Biotechnology

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Notes, written 4 Aug. 2014:

- *Since composing this piece, I've become more convinced that there are two sides to the GMO debate. I think each side doesn't realize that the other has some legitimate points. I haven't formed firm opinions on the topic because I don't find it to be the most pressing issue to study.*
- *This piece was written on the assumption that environmental preservation is good. I now realize that this isn't always the case, although it's important to evaluate policies on a case-by-case basis. For instance, does Bt corn cause lots of suffering to insects? If GM crops are more targeted than broad-spectrum insecticides, does this keep non-pest insect populations higher and therefore result in more natural insect suffering? Does increased herbicide use with Roundup Ready varieties reduce plant biomass and thus insect suffering? Questions like these should be explored further.*

The original paper:

Biotechnology is something that can, and will, change the world forever. One aspect of it, genetic engineering involves the insertion of genes from one organism into another. While there may be benefits, many of the effects could turn out to be negative, especially in the areas of human health, the environment, and society. Corporations such as DuPont, Upjohn, Bayer, Dow, Cib-Gegy, Rhone-Poulenc, and Monsanto, which are currently involved in biotechnology, at one time promised great things with chemicals. The Many of these promises led to problems in human health and environmental damage. Now those same corporations are making similar promises similar with biotechnology. A certain indication of the danger of biotechnology is that insurance companies will not back up biotech corporations because the risk is too great. The many ethical concerns are valid, but the majority of the concern should come from facts and research. What little research has been done has been enough show us that we need to slow the technology way down and, at least temporarily, confine it to laboratories. Biotechnology, of any technology yet, has the greatest potential to enormously disrupt, and possibly destroy human civilization.

Genetic engineering allows humans to take genes from certain organisms and put them into other organisms. Unlike what the biotechnogy industries claim, genetic engineering is not an extension of breeding and artificial selection because species boundaries that were never possible in nature can now be crossed. For such a powerful technology, very little regulation has taken place, especially in the US. No section of the government has been set up to deal with genetically modifies organism (GMOs). The Food

and Drug Administration (FDA) says that genetically modified (GM) food will not be treated any differently than conventional food and will not be labeled, even though consumers should have the right to be aware. A 1997 public opinion poll of Americans showed that 93% would prefer mandatory labeling of genetically engineered (GE) food. Other studies have had similar results (usually 85-90 percent of consumers). GE foods are already labeled in the European Union, Japan, Russia, Australia, New Zealand, and South Korea. Thailand banned GE crops on April 6, 2001, and Sri Lanka did the same on May 1, 2001. China banned growing GM rice, corn, soy and wheat on April 18, 2001, for fear of losing export markets. In 1992, the FDA said that it would find GM food as "generally recognized as safe" (GRAS) unless the producer said otherwise. The only time it would label the food was when there were reasons "to which the consumer must be alerted", such as peanut genes because many are allergic to peanuts. The FDA also discourages the use of labels such as "biotech free" because the administration claims that those GE-free foods may be contaminated with a small amount of genetically engineered material. They also claim that it is misleading because it makes organic foods sound superior. The United States Department of Agriculture (USDA) also fails to adequately regulate genetic engineering. This department requires field testing for crops considered plant pests (organisms that can harm plants) before commercial planting, but according to an article in American Scientist, the information submitted to the USDA by biotech corporations is written in a way so even if hazards exist, they are not revealed in the report. Organic farming, which we should be concentrating on, receives less than 1% of the $2 billion spent by the USDA on agricultural research annually.

Corporate pressure on the government is responsible for the lack of safety measures and labeling, as it would greatly decrease GE food sales. Scientist working for industries will often hide or alter their findings. Forty-one percent of biotech firms said they had at least one trade secret associated with their research. In the National Academy of Sciences (which advises Congress about scientific issues), 37% of the scientists admitted to having "industry affiliations" with biotechnology. Independent groups, of which there are currently very few, should be carrying out the research for such a potentially devastating technology. Similar to the way industry affects research was a comparison of studies of cancer drugs funded by drug companies and by independent groups in the October 20, 1999 issue of the Journal of the American Medical Association. The study found that industry is 8 times more likely to change the results to benefit the industry.

Charles Margulis, a GE campaigner for Greenpeace, made the point that nobody has "really been looking for them [problems or risks with genetic engineering] yet. There's not really much monitoring of this technology once it's released into the environment or into the food supply. Any epidemiologist will tell you the first rule of evidence is that evidence lacking is not lack of evidence."

The amount of GE crops has greatly increased in the past decade. From about zero acres in 1994 the number grew to 70 million in 1999. About 500,000 cows have rBGH, a bovine growth hormone. The US, Argentina and Canada currently grow 99% of GE crops, and the US alone grows 72%. Corn, soybeans,

potatoes, squash, tomatoes, chicory, papayas, and dairy products are a few of the GM foods grown in the US. Tofu and 60% of processed foods contain soybeans, which could be genetically engineered. Some predict that almost all food will be genetically modified within the next 5-10 years. Within 10-15 years, some scientist predict that all major crops in the world will be genetically engineered to resist herbicides, pests, viruses, bacteria, fungi, and stress.

