and development.

Observers' initial reactions were mixed. The report "is the first to employ a comprehensive set of indicators integrating biophysical and sociocultural measures," says ecologist Bruce Wilcox of the University of Hawaii, Honolulu, who edits the journal *Ecosystem Health*. David Rapport of the University of Guelph in Ontario, Canada, however, is disappointed. "No attempt is made … to relate human activities to the changes in American ecosystems, and no attempt is made to evaluate the health of U.S. ecosystems," he says. But Chet Boruff of Farmers National Marketing Group in Moline, Illinois, defends the report's neutrality: "That's the best way to build understanding … and to come up with a report that is unbiased."

–BEN SHOUSE

Ben Shouse is a writer in Santa Cruz, California.

ANIMAL RESEARCH

Coulston Chimps Head to Retirement

The beleaguered Coulston Foundation, formerly the largest chimpanzee research facility in the United States, is no longer in the primate research business. On 16 September the Florida-based Center for Captive Chimpanzee Care took over Coulston's Alamogordo, New Mexico, facility. The new caretaker for the 266 chimpanzees and 61 monkeys plans to retire the animals from research, eventually relocating many to a sanctuary in Florida.

The Coulston Foundation had long been dogged by complaints about and government investigations into its animal care practices. Last summer the National Institutes of Health (NIH) let lapse the foundation's Animal Welfare Assurance, which is required for government-supported animal research (*Science*, 24 August 2001, p. 1415). Faced with mounting debts and few customers, the foundation's president, Frederick Coulston, agreed to sell its property and equipment to the Center for Captive Chimpanzee Care (CCCC), for $3.7 million, and also donate the remaining animals. About two dozen Coulston-owned chimpanzees are housed at other research facilities, but Carol Noon, president of CCCC, expects them to be retired as well.

Toxicologist and millionaire Coulston founded the nonprofit in 1993. Despite complaints of negligent and unsafe practices from animal-rights groups, by 1998 the foundation was the nation's largest chimpanzee research facility, housing more than 600 chimps. The foundation's troubles mounted as a series of inquiries by the U.S. Department of Agriculture (USDA) and the Food and Drug Administration found Coul-