BRAVE NEW FOOD

Andrew Kimbrell

The human imagination has never been limited by species boundaries. The Greeks imagined a mythological creature, the Chimera, a hideous, fire-breathing she-monster having the body of a goat, head of a lion, and tail of a dragon. The Chimera represented darkness, drought, and the underworld, and its name has become the general term for all such mixed-species creatures. Other ancient chimeras include the Griffin, Greek symbol of enlightenment and superior mind, with the body and legs of a lion and beak and wings of an eagle; the Hindu Garuda, the half man, half bird destroyer of evil; and perhaps the most famous chimera, the Egyptian Sphinx, with its human head representing wisdom and its lion body symbolizing strength.

In recent years, scientists have discovered a process for creating chimeras that transcend species boundaries. But this time the chimeras are not solely figments of human imagination. They are real-life "transgenic" animals: animals genetically engineered to contain genetic material from humans and other species. Unlike the mythological creatures of past ages, these chimeras are not fabulous beasts with religious or sacred meaning; rather, they represent attempts by biotechnologists to create more efficient and profitable animals for a variety of purposes, perhaps most importantly for food. Researchers are engineering genes from humans and other species into livestock and poultry to

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create "super" animals for slaughter and consumption.

FIVE-TON COWS AND TWELVE-FOOT-LONG PIGS

Pig No. 6707 was meant to be "super": super fast growing, super big, super meat quality. It was supposed to be a technological breakthrough in animal husbandry—among the first of a series of high-tech animals that would revolutionize agriculture and food production. Researcher Vernon Pursel and his colleagues at the U.S. Department of Agriculture (USDA) research center in Beltsville, Maryland, had created this pig to be like no other, and to a certain extent, they had succeeded. No. 6707 was unique, both in its physiology and in the core of each and every cell. For this pig was born with a human gene engineered into its permanent genetic makeup. Using microinjection techniques, Pursel and his team implanted the human gene governing growth into the pig while it was still an embryo. The idea was to have the human-growth gene become part of the pig's genetic code and thus create an animal that, with the aid of the new gene, would grow larger and faster than any before.

With his transgenic "super pig" Pursel had hoped to mimic the heralded results achieved by fellow genetic engineer Ralph Brinster. In 1982, Brinster, working out of the School of Veterinary Medicine at the University of Pennsylvania, electrified the scientific community with his successful creation of a "super" mouse, a chimera engineered to contain the human-growth gene as part of its permanent germ line. Science journals featured the startling picture of two female mouse siblings side by side, the one without the human gene weighing twenty-eight grams, the other, with the gene, dwarfing its sibling and weighing over twice as much (fifty-nine grams).

Researchers assumed that what worked for mice would work for livestock. They dreamed of future farms with pigs and other livestock growing many times larger than current animals. However, Pursel's transgenic pig did not turn into a "super" pig. The human genetic material they had injected into the animal altered its metabolism in an unpredictable and unfortunate way. The mixture of genes proved too complex to effectively control. No. 6707 was, in fact, a tragicomic creation, a "super cripple." Excessively hairy, lethargic, riddled with arthritis, apparently impotent, and slightly cross-eyed, the pig rarely even stood up. The USDA tried to rationalize its experiments by noting that though the transgenic pigs were not bigger, nevertheless, because of their large muscle mass, their meat would be "leaner." Whatever spin Pursel and others tried to put on their transgenic creations, it was clear that No. 6707 was the wretched product of a science without ethics.

Brinster and Pursel were the pioneers. But now, each year, researchers around the world are conducting tens of thousands of experiments designed to create transgenic animals. In 1990 alone, researchers in Great Britain inserted foreign genes into 11,399 pig embryos, creating sixty-seven transgenic animals. Bioengineer John Clark, of the Institute of Animal Physiology and Genetic Research at Edinburgh, admitted that many of his pigs, like their American counterparts, continued to suffer stress and joint problems but vowed to continue his work in the name

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of "growth and feed efficiency."

Elsewhere, British researchers have genetically engineered 4,500 sheep embryos, resulting in thirty-four transgenic animals. Researchers in Sydney, Australia, inserted the insect-killing gene from a tobacco plant into the sweat glands of sheep in the hope that when fly larvae burrow into a sheep's skin they will be killed by the enzyme produced by the engineered genetic material. Researchers in Vancouver, Canada, have experimented with boosting salmon size using chicken, human, and cattle growth hormones.

As the creation of transgenic animals increases internationally, the United States remains the undisputed leader in genetic engineering of animals. Over the last decade, government and private researchers have spent billions of dollars, much of it provided by taxpayers, to create a variety of transgenic animals. Pursel and dozens of other scientists have inserted a wide range of genes, including over two dozen different human genes, into animals. Livestock containing human genes has become commonplace at several U.S. corporate, university, and government laboratories. Carp, catfish, and trout have been engineered with a number of genes from humans, cattle, and rats to boost growth and reproduction. Researchers at the University of California at Davis used cell-fusion techniques to create "geeps," astonishing sheep-goat combinations with the faces and horns of goats and the bodies of sheep. Researchers at the University of Wisconsin have engineered chickens that no longer contain the genetic trait for brooding. By genetically altering these hens to eliminate the "mother instinct," researchers believe they have created more efficient egg producers.