Many people would consider gene coding and insertion as discovery, not invention and shouldn't be patentable. However, one Supreme Court case made the patenting of life forms legal. The case, Diamond vs. Chakrabarty, in 1980 started when a microbiologist form General Electric, Ananda Mohan Chakrabarty, developed a bacterium that could take in oil. When the microbiologist applied for a patent, the Patent and Trademark Office (PTO) said that life couldn't be patented. General Electric sued and won the case 5 to 4. The dissenters wrote that it was the job of Congress, not the Supreme Court, to change patent laws. The first animal (a transgenic mouse) was patented on April 12, 1988. Many patents are granted even though only a few genes in an organism are changed. The US company, Biocyte, was able to patent all blood cells that came from the umbilical cord of a newborn, simply because scientists were able to deep-freeze the cells without even changing them in any way. The cells are useful in marrow transplants and with a patent, you have to pay to use them. The company, Myriad Genetics, patented a gene that causes breast cancer in some women with a history of breast cancer in their families. Many feared that a patent would increase the price of screening tests and prevent more research because the price of getting access to the gene might be too great. Some patents are so broad, corporations can have monopolies over an entire species. Dr. Geoffrey Hawtin, director general of International Plant Genetic Resources Institute stated that the "granting of patents covering all genetically engineered varieties of a species…puts in the hands of a single inventor the possibility to control what we grow on our farms and in our gardens. At the stroke of a pen, the research of countless farmers and scientists has potentially been negated in a single, legal act of economic highjack." Many biotech corporations are looking all over the world for useful genes, as they cannot create new genes in the laboratory. They will often exploit indigenous people by taking genes from plants whose abilities were discovered through many generations of trial, and pay little in return. They may also take genes from people in certain areas with unique physical characteristics.

With these many genes, scientists create a multitude of GMOs, with many different purposes. While many of them have too many problems and risks already identified, some have the potential to be worthwhile. Some may be engineered to remove hazardous waste with "bioabsorbtion." We may also be able to produce new medicines, measure the breakdown of pollutants, and create mosquitoes that do not transmit diseases. It is probable that problems will arise as these GMOs are used, so we must carefully regulate and study these organisms before they are used.

Cloning is another aspect of biotechnology that promises some benefits. A scientist can grow tissue in a laboratory, which could then be transplanted to someone in need of tissue. The grown tissue would

match perfectly and would not be rejected by the body. Grown bones and joints would not loosen, would not cause infection, and would merge with the surrounding tissue. "Therapeutic" cloning (where human embryos are destroyed after 14 days) should always be used. By 2020, 95% of body parts may be able to be grown in labs for transplantiation. With cloning, too, we need to be careful and cautious, although the risks are not as great, because nothing is uncontrollably released into the environment.

The ethical issues about cloning mostly concern the cloning of humans, for which there is not really a pragmatic purpose. Endangered animals should also not be cloned. The majority of those created have premature ageing and birth defects, such as being larger, having underdeveloped lungs, and getting bacterial infections within weeks. Baby clones are also 3 times as likely to die. Because clones have no genetic diversity, they are easily killed. If one animal were infected with a disease, the whole group of animals would die, because they wouldn't have different genes to prevent them from getting the virus as well. Also, these animals could probably only live in zoos because their natural habitat was destroyed. Instead we should focus on preserving habitats so wildlife does not become endangered in the first place.

There are several ethical concerns also involved with genetic engineering. Animals with deformities form experiments go through life suffering. A few years ago, a human growth hormone was inserted into pig embryos with hopes of producing fast growing and large pigs. Instead, it resulted suffering because of abnormalities, including too much hair, arthritis, lethargy, and being cross-eyed. There are over 200 "freak" animals waiting to be patented by the government. Without labeling, followers of certain religious and vegetarians will not be able to tell if what they are eating contains genes from animals, including humans. If genetic information got into the wrong hands, it could create a new kind of genetic discrimination. For example, employers could choose workers based on the information and health insurance companies could deny insurance to certain individuals.

Without such a new technology, it would only seem logical that there is uncertainty involved. There are various methods of putting genes into cells. Recombinant DNA involves inserting a gene into a virus or plasmid (which is a small ring of DNA) and then inserting that into a cell. Electro and chemical poration is when pores are made in the cell membrane and the gene is put through. The bioballistics technique involves shooting a sliver, that has a gene on it, into a cell. With all methods of insertation, it is impossible to control where the DNA goes in the cell. It may not work or may even cause other side effects. Genes that do a certain task in one organism may work very differently in another. When a gene for red color from corn was inserted into petunias it decreased fertility, gave the plant more resistance to fungi, caused the roots and leaves to have defects, and turned it white. A salmon with a growth hormone grew too quickly and turned green. These effects are known as pleiotropic effects. Molecular biologist, Dr. Michael Antoniou, explained that the "function of a given gene in a group is dependent on all the other genes that are present within the same family [group of DNA]. Furthermore, the genetic activity in one family of genes can affect the function of genes in other groups of genes. It is also clear that genes and the proteins that they give rise to,

have co-evolved together to form an extremely intricate, interconnected network of finely balanced functions, the complexities of which we are only just beginning to understand…" On March 6, 1992, the FEDA microbiologist, Louis Pribyl, stated that the FDA "reads very pro-industry, especially in the area of unintended effects… This is industry' pet idea, namely that there are no unintended effects that will raise the FDA's level of concern. But time and time again, there is no data to back up their contention, while the scientific literature does contain many examples of naturally occurring pleiotropic effects. When the introduction of genes into [a] plant's genome randomly occurs, as is the case with the current technology (but not with traditional breeding), it seems apparent that many pleiotropic effects will occur. Many of these effects might not be seen…[u]ntil more of these experimental plants have a wider environmental distribution…" A virus or bacterium is often inserted as a "promoter" into a cell to start a gene working. It's possible that the promoter will force genes to produce things at 10-1000 times their normal levels. Something that is normally harmless in small levels could become toxic. For example, when yeast was genetically engineered for increased fermentation, enough methyl-glyoxal was produced (about 30 times normal levels) that it became toxic. As evidence of more uncertainty, newspapers recently reported that Roundup Ready soybeans (those that could survive being sprayed with Roundup) contained extra genes, at which the engineers were not aware were in it.

