antibiotics that spur resistance to drugs used in human medicine. The panel's advice was partly heeded in Europe, where key antibiotics like penicillin and tetracycline were taken out of agricultural use in the 1970s.

But it has been mostly ignored in the United States, where industry officials insist that antibiotics keep animals healthy and thus safeguard the food supply. "While there's a theoretical link [between resistant strains in livestock and people], we think that there's so many things that need to happen that the risk is diminishingly small," says the Animal Health Institute's Carnevale. Even if antibiotic use on the farm does pose a threat, it pales in comparison with the scourge of resistance from human medical practices, says Robin Bywater, a Reigate, U.K., consultant for Pfizer, which produces animal antibiotics. Besides, Bywater says, the drug-resistant pathogens most dangerous to people—such as *Staphylococcus aureus* or the tuberculosis bacterium—do not infect livestock.

The main skirmishes now are over the practice of using low doses of antibiotics to make livestock fatter on less feed. Three years ago, the World Health Organization argued for phasing out use of antibiotics for this purpose, if the animal drugs are used in people or breed resistance to human drugs that work by a similar mechanism. The European Union agreed and banned the use of avoparcin and four other drugs as growth promoters.

The FDA, meanwhile, has given mixed signals regarding so-called subtherapeutic uses—growth promotion and illness prevention—of animal antibiotics. In a series of actions since 1994, the agency has approved the use of quinolones to treat and prevent infections in poultry and beef cattle. But in 1998 it floated draft regulations that would raise the bar for all uses of new animal antibiotics. The regulations would require companies to carry out resistance studies before and after a drug's approval, and to pull any drug from the market if the target bacteria develop resistance to human antibiotics. "We're most concerned about those pathogens for which the disease is serious in humans and for which the drug we're considering may be the drug of last resort," such as quinolone-resistant *Salmonella* and vancomycin-resistant enterococci, says Stephen Sundlof, director of the FDA's Center for Veterinary Medicine. "The only scientific way we have to do it is to look at it on a case-by-case basis."

Congress, however, may prod the FDA into a more aggressive stance. A bill introduced last year by Representative Sherrod Brown (D–OH) would order companies to discontinue using seven antibiotics for any reason other than to treat illness in animals—unless the industry proves that the drugs won't harm human health. Brown hopes the bill, opposed by the agriculture industry, will pass in 2 or 3 years. "The burden should be on the drug industry to prove that they are safe, not on the FDA to prove 100% that they are unsafe," he told *Science*.

Researchers are also trying to provide industry with alternatives to antibiotics that can keep livestock healthy. These include probiotics, in which healthy gut bacteria are infused into animals before they are weaned to crowd out pathogens; vaccines; and animal husbandry practices that prevent infections from spreading from farm to farm. Although these possibilities hold promise, "there is no one magic bullet" in the pipeline, says microbiologist Paula Fedorka-Cray of the U.S. Department of Agriculture's Russell Research Center in Athens, Georgia.

Wegener and others believe that U.S. regulators must follow the lead of their European counterparts and act quickly to get livestock antibiotics off the market for uses other than treating sick animals. Otherwise more outbreaks like the one in Denmark could occur, he says, adding, "I have difficulty understanding why we should take that risk."

–DAN FERBER

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PHILANTHROPY

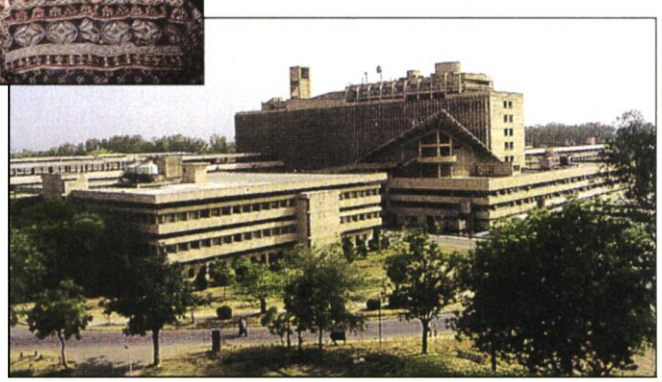
Indian Schools Cash In on Silicon Valley Wealth

