class next year.

Not that every student in Active Physics is learning all the time. During Callahan's eleventh-grade section, a student abruptly stops working and saunters back to her lab stool, obviously bored. "She's basically waiting for her parents to sign the papers so she can drop out of school," the teacher explains afterwards. "But during the home design unit, she was the class leader."

Ninth-grader Jared Stahler wonders how he'll do in the regular chemistry course next year; he thinks he does better in Active Physics. The chapter on vision has been so interesting, he says, "my mom says I should study optics."

Jenny Caverly, a Catasauqua senior, signed up for Active Physics because it sounded like fun. And it has been, she says. The chapter on driving has been very informative, she adds, although her parents still won't let her get a license. Last semester she took a self-paced environmental science course. "They'd hand us this big pile of assignments and tell us to do it by such-and-such date. It was busy work, you know? I didn't learn anything." Active Physics has been completely different from her other science classes, Caverly says. "I don't really think of it as science."

Jean Kumagai

LBNL Creates Water Purifier for Developing Countries

Lawrence Berkeley National Laboratory has traditionally been known for its large-scale research projects, especially in particle physics. But recent shifts in funding have spurred it to diversify and to put increasing emphasis on smaller projects with a near-term payoff. One small team of physicists at the lab has developed a water purification system, based on the use of ultraviolet radiation, that is designed to tackle widespread contamination in rural areas of developing countries. In those areas, often-deadly waterborne diseases such as cholera, typhoid fever, dysentery and infectious hepatitis pose a serious health threat. "Our system," says project leader Ashok Gadgil, "is safe, inexpensive, durable and portable, and it can be assembled and maintained locally."

The approach itself is not new; indeed, UV radiation is used widely for water disinfection in Europe, and is beginning to catch on in the US (where about 5% of waste water is now UV-treated). Some efforts were also made in New York State in the early 1900s, but were abandoned in part because of the introduction of chlorine for water purification. Chlorine kills pathogens more effectively than UV radiation, but consistent application can be a problem. Also, many people do not like the taste, and chlorine reacts with naturally occurring organic compounds to produce carcinogenic by-products.

A WATER PURIFICATION UNIT, open for maintenance, surrounded by villagers in Bhupalpur, India. Water is pumped into the blue plastic holding tank and then is disinfected by flowing past the UV lamp in the unit. No women appear in the photo because, although they typically attend to the community's water needs, "it would be culturally inappropriate for them to pose for a male stranger [the photographer]," Ashok Gadgil explains. (Photo courtesy of Urminus Industries.)

UV radiation inactivates the DNA in bacteria, viruses and molds, with the germicidal effect peaking broadly at 260 nm. The LBNL treatment system therefore uses a low-pressure mercury arc lamp, which has strong narrow-band emission at 254 nm.

The LBNL design is the first in which the lamp is not immersed in the water during disinfection—a significant improvement because there is no light blockage caused by a build up of mineral deposits and algae on the lamp. Water is disinfected as it flows in a shallow pan a few centimeters below the lamp; exposure to UV light for 12 seconds disables 99.999% of *Escherichia coli*, the bacterium used as a representative marker.

The water flow is gravity driven, making the design very energy efficient. The only power required is 40 W for operating the lamp; the unit can be run even from a car battery, as was the case in initial field tests carried out in 1993–94 in the state of Uttar Pradesh in northern India (see the photograph). It can be installed, for example, between a holding tank and pipelines that feed a communal faucet, or it can be hooked up directly to a pump.

The unit, which has been modified in response to the field tests, now measures 69 cm by 34 cm by 25 cm and weighs approximately 7 kg. (Because there is a patent pending, LBNL's patent department has withheld critical details about the unit's internal dimensions.) And the lamp is now securely enclosed to prevent accidental exposure to harmful UV radiation.

The unit treats up to 15 liters of water per minute, and could serve a community of a thousand people for about $70 per year. All components are mass-manufactured. The unit needs to be cleaned about every six months, the lamp replaced once a year and the lamp ballast replaced every two years.

Gadgil and his team have not carried out further field tests on the modified design because their funding ran out last fall. But negotiations for licensing the technology to EEG Inc are in their final stages. Elwyn Ewald, director and co-owner of the small Chicago business, says that countries in Asia, Africa and South America have indicated interest. Although Ewald believes there is enormous need and market potential, he says "it will be a big challenge to get this to work," anticipating the hurdles of arranging reliable power supplies and getting communities to use and maintain the unit properly. Gadgil is pleased that his team's efforts may make an impact. He also points out that "to effectively combat disease, disinfecting water is a necessary first step, but education in public health and hygiene is essential."

Toni Feder ■