Biotechnology also affects farmers themselves. Farmers do not gain extra revenue from GE crops and many fear losing money from export markets to Europe and Japan (which banned GE imports). Biotechnology also drives small farmers out and produces more large plantations and monopolistic and oligopolistic corporations. Small farms, apart from helping to protect rural America, often are more diverse and more productive. In Syria, farms between 1 and 2.5 acres were an average of three times more productive than a 37 acre farm and farms between 12 and 17 acres in Peru were an average of four times as productive as a 37 acre farm. With the patenting of GMOs, farmers may have to lease plants and animals from corporations and pay royalties. Farming could possibly eventually be moved into industrial factories owned by biotech corporations. Right now, many biotech corporations are buying small seed companies that could potentially be competitive, in an effort to further their monopolistic control.

Biotechnology is likely to lead to a decrease in genetic diversity. With only the crops with desired genes grown, many others will die out. About 30,000 species go extinct every year. A study by the UN Food and Agricultural Organization showed that we have lost 75% of genetic diversity in farming since the beginning of the century. Decreased species diversity apart form harming the environment, leads to increased risk of disease spreading, because the similar varieties have no unique protection. The Irish potato famine in the 1840's was caused by limited genetic diversity. In 1970, 15% of US corn was destroyed by a virus. Eighty percent of the US corn has been standardized to make cross-breeding easier, so the virus spread quickly. Eventually, the virus spread to 581 countries and 28 states. J. Browning of Iowa State University said that such "an extensive, homogeneous acreage of plants… is like a tinder-dry prairie waiting

for spark to ignite it." Author Jeremy Rifkin, in his book, The Biotech Century, points out that by, "focusing on short-term market priorities, the biotech industry threatens to destroy the very genetic heirlooms that might one day be worth their weight in gold as a new line of defense against a new resistant disease or super bug."

One of the most frightening things that will come out of biotechnology research is biological weapons. They are outlawed for offense by an international treaty but the US and other countries continue to build them for "defense" (even though they are the same for defense and offense). Being developed are bacteria that do not resist antibiotics, more deadly and longer-living viruses, organisms immune to natural human resistances or vaccines, pathogens that disrupt hormones to the point of death, and harmless bacteria can be turned into deadly ones. Some experts say that it's possible that pathogens are being designed to target only specific racial groups. Biological weapons can also be used to destroy certain plants and animals used for farming, to weaken the economy of a certain country. These weapons are very powerful, as seen by a report by the US Office of Technology Assessment in 1993. It said that 3 million people could be killed from a mere 220 pounds of anthrax spores released over Washington D.C. The possible damage companies with nuclear weapons, although biological weapons are much easier and cheaper to create.

The biotech industry is spending billions of dollars on propaganda to convince the public that biotechnology is a perfect solution. One of their main points is that with better crops, they will be able to "feed the world." However, when you look past the superficial message, you can see why it is propaganda and not fact.

Terminator technology is one of the main restrictions keeping poor, third world farmers from benefiting. The Terminator gene in plants causes them to sterilize themselves, so instead of saving seeds from year to year (which most farmers do), they must go back and buy new ones. Corporations claim that it would be like copyright infringement to copy seeds. Since it's patenting on March 3, 1998, Monsanto has declared that it will not use the technology. However, the USDA continues to promote and develop it. About half of the world's farmers rely on saving seeds to provide food for about 1.4 billion people. They cannot afford to pay extra for new seeds. Camila Montecinos of Centro de Educacion y Technologia (CET) of Chile, describes terminator technology as "an immoral technique…The sole purpose is to facilitate monopoly control and the sole beneficiary is agribusiness…[I've] talked to a number of crop geneticist who have studied the patent. They're telling us that it's likely that pollen from crops carrying the Terminator will infect the fields of farmers who either reject or can't afford the technology… This is the neutron bomb of agriculture."

GE seeds are also more costly to buy, and those farmers without enough money for food will not be able to buy expensive seeds. A study by the Research Foundation for Science, Technology, and Ecology (RFSTE), based at New Delhi showed that Indian farmers, if they switched to Bt-cotton seeds would pay up to 9 times what they have to pay for normal crops. GE crops generally also produce lower yields compared

with normal crops. Studies have shown that Roundup Ready soya produce 5-10 bushels fewer per acre. A 1997 University of Purdue study found that, in the same growing environment, GE soya yielded 12-20% less. In 1997 and 1998, the National Institute of Agricultural Botany (NIAB) in the UK performed trials which showed that GE winter oilseed rape and GE sugar beets yielded 5-8% less than normal varieties. A study performed in 1999 by the University of Wisconsin showed the levels of GE soya in 21 locations, in northern states, in 1999 as compared with 1998. In all but 4 of the locations, less was produced by the GE soya in 1999.