A $1 billion campaign to shore up the elite Indian Institutes of Technology is part of a tidal wave of philanthropy that hopes to raise up Indian higher education

NEW DELHI AND HYDERABAD—The 13 CEOs who gathered in December for a meeting with Indian Prime Minister A. B. Vajpayee had all made their fortunes in Silicon Valley, California. Born and raised in India, and educated at one of the six elite Indian Institutes of Technology (IIT), they had decided it was time to give something back to their native country. In particular, they had come to seek Vajpayee's blessing for a bold plan to raise $500 million from wealthy IIT alumni like themselves for new buildings, equipment, and programs at their alma maters.

The prime minister was delighted, but urged them to think even bigger: "He said, why not pick up the entire tab?" recalls Kanwal S. Rekhi, the retired technology chief at Novell Inc., who now runs a small California company, IndUS Entrepreneurs, that fosters collaborations between the two democracies. The startled executives ran the numbers and calculated the cost to modernize the institutes at $1 billion. Unfazed by the sum, the self-made multimillionaires said OK, but under two conditions: The money, to be raised over 6 years, would go directly to the IITs, and an independent board of trustees, made up of the country's business and academic elite, would replace the government as overseer. Vajpayee said he'd look into it.

These high-tech tycoons are part of a startling new trend in India. Even as they begin passing the hat for the IITs, another group of Indian-born, U.S.-based software engineers led by Purnendu Chatterjee, managing director of the New York–based Chatterjee Group, wants to raise the same amount—$1 billion—to set up a series of world-class centers of higher learning in India (*Science*, 31 March, p. 2389). And individual expatriate Indians are donating to other high-tech causes back



Deep pockets. Kanwal Rekhi, right, and others hope to raise $1 billion for the six Indian Institutes of Technology, including the Delhi campus, inset, headed by V. S. Raju, left.

CREDITS: P. BAGLA

home. Although a few observers are grumbling privately that such largesse is a thinly veiled attempt by wealthy individuals to seize control of state assets, most view the charity drives as part of the long-awaited payback on India's massive brain drain of the last few decades. "We welcome the initiative," says Science and Education Minister Murli Manohar Josh, who says it recognizes the fact that India is fertile ground for growing future high-tech entrepreneurs. That receptivity is a change from the past, when rules prevented such individuals from making direct donations to universities and there was a feeling that it was not right for public institutions to accept private support.

The high-tech executives are already making an impact on their alma maters. In 1998 Rekhi gave $5 million to IIT-Mumbai to establish a school of information technology that has been named after him. Another successful computer scientist, Desh Deshpande, founder of Sycamore Networks of Chelmsford, Massachusetts, has pledged $100 million over the next 20 years to his alma mater, IIT-Madras.

All this philanthropy could not have come at a better time for the IITs. They were formed shortly after Indian independence as "institutions of national importance," but have struggled to keep up with the fast-changing and burgeoning fields for which they provide human capital. With enrollments up 35% to 40% in the past 4 years to an average of 2500, students endure packed lecture halls and overcrowded youth hostels. V. S. Raju, director of IIT-Delhi, estimates that the six IITs will need approximately $220 million in the next 3 to 4 years just to maintain existing facilities—an amount unlikely to come from the government, which provides roughly 80% of each institute's operational expenses.

What makes this new wave of private donations especially remarkable is that there is no history in India of academic philanthropy from expatriates. As recently as 1994–95, the total alumni contribution to all the IITs was less than $250,000. But that was before the New Economy began turning entrepreneurs into megamillionaires. Last August, N. R. Narayanamurthy, head of the fund-raising committee for IIT-Kanpur and chair of Infosys Technologies Limited of Bangalore, raised $1 million during a single lunch meeting in San Francisco. Narayanamurthy himself gave another $2 million to the school for a new computer lab. The $3 million represents roughly 30% of IIT-Kanpur's annual operating budget. Efforts to help IIT-Mumbai have been even more successful, with alumni in Chicago pledging $22 million in the span of a few days in December. That's more than the institute's annual operating budget of $20 million.

