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SCIENCE

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Genetically modified crops are the spearhead of a biological revolution

In the fall of 1997 a california high school biology class started their week just like any other week, or so it seemed. "This week we are going to be genetic engineers," the teacher told the class. The first assignment was simple: make a plain bacteria glow in the dark. The students followed instructions, took a supply of isolated "glow-in-the-dark" genes, and spliced them into the bacteria's DNA. VoilÃi, glow-in-the-dark bacteria--a creature that never existed before. Another class engineered a bacteria resistant to three antibiotics. If this is what high school students are doing, imagine what fully trained and heavily funded scientists are up to.

Today enormous effort is focused on mapping the entire sequence of DNA of humans and other species. The purpose is clear enough to scientists, if not to the rest of us: apply genetic engineering to every aspect of human existence, from hereditary diseases to the production of drugs to the foods we eat. Of course, they have already massively succeeded--in the US at least--with altering foods humans eat every day.

A mere three years after the first large-scale commercial

harvest, genetically modified crops cover one-fourth of US crop-land--more than 90 million acres, according to 1999 industry estimates. Included are 35 percent of all corn, almost 55 percent of all soybeans and nearly half of all cotton, according to an article in Consumer Reports (Sept. 1999). Tests by that magazine showed that 60 percent of the processed food bought by Americans--chips, soy milk, baby formula, etc.--contained genetically modified ingredients. But according to polls, only a third of Americans are aware there is any GM food on their supermarket shelves.

Europeans, on the other hand, are more informed and extremely suspicious of the technology and the huge agri-businesses promoting it. They have protested the technology, destroyed test fields and held rallies all over Europe. Labeling requirements and government restrictions effectively prevent the marketing of GM foods in Europe. As one result, import of US corn to Europe has dropped from \$305 million in 1996 to \$1 million in 1999 because the GM corn isn't separated from the non-GM corn.

Scientists and companies promoting the technology assure the public it is safe, characterizing it as "just an improvement" upon traditional practices of selective breeding. But there is a major difference. Selective breeding is restricted to the crossing of two closely related species of plants. With GM foods, this restriction is overridden. A gene can be taken from any organism--plant, animal, bacteria or virus. GM plants that incorporate genes from animals (or non-plants) are called "transgenic plants"-- organisms impossible to produce by natural processes. There are GM potatoes with a chicken gene, and a strawberry with an arctic fish gene which produces its

own antifreeze and thrives in colder climates. Transgenic crops are no longer just laboratory phenomena. Since 1986, 25,000 transgenic field trials have been conducted worldwide--a full 10,000 in the past year.

But not all scientists embrace the new technology. Hinduism Today contributor Vatsala Sperling, a trained microbiologist, details her strenuous objections on page 66. Opponents warn that genetic modification takes the human race--and every other creature on the planet--into an uncharted world with unknown consequences. Transgenic plants are new to the environment and could have unforeseen interaction with natural plants, such as the creation of "super weeds" resistant to any known weed killer. Then there is Bt corn, one of the first commercial modifications of corn (and other crops) which allows the plant to produce its own pesticide, the same toxin as *Bacillus thuringiensis* (Bt) bacterium, a natural pesticide more benign than many synthetic chemical pesticides. Bt can even be used in organic farming. A Bt plant can kill most destructive insects that attack it. There is a big difference between Bt used as a spray and Bt generated by a plant. In the first case, the spray kills bugs and dissipates; the bugs have little chance to develop resistance. In the second case, the bug is exposed to the toxin over a long period of time, exactly the conditions favorable to the evolution of Bt-resistant "super bugs."

Recent experiments have shown that monarch butterflies die when they eat milkweed dusted with pollen from Bt corn. Other insects may as well, causing a ripple effect through the natural food chain. For organic farmers, who almost solely use Bt for pest control, pesticide resistance would be disastrous as

they can't use other chemicals and remain organic. Monsanto company, which holds a key patent on this technology, insists the Bt corn's toxin can't affect humans, but how is that to be proved?

Most of agricultural genetic engineering is fueled by huge multinational businesses like Monsanto, Aventis, Novartis and DuPont. Protesting Europeans and Americans object that such profound manipulation of life is happening for the sole reason of making money, and with apparent scant regard for ethical, social, economic and environmental issues.

The genetic modification that has caused the most outrage to date is the "terminator" technology, so called because it causes plants to produce sterile seeds. This diabolically insures that farmers have to buy new seed each year and cannot grow their own, as most farmers do in developing countries. Protesters in South India set ablaze two Monsanto test plots in protest of the terminator technology. Scientists admit to an even greater consequence: the possibility that terminator genes might "escape" and cross over to other crops or wild plants and render them sterile. This could produce an ecological mega-disaster. For now, Monsanto has dropped development of the technology.

Not all genetically modified foods are "for-profit." Scientists based at the Swiss Federal Institute of Technology in Zurich genetically engineered "yellow rice" that could help alleviate the serious problem of vitamin A deficiency. An estimated 124 million children suffer from this deficiency, putting them at risk of permanent blindness and other dire ailments. The rice

produces beta-carotene, which all animals must take into their bodies in order to make vitamin A. To make yellow rice, the scientists inserted three genes, two from the daffodil and one from a bacteria. The Institute doesn't want to sell the rice; they want to give it away, especially to Southeast Asia. In fact, India has been selected as its testing ground. Clearly a "not in my backyard" situation, Institute scientists are forbidden by law to distribute or even test their experimental rice in Europe outside their lab.

GM foods in the US are not labeled as such because in 1992 the US Food and Drug Administration categorized GM foods as "the same as or substantially similar to substances commonly found in food," and thus need not be labeled or tested for safety. But American consumers do want GM foods labeled. If it was, according to a 1999 Time magazine poll, most people wouldn't buy it.

Currently there is no conclusive evidence that genetically engineered food now on the market is unsafe to eat. Nor is there proof that it is as safe as natural foods. Many informed people are deeply concerned about the way the technology is being released with insufficient regard for safety. There is little independent testing. Government regulations are lax or nonexistent. Unsuspecting consumers are serving as guinea pigs. New varieties are being set loose in the environment without knowledge of the possible consequences. No doubt, GM technology is not going to go away, but governments, agencies and individuals are moving forward to get aware and educated about it.