Overpopulation may be the most prominent and threatening problem facing the world today, as it has an enormous impact on the environment. The population increases by 263,000 each day!! When the standard of living of families increases, the number of children usually decreases. However, because the standard of living is so poor in third-world countries, they have many children as well as little money and little food.

To eliminate hunger we should concentrate on reallocation of resources to third-world countries. Unlike the biotech corporations want us to believe, there is enough food already produced – enough to feed 9 billion people. Many of the starving people live in countries with enough food, except most of it is exported, and without money, the people in the countries can afford very little. A study by the United Nations revealed that in the early 1990's 78% of undernourished children in the developing world under the age of five, lived in countries with food surpluses.

Poverty also decreases the health care of those in third-world countries. Diarrhea, for example, (which is caused by an unsanitary water supply) prevents a person from absorbing some nutrients in their food. The more education and status people have, the better their standard of living and the less their hunger. A 1999 study of hunger in 63 countries showed that better health, better women's education, and better women's status accounted for ¾ of improvements in hunger since 1970. The last ¼ was due to increased amounts of food. Pedro Sanchez, the Director General of the International Centre for Research in Agroforestry (ICRAF) made the point that, "third World farmers don't need improved seeds, but rather improved natural resource management, including soil and water management, crop rotations, and nitrogen-fixing crops." This has very often proven to be true. In Latin America, green manures and cover cropping have increased corn yields from 1-1.5 tons/hectare to ¾ tons/hectare. Over 300,000 farmers in southern and western India tripled sorghum and millet yields to 2-2.5 tons/hectare by improving soil and water management. About 200,000 Kenya farmers used soils and water conservation to more than double their production of corn to 2.5-3.3 tons/hectare as well as improve their vegetable production. Pedro Sanchez pointed out that neither GM nor regular crops can be taken full advantage of until these problems are solved. Farmers should also reduce nutrient losses, prevent runoff and erosion, maintain plant cover, improve nutrient recycling, disturb the soil as little as possible, and plant different types of crops together. Author Luke Anderson explained that these "sustainable agricultural systems are able to provide substantial

increases in yields whilst encouraging the use of local resources and helping communities become more self-reliant. In contrast, multinational corporations, who are in the business of selling seeds, fertilizers, and chemicals, aim to tie farmers to external inputs, which come only from them, at their price. Such corporations are naturally reluctant to acknowledge the potential of agricultural systems that are outside their control." Brian Halweil, a researcher at Worldwatch Institute, summarizes the solution by arguing that "… [I]f we are interested in eradication hunger and poverty in the developing world, there are approaches other than investment in biotechnology that are better understood, less risky, and which may ultimately prove more effective."

Genetically engineered crops may also have damaging effects on human health. With little regulation and testing, consumer are the "guinea pigs" who will have to find those health threats. In 1989, a GE brand of L-tryptophan (a dietary supplement) caused the death of 37 American and gave 5,000 others the potentially deadly blood disorder, Eosinophilia Myalgia Syndrome (EMS). 1500 others had permanent disabilities, including chronic neurological problems, swelled and cracked skin, heart trouble, and paralysis. Because the supplement was not labeled as genetically modified, it was hard to find what caused the outbreak. When GE potatoes with snowdrop lectin were fed to rats, those animals showed sign of viral infection, a decreased immune system and decreased organ weight. A US Government memo from 1993 talked of an experiment where 4 out of 20 female rodents who were fed a GM tomato, FlavrSavr (owned by Monsanto) had stomach lesions. Another study by a Scottish scientist showed the rats fed insect-resistant potatoes suffered growth problems damaged immune systems and shrunken brains. Cows with the bovine growth hormone, rBGH have 4-5 times the amount of insulin-like growth factor (IGF-1), which increases the risk of breast, prostate, and colon cancer. The European Unions banned rBGH in 1994, Canada did the same in 1999, and now the US is the only industrialized country in the world still to use it. In 1998, British scientist, Arpad Pusztai, found that after rats were fed transgenic potatoes, they had worse immune systems and halted growth. The effects in humans wouldn't be the same as a rat's but could be similar. After Pusztai made an appearance on television about his findings, he was fired. In 1999, he theorized that the health effects might not have been from the potatoes, but from the process of genetic engineering itself. If this theory turns out to be true, similar health effects could occur in all GE foods.

Other various health risks also exist with genetic engineering. GE foods can have lowered nutritional value. The FDA declared Monsanto's soybeans "substantially equivalent" to regular soya, but some tests have shown the GE soybeans have less protein and less of the important amino acid, phenylalanine. Test have also shown that the soybeans have 27% more trypsin inhibitor, which can be an allergen, can cause problems, with protein digestions, and has been known to cause extra large pancreases in rats. GE soybeans have also been proven to have very different levels of isoflavones, which are thought to have benefits to human health. Monsanto may begin to sell RoundupReady grass, which will increase the use of the herbicide Roundup, which can cause cancer of white blood cells and has caused disruption of sex hormone