Although genetic engineering increasingly breaks down species boundaries, there are still some limits. Up to this point, transgenic manipulation has involved the transfer of only a single gene, such as that triggering growth, between species. However, most believe it is only a matter of a few years before scientists will successfully engineer multigene traits into plants and animals. Recently, the congressional Office of Technology Assessment (OTA) predicted that within the next decade we could witness the engineering of complex genetic traits, including those involving human behavior, into other species. Researcher J. Mintz, who successfully transplanted rabbit growth genes into mice, predicts that we may soon see "five-ton cows and pigs twelve feet long and five feet tall." Others have predicted the creation of a wide variety of transgenic creatures, from monster chickens to oysters that will survive in polluted waters and wolves that avoid sheep. "Right now, we don't know what the limits are," says Michael Phillips of the OTA. "All the traditional rules we thought about the . . . animal kingdom . . . are thrown out the window."

Other genetic engineers are more conservative about prospects for the future. USDA researcher Pursel employs a mechanistic metaphor to describe the current state of research: "We're at the Wright brothers stage compared to the 747. We're going to crash and burn for a

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number of years and not get very far off the ground for a while." Of course it is animals like Pursel's pig No. 6707 that pay the price for researchers' "crash and burn" persistence.

Genetic engineers in the United States and Canada have also begun to successfully clone higher mammals, including cattle. Although glitches have occurred, biotechnologists now feel they can alter animals to be more efficient sources of food and then clone unlimited copies of the "perfect" lamb, pig, or cow. Marv Pace, director of the American Breeders Service (a subsidiary of W.R. Grace), states, "This technology removes the gamble in anticipating an offspring's sex, genetic makeup, and production capabilities. Our goal is to have the first proven female clones for market by the mid-1990s. We will then offer products . . . to both the dairy and beef producers."

Now companies can own their genetically engineered and cloned animal species just like any other product. In April 1987, the U.S. Patent and Trademark Office ruled that genetically engineered animals could be patented, just like a tennis racket or computer. Over 190 genetically engineered animals are now patent pending. These include genetically altered cows, sheep, and pigs.

Numerous consumer, animal welfare, religious, and environmental groups have expressed their deep concerns about the genetic engineering, cloning, and patenting of animals. The core of their objections is ethical. Sen. Mark Hatfield of Oregon has recommended a moratorium on the patenting of animals. He asks some important questions: "Will future generations follow the ethic of this patent policy and view life as mere chemical manufacture and invention with no greater value or meaning than industrial products? Or will a reverence-for-life ethic prevail over the temptation to turn God-created life into reduced objects of commerce?"

In a lead editorial titled "Life Industrialized," the *New York Times* had an answer to the senator's questions. According to the *Times*, "Life is special, and humans even more so, but biological machines are still machines that now can be altered, cloned, and patented. The consequences will be profound, but taken a step at a time, they can be managed." As scientists gear up to genetically engineer and perhaps eventually clone humans, just as they now do other animals, the *Times*' view leads to frightening, Orwellian future visions of an engineered and cloned society.

FRANKENPLANTS

Besides food animals, the U.S. government and several corporations are also field-testing numerous food plants with never-seen-before genetic combinations. Among these new creations are cantaloupe and yellow squash containing genes from bacteria and viruses, potatoes with chicken and wax moth genes, tomatoes with flounder and tobacco genes, corn with firefly genes, and rice with pea genes. The vast majority of these plants have been genetically engineered to increase their

shelf life or appearance. Less than 5 percent of the genetic changes currently being engineered into plants have any relationship to improving nutritional content.

As with the creation of genetically engineered animals, consumers have good reason to be concerned about the new genetically altered plants. In addition to the serious ethical questions that surround the attempt to transform the earth's biotic community into altered, cloned, and patented products, genetic engineering of food plants raises significant environmental and economic concerns.

Of immediate urgency is the threat of biological pollution. When hundreds (and soon thousands) of novel, genetically engineered plants and animals are taken out of the laboratory and introduced into the environment, ecological havoc could result. Scientists compare the risk of releasing genetically engineered organisms into the environment with that of introducing exotic organisms to North American habitats. Although most of these organisms have adapted to our ecosystems, several, such as chestnut blight, kudzu vine, Dutch elm disease, and the gypsy moth, have been incredibly destructive. In one survey, the top one hundred environmental scientists in the United States warned that genetic engineering's "imprudent or careless use . . . could lead to irreversible, devastating damage to the ecology of the planet."