Many IIT alumni are content to give without asking anything in return, but others would like a bigger say in the way IITs are run. Although the prime minister's office had initially agreed with the idea of an independent board of trustees, Rekhi says, newspaper stories questioning whether the plan constituted a "takeover" that would threaten the institutes' independence have pushed the idea onto the back burner. The industry leaders say they never intended to seize control—"running the IITs is not such a good business," says Rekhi—but only wanted to ensure that the money was used for the desired ends. "I do not think it will make IITs beholden to anybody," says Nandan M. Nilekani, managing director of Infosys Technologies Limited in Bangalore, who so far has donated $1.4 million to IIT-Mumbai.

While some wealthy benefactors are trying to shore up their alma maters, others are trying to set up de novo private institutions. The Global Institute of Science and Technology (GIST) would consist of six research-centered institutes offering undergraduate, graduate, and postgraduate courses. Each institute would enroll up to 2000 students, with any surplus being plowed back into the facility. Some $300 million has already been pledged for the new institutes, which are currently before the influential Scientific Advisory Committee to the Indian Cabinet. Raghunath A. Mashelkar, director-general of the Council of Scientific and Industrial Research in New Delhi, says GIST addresses "a crying need" for another world-class research facility as well as additional training capacity.

Although the IITs and GIST are receiving most of the attention, other institutions are also getting into the act. K. B. Chandrashekar, co-founder and chair of Exodus Communications of Santa Clara, California, has funded a $600,000 center for excellence in Internet and telecommunications at his alma mater, Anna University in Chennai, as well as a remote learning center for students to take courses at any of the school's four campuses. "I got all my education in India, and the first 7 years of my work experience was in India," says Chandrashekar, who plans additional gifts.

Indian government officials see the new wave of philanthropy as the next step in boosting the nation's economy. Vajpayee has talked about creating "Silicon Valley–like conditions in India so that promising young Indians can create world-class ventures while living and working in India." Chandrashekar has an even more expansive vision: "By providing a better infrastructure and making it affordable for all people," he says, "we can make India a superpower through its intellectual capital and not through war."

–PALLAVA BAGLA

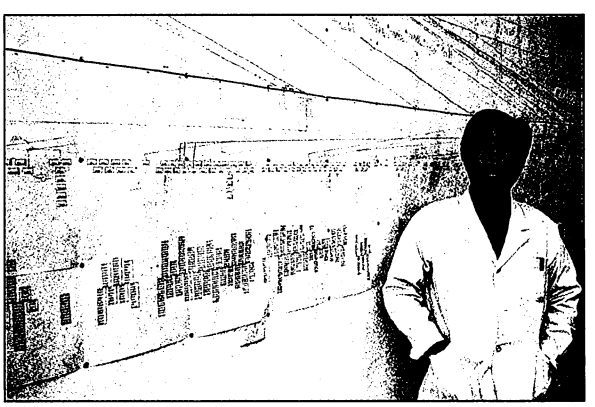
GENOMICS

Money and Machines Fuel China's Push in Sequencing

China hopes that a heavy investment in genomics will help it to fight disease, foster economic growth, and tap its vast biological diversity

BEIJING—Yang Huanming, who directs the human genome center at the Chinese Academy of Sciences' (CAS's) Institute of Genetics, is still unhappy with a deal that two Chinese laboratories struck last spring with a foreign-owned company based in China. The labs agreed to pay Shanghai GeneCore Biotechnologies $225,000 to sequence a prawn virus that threatens China's lucrative shrimp industry. They also ceded one-third of the intellectual property rights on the 300-kilobase sequence. The labs had to pay this steep price, Yang says, because they lacked the capacity to do the work in-house.

Negotiating from a position of weakness so rankled Yang that he and his colleagues lobbied the government for the capacity to do such sequencing jobs themselves. They prevailed: By the end of this month, Yang's center will have enough se-



Small steps, big gains. CAS's Yang Huanming with a map showing the Beijing center's progress toward sequencing its allotted 1% slice of the human genome project.

CREDIT: REN YUE