production in mice. As for pesticide producing plants, the EPA has no limit of how much pesticide can be in a plant, even though there is a limit on the amount allowable on food. A plant, which normally produces toxins in a non-edible part but not in the edible part, could be a danger if it was genetically engineered. Because an inserted gene has unpredictable effects, insertational mutagenisis (unpredictable effects form insertion) could cause the toxins to be produce in the edible part of the plant. On May 2, 2001, scientists in the Toronto Globe and Mail Newspaper warned that if plant material form plants in the open environment that were genetically engineered to produce medicines or chemicals, drifted into and contaminated plants grown to eat, the consumers of the contaminated food could be ingesting medicines or chemicals. In September of 2000, a GE type of corn, that was permitted for cows to ingest but not humans, found it's way into Taco Bell tacos. This mishap shows how easily mistakes with this kind of consequence can occur. Some genetic engineering removes parts of a plant, such as caffeine from coffee. Often these are essential parts of the plant and, without these, plants may not be able to protect themselves as well against fungi, which may cause toxins, including afloatoxins. Caused by fungus spores on grains and vegetables, afloatoxins form the most in hot and humid climates. Because afloatoxins contribute to liver cancer, there is a limit as to the amount that can be on foods. In 1999, researchers in Corpus Christi, Texas, found afloatoxin levels on Monsanto's Bt-producing corn were alarmingly high and much higher than levels on normal non-Bt corn varieties. If these GE crops were grown in places such as Latin America, where it is even more humid and hot, the afloatoxin levels would undoubtedly be even higher. In the biotech propaganda, golden rice is usually used as a way that genetic engineering will aid the hungry and malnourished. Golden rice is rice that has been genetically modified to produce vitamin A in its starch. Especially in poorer countries, people are going to have little variety in their diet. Many malnourished people will probably rely on golden rice for a large portion of their diet, and get vitamin A toxicity. Municipal sludge is being used as a fertilizer but often contains toxic metals making it unusable. Some plants may be genetically engineered to remove metals (such as mercury) form the sludge and store them in parts of the plant, which are not consumed. Problems would arise if the metals were not fully prevented from entering the edible portions of the plant. Apart from potentially impacting human heath, ecological problems as to the disposal of the plant could be unsafe.

Many are concerned about the effects GE foods could cause as allergens. GE foods may contain genes from other substances and new proteins may be formed, which could cause allergic reactions, and, without labeled foods, the consumer has no way of figuring out what substance in the food caused the reaction. For just the currently know allergens, 8% of children and 2% of adults have food allergies. A study by scientists at the University of Nebraska of Lincoln in March of 1996, found that soybeans containing proteins from Brazil nuts could set off a potentially deadly reaction in those allergic to Brazil nuts. All known allergens are proteins and many GE foods contain proteins from bacteria and other such organisms. None of these proteins have ever been in the human diet, so the effects are virtually unknown.

Dr. Marion Nestle of NY University said that it "is in everyone's best interest to develop regulatory policies for transgenic food that include premarketing notification and labeling."

GE plants may have genes, which could render antibiotics ineffective. Oftentimes scientists will use antibiotics as a marker to determine which cells are genetically engineered (the GE cells are the ones that survive). Many plants still contain antibiotic resistance although it does not absolutely need to be used. There are ways to find genes without antibiotic resistance are it is possible to remove that resistance once it is in. With many of the plants grown, many genes will be dispersed into the environment, which could be taken in by animals and humans. Tests have shown that antibiotic-resistant plants can transfer their genes to the soil and even other organisms in the soil. Some say that eating foods with antibiotic resistance could create resistant bacteria in the gut. Already, mainly due to simply overusing antibiotics, more are killed every year from an antibiotic-resistant bacteria than from automobile accidents. A gene in GM corn, which was grown in Europe in 1998 (called the bla gene) is resistant to Ampicillin, Penicillin G, Amoxycillin and Phenoxymethypenicillin. These antibiotics are often used, and in 1996, they were prescribed 12 million times, just in Germany alone. They are used for tonsillitis, whopping cough, pneumonia, scarlet fever, inflammation of the middle ear, and other ailments. Certain potato plants contain the nptlll gene, which is resistant to Amikacin, a backup antibiotic which is used as little as possible to prevent resistance to it. In 1999 a report by the British Medical Association, a leading British association of doctors, said that there "should be a ban on the use of antibiotic resistance marker genes in GM food, as the risk to human health from antibiotic resistance developing in microorganisms is one of the major public health threats that will be faced in the 21st century. The risk that antibiotic resistance may be passed on to bacteria affecting human beings, through marker genes in the food chain, is one that cannot at present be ruled out."

Probably the most justified concern about genetic engineering is its impact on the environment. Jeremy Rifkin, an author and president of the Foundation on Economic Trends in Washington, DC, makes the point that there " is not a single instance in history in which the introduction of a major technological innovation has had only benign consequences for the natural world. New technologies allow human beings to exploit and expropriate nature for short term gain, but always at the expense of polluting, depleting, and destabilizing some portion of the biosphere in the process. The power to transform, remake, and exploit nature in wholly now ways virtually guarantees that the biotech revolution well inflict its own from of damage on the earth's environment. Indeed, genetic pollution is likely to pose at least as significant a threat to the biosphere in the coming century as petrochemicals have in the current [20th] century.