Some genetically engineered plants create unique environmental problems. Many novel plants have been genetically designed to be pesticide and herbicide tolerant. Mass use of such plants would lead farmers to release even greater amounts of these chemicals into our environment. Still other plants are being genetically engineered to produce their own Bt (*Bacillus thuringiensis*) toxin. Substantial evidence is now accumulating that the widespread use of crops engineered to produce their own toxins will, in fact, cause the evolution of pests that are resistant to Bt, making this valuable, naturally occurring bacterium useless to agriculture as a biological agent.

There are also potential human health problems. A genetically engineered tomato coproduced by Calgene and Campbell Soup contains an antibiotic-resistant gene that might confer resistance to common antibiotics on children who consume large amounts of the tomato or related products (catsup, soup). These antibiotic-resistant genes are also being placed in dozens of other plants, including squash, melons, and berries. Other potential human health concerns associated with genetically engineered plants include fears about consuming plants that have elevated levels of toxicants or allergens.

The increased use of genetically engineered animal and plant foods could also have an extraordinary social and economic impact on our farming system and could virtually eradicate the small farmer, both in the United States and abroad. As corporations engineer and patent plants and animals, only large, highly capitalized farms would survive the increased overhead costs of raising these patented organisms and the price fluctuations caused by the greater amount of produce flooding the market.

Additionally, new techniques in cloning tissue of various plants could eliminate outdoor farming of certain crops altogether. As summarized by Stew Smith, the senior economist of the Joint Economic Committee of Congress, "Biotechnology will likely become dominant in the coming decades and will drive activities from the farm to the nonfarm

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sector at an increasing rate. . . . [This] will lead to a more industrialized system, with most farming activity conducted by part-time farmers and nonfarm firms performing much of the production activity away from the soil. Full-time, family owned and managed farming as we have known it will cease to exist."

OUT OF THE LAB, INTO THE SUPERMARKET

Despite unresolved and significant ethical, environmental, and economic concerns, the Food and Drug Administration announced in May 1992 that genetically engineered food will be allowed onto the market without special labeling or safety testing. The government's announced policy does not treat genetically engineered food differently from natural or traditionally bred food, even though products of this technique combine genetic material from dissimilar species for the first time in history. In that there will be no special labeling of such foods, people will not know whether or not they are consuming genetically altered food. In fact, the government will not even compile a comprehensive list of foods that have been genetically engineered.

Public reaction to FDA policy on genetically engineered food has been massive and negative. The agency has received thousands of letters and cards from angry consumers. The outpouring of sentiment should not be surprising. A 1992 survey by USDA showed that most of the public does not approve of transgenic animals and plants being designed by genetic engineers. When asked, "Would a chicken be acceptable or unacceptable if some of its genes came from a human?" only 10 percent of those polled found such a chicken acceptable. When asked whether potatoes with genes from an animal would be acceptable, only a quarter of those polled thought it was. When asked if a chicken made less fatty by insertion of genes from another animal was acceptable, almost 60 percent opposed this form of genetic engineering. Over 70 percent of those polled disapproved of inserting genetically engineered bacteria or viruses in food plants. Interestingly, 79 percent of the public felt that citizens should have a greater voice in decisions on whether or not biotechnology should be used.

In addition to concerns about our health, much of this opposition was based on moral concerns. According to the survey's author, "People who responded that religion is important in their lives have less-favorable attitudes about biotechnology. Furthermore, the high potential for moral objection to biotechnology suggests that the issue may increasingly be framed in terms of basic values and beliefs."

In May 1993, under heavy public pressure, the FDA announced that it would reopen the debate on the labeling, testing, and registering of genetically engineered foods. Although it maintains its prior position against labeling, it asked the public for further comments on this and other issues surrounding genetically engineered foods.

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As the FDA attempts to decide how to regulate genetically engineered foods, we are witnessing the appearance of several controversial biotechnology products in supermarkets around the country. The FDA has approved the use of bovine growth hormone (BGH), a synthetic hormone injected into cows to increase milk production. Author and activist Jeremy Rifkin has launched a consumer boycott of all dairy and beef products derived from herds being treated with the hormone. Calgene and Campbell have also introduced their genetically engineered tomato into the market. Unfortunately for the companies, the tomato has performed poorly in taste tests, and a consumer boycott is being organized against it.

The controversy surrounding the genetic engineering of animals and plants for food will certainly grow in the coming years, as more and more genetically altered fruits, vegetables, and meats are marketed. Behind the important questions of consumer safety and environmental degradation lies an even larger concern over the appropriateness of unlimited cross-species genetic engineering. As scientists attempt the breathtaking feat of redirecting the evolutionary process to create more efficient animals and plants, policymakers must be called on to limit this technology and provide answers to the many historic questions presented by cross-species genetic transfers: Is it ethical to alter without limit the genetic codes of animals and plants for efficiency and profit? Do animals have a right to their own genetic integrity? What does it mean to be human? Is there a limit to the number and type of human genes that should be engineered into other animals or plants? Is there a distinction between life and machine? Should we patent life-forms just as we do other mechanical products? As the engineers and marketers of life continue to push their creations into the marketplace, we have yet to find the answers to these questions.■