One of the concerns is the possibility of the creation of new, more powerful viruses. Some GE plants are resistant to viruses and it's possible that protein genes could combine with viruses in the plant to create viruses that never before existed. Experiments have shown that a virus-resistant tobacco plant produced a new virus by recombination, which is when virus genes become mixed up and form new combinations. If "super viruses" were created, crops over whole continents could be destroyed. Author Luke Anderson points

out: “It is argued that genetically engineered crops are no more likely to generate new viruses than any plant that has been infected by two or more different viruses at the same time…Transgenic virus-resistant crops, however, will contain viral genes in all of their cells all the time they are growing; this, together with the fact that virus-resistant crops are so soon to be released over millions of acres, increases the probability that new viruses will be generated.” Papaya and squash plants have been genetically engineered to resist viruses. In the US, there are permits granted or pending for virus resistance in beets, cucumbers, lettuce, melons, peppers, potatoes, sunflowers, tomatoes, and watermelons. Virus resistance has been working, but it has the potential to cause environmental and ecological problems. Charles Margulis offers a better solution: “What farmers around the world have seen is that, when you plant mixed plant varieties, even just two varieties instead of one, you’ll see the spread of the disease slow down incredibly. The more varieties you plant, [the more] you tend to see the disease slow down… What tends to happen in nature is that a virus will infect one variety, maybe two, but certainly not three or more. That’s the ecological approach to that problem [of viruses], which…could be successful in the long run as opposed to a genetic fix, which may have a very short life.”

Another concern with GMOs is that genetically engineered genes, such as those that are resistant to herbicide, could spread to weedy or other closely related plants, possibly causing the weedy relatives to become resistant to the herbicide, which is called horizontal gene transfer. The genes are likely to spread from pollen but may spread in other ways as well. A study with GM potatoes showed that genetic pollution can travel up to 1.1 kilometers away from the original crops. As well as herbicide resistance, pest resistance, virus resistance as well as other things such as terminator genes could transfer, which would cause ecological disaster. In October of 2000, German researchers found that a sugar beet designed to resist one herbicide acquired resistance for two. A 1996 study by a Danish research group found that when a GE oilseed rape plant was grown next to eh weedy relative, *Brassica compestris*, the two cross pollinated and 42% of the 2nd generation of weeds contained genes of herbicide resistance. Many GE fields grown near organic crops are polluting the organic crops with GE genes. In developing countries, where many biotech corporations hope to collect lots of revenue, there is more biodiversity and most cultivated crops are planted closer to native plants so the chances for gene spreading are even greater and more threatening. Also, studies have shown that, contrary to the biotech industry’s claims, wild plants with genes from GM plants do not die out because they cannot compete, but often do very well.

Plants that are resistant to herbicides (such as Roundup Ready soybeans) pose another major environmental threat. Over 50% of GE crops are developed to be resistant to herbicides. The same companies that produce herbicide-resistant plants also produce herbicides (such as Monsanto). This is an easy method for farmers to use because the crops are not damaged by the herbicides and therefore it occurs more frequently. The corporations would not make herbicide resistant crops if it lowered the use of herbicides. In 1999, in the Midwest, the amount of herbicide used on GM soybeans was 2-5 times high than

that of normal soybeans. Another study this year found that ½ pound of extra herbicide per acre was put onto Roundup Ready soybeans – which amounts to about an extra 20 million pounds this year. Because of the extra pesticides used, Monsanto has requested an increase in the allowable limit of herbicides on food from 6 parts per million to 20 parts per million. With more herbicide used, it is more likely that weeds will become resistant to it. Australian reports show that the common weed, ryegrass, may have developed resistance to Roundup from only ten sprays of it over 15 years. Once resistance is developed, new herbicides will be needed, and the whole time, the large amounts of chemicals will be damaging the environment. One of the main chemicals in Roundup, glyphosate, is very damaging to beneficial soil bacteria, as well as other organisms. Glyphosate can kill fish in concentrations as low as 10 ppm and the US Fish and Wildlife Service has found that 74 endangered plants may be damaged by too much use of it. AgrEvo's herbicide, glufosinate, contrary to the industry's claims, is not 'environmentally friendly', as it is very toxic and damaging to animals, including humans, and mainly damages the nervous system. Glufosinate is soluble in water, which means it can easily find its way into water and affect marine organisms. The EPA has identified it as toxic to water organisms, even in very low concentrations. Many weeds that exist today were, at one time, introduced purposely. If, at one point in the future, a plant with herbicide resistance became a weed, it would be very hard to get rid of. Margaret Mellon, from the Union of Concerned Scientists, explained: "Sooner or later, weeds will begin to develop resistance to Roundup [and other herbicides] and more applications of the herbicide will be required. Increasing use of Roundup, of course, will likely increase the rate of herbicide resistance development and pretty soon, farmers will again have lots of weeds and even fewer weed control options."

Plants are also genetically engineered to produce their own pesticides. The biotechnology companies claim to be helping the environment by using less pesticide, and, while less pesticides are used, these plants are far form environmentally friendly. The main pesticide used is called *Bacillus thuringiensis* (Bt), which the GE plant produces in every cell of its body for its whole life. It has been used for over 50 years by farmers as an organic pesticide because it is only affects caterpillars, it wears off in the sun and does not get into the ground. As a pesticide, it is used sparingly and not often. Many scientists fear that insects will become resistant to plants producing Bt, rendering it ineffective. Two of the main factors that cause evolution to occur very rapidly are if the organism trying to adapt has a short life span to produce many well-adapted generations and if environmental conditions change drastically enough to greatly influence the survival of the species. For insects eating Bt crops, both of these factors are present and abundant. A recent study, reported by the Australian Broadcasting Corporation, found that insects were becoming resistant to Monsanto's Ingard Cotton. In a field test of GM crops, about 20% of bollworms survived the pesticide produced which means that 20% would reproduce their resistant genes to subsequent generations. In 1998, 8 major insect species had acquired resistance to Bt, including the Colorado potato beetle, the diamond back moth, and the tobacco budworm. The EPA in 1999 predicted that many of the insects targeted by BT crops

will become resistant within three to five years. To help deal with the problem of resistance, farmers are supposed to grow refuges, sections of non-Gm plants, around their GM crops to slow down resistance. However, most farmers do not take the time or spend the resources to grow these refuges, as they are not heavily monitored. Jeremy Rifkin also says that "[t]his refuge idea won't stop insects from moving across boundaries…[I]nsects will pass through refuges at will. The idea that you can restrain them is absolutely absurd." In July of 2000, it was discovered that refuges were not working because non-resistant insects from the normal crops would not mate with more resistant insects form the GM crops. Because of resistance that has and will develop to Bt, organic farmers will no longer be able to use Bt as a natural, harmless pesticide.

Bt plants can and already have hurt other organism in the environment. The pesticide is in the pollen and when the pollen spreads, it can kill other organisms. A study by John Losey at Cornell University involved monarch caterpillars on milkweed leaves, one with Bt pollen on it and the other withtout it. After 4 days, none of the caterpillars on the normal leaf had died, but almost half of the caterpillars on the leaf with Bt pollen had died, and the survivors on the Bt leaf grew more slowly, as well. An Iowa State University study found that almost 20% of monarchs on mildewed leaves, taken from fields of crops that produced Bt, died but none on normal leaves died. A predator feeding on prey affected by Bt may also suffer harm, such as a lacewing eating smaller organisms. Bt may also hurt the endangered Karner Blue Butterfly, and there are many other species of threatened or endangered butterflies and moths, which could also be hurt from Bt pollen. It also has the potential to be harmful to other organisms including ladybugs, bees, possibly birds and beneficial soil organisms.

There are still many more environmental concerns about GMOs. If laboratory experiments managed to escape, it could be devastating to the environment as well as to human health. In the late 1980's, there was much justified concern when the AIDS virus was injected into mice, because if one of the mice escaped and mated, it would produce a whole population of mice with AIDS. Although there is a possibility of GMOs escaping from a laboratory, the real danger lies in purposely releasing them into the environment. They are alive and therefore much more unpredictable than things such as petrochemicals. Once an organism is released, it is nearly impossible to recall it. Laboratory work on genetic engineering should continue, but we should stop releasing GMOs into the environment until we are absolutely sure they are safe, which should take years and years to determine. Independent researchers should then have them closely monitored and stop any release if any, even potentially harmful situation is discovered. Field tests, to determine how a GMO will affect its environment, are too often too inaccurate. Most of the time, scientists working for industry will change the data, and when the tests are done by reliable scientists, they still do not show how the GMO will react on a larger scale, over longer periods of time, or in many different environments, with different ecosystems, organisms, soils, weather, climates, and other factors. Observing horizontal gene transfer, weed and insect resistance, and other problems is much less likely. Researchers from the Scottish Crop Research Institute found that more pollen was escaping from GE oilseed rape than

was found with small scale tests, and that the pollen was able to fertilize plants 2,500 meters away. Jeremy Rifkin makes the point that " if the field tests are designed in such a way as to reveal little or nothing of the potential risk that might occur in large scale commercial releases, then the exercise is little more than a regulatory farce, an elaborate fiction given the appearance of scientific legitimacy without the substance."

Another environmental concern is that of GM fish, which could alter ecosystems and cause extinction. GM fish (which would be much larger than normal) would use up much more food and could cause smaller fish of the same species to die of starvation. Also, when a larger GM fish mates with a smaller fish, the survival rate of offspring is much lower. Some biotech corporations say that they will sterilize the fish and confine them so they do not escape, but sterilization is not 100% effective and if one fertile fish escaped, it could cause disaster. Even if the escaping fish were sterile, they could still crowd out smaller fish. Pacific salmon are being genetically modified so that they can mate and reproduce in the ocean without traveling upstream. This could cause a disruption of the ecosystem upstream, including the predators, such as bears, that need the fish migrations.

Another concern deals with the GE bacterium, *Pseudomonas syringae* (ice minus) that creates ice crystals on plants. The bacteria normally produces ice crystals, but researchers were able to use recombinant DNA to remove the part of the bacteria that creates ice. It was hoped that if this was sprayed onto crops, it would prevent natural frost, but the spraying of ice-minus could disrupt precipitation and global climates because of its ice-making ability. There was more concern over a GM organism that has the ability to destroy lignin (the substance that makes wood hard). It could be used to clean up effluent left over form paper manufacture or could decompose organic materials for energy. However, if these organisms escaped and were successful, forests all over the world could have their lignin eaten.

Other environmental threats may result because of disruption in the food chains or ecology due to GMOs. GMOs that produce such things as plastics could be harmful to animals that consume them. Other species may die out for various reasons as well. Researchers from the Scottish Crop Research Institute found that ladybugs that ate aphids that had eaten GE potatoes, suffered form reproductive problems and died sooner (the females lived about half as long as normal ladybugs). The females eating the GE material had their egg production lessened by 1/3 and when males from the GE group mated with females from the normal group, there were 4 times as many unfertilized eggs. About 3 times the number of eggs from females in the GE group died before hatching. With a lower population of one species, the predators that normally eat the species would also die out. If the species that is reducing in numbers from genetic engineering is a predator, its prey will overpopulate and die off from lack of food afterwards. Genetic engineering could throw off millions of years of evolution and ecological balance.

GMOs may also increase the number of invasive species. With new traits, a GMO might be able to live in a new habitat and could be invasive. GE fish that are engineered to be able to live in colder water could move to colder habitats. Salt-tolerant rice could spread to estuaries and drive out many native species.

If genetic engineering will not work without consequences, we have another option of concentrating only on organic agriculture. It is the better of the two options as it is safe to humans and does not damage the environment (except in the way that all agriculture does because it involves planting non-native species). Biotech corporations are saying that crops that produce pesticides are better than spraying pesticides, but with organic food, you do not have the problem of either form of pesticide. David Pimentel, Professor of Ecology and Agricultural Sciences at Cornell University, said that, "[a]lthough pesticides are generally more profitable, their use does not always decrease crop losses. For example, even with the 10-fold increase in insecticide use in the US form 1945 to 1989, total crop losses form insect damage have nearly double from 7% to 13%." A study in the November 11, 1998 issue of Nature, showed that yields of organic crops equaled normal crops after 4 years. It also said that with organic food, quality increases and more crops are yielded during droughts. Jeremy Rifkin said that, "[w]e could use this same [genetic] information we're learning on [the] genomic nature of our plants and our ecosystems to create a sophisticated, market-driven, cheap, efficient organic-based approach to agricultural production in the 21st century…[in which] there's no gene splicing between species. Instead, we upgrade classical breeding with state-of-the-art genomic science… The environment's not the enemy. The environment's the partner… Instead of playing God and being an architect and creating a second genesis, and trying to rearrange millions of years of genetic blueprints, what we ought to be doing is understanding the genomic makeup of the world around us and how genes interact with environments and ecosystems."

Biotechnology is very dangerous and has destructive potential. Unlike most other industrialized countries, the US has very little regulation and does not even require labeling. There are a few possible benefits that may come out of this technology, but unless we use it very carefully, the destruction will definitely outweigh the benefits. We need more time to research and think before unleashing such a devastating technology. We can already see myriads of ways that GMOs can disrupt human health. There is much uncertainty with insertion, and, unlike the propaganda claims, GE food will not end hunger. It may actually cause more starvation because poor farmers will not be able to afford it. The problems identified are only those currently known. Many worse effects may not have been sufficiently tested or may take longer to have visible impacts. We should stop the release of GMOs into the environment until meticulous, independent tests show them to be absolutely safe. If it becomes apparent that the GMO will have even a chance of negative effects, it should not be released into the environment. At the very least food needs to be labeled so consumers con know what they're eating. However, violent methods, such as burning down buildings an destroying GM crops, should not be used. They are not productive and give a bad message to the public about the protests of genetic engineering. Similar tactics to genetic engineering were made by similar companies in the past and caused much damage. This time the outcomes will be much more serious, unless something is done about it. America should be the country leading the way in regulation and caution,

not lagging far behind. After all, the effects of genetic engineering will last practically forever, in terms of human existence.

"Up until now, living organisms have evolved very slowly, and new life forms have had plenty of time to settle in. Now whole proteins will be transposed overnight into wholly new associations, with consequences no one can foretell, either for the host organism, or their neighbors. It is all too big and is happening too fast…[G]oing ahead in this direction may be not only unwise, but dangerous."

-Dr. George Wald, Professor Emeritus in Biology from Harvard University and Nobel laureate in medicine

"Herbicide-tolerant crops perpetuate and extend the chemical pesticide era and its attendant human health and environmental toll. Crops genetically engineered to resist herbicides, insects, and virus diseases, like chemical pesticides, will be sold to farmers as single, simple-to-use products to control pests and sustain continuous monoculture. They are being developed to fit immediately and easily into conventional agriculture's industrialized monoculture. Biotechnology is being developed with the same vision that promoted chemicals to meet the single, short-term goals of enhanced yields and profit margins. This vision embraces a view of the world characterized by beliefs that nature should be dominated, exploited and forced to yield more; by preferences for simple, quick, immediately profitable 'solutions' to complex ecological problems; by 'reductionist' thinking that analyzes complex systems like farming in terms of component parts, rather than as an integrated system; and by a conviction that agricultural success means short-term productivity gains, rather than long-term sustainability."

-Jane Rissler, Union of Concerned Scientists

"The perception that everything is totally straightforward and safe is utterly naïve. I don't think we fully understand the dimensions of what we're getting into."

-Professor Philip James, Director of the Rowett Research Institute, Aberdeen

"The genetic modification of food is intrinsically dangerous. It involves making irreversaible changes in a random manner to a complex level of life about which little is known. It is inevitable that this hit-an d-miss approach will lead to disasters. It must disrupt the natural intelligence of the plant or animal to which it is applied, and lead to health-damagine side-effects."

-Dr. Geoffrey Clements, leader of the Natural Law Party, UK

"I see worries in the fact that we have the power to manipulate genes in ways that would be improbable or impossible thourgh conventional evolution. We shouldn't be complacent in thinking that we can predict the results."

-Colin Blakemore, Waynflete professor of physiology at Oxford University and President of the British Association for the Advancement of Science.

"The FDA has place the interest of a handful of biotechnology companies ahead of their responsibility to protect public health. By failing to require testing and labeling of genetically engineered foods, the agency has made consumers unknowing huinea pigs ofr potentially harmful, unregulated food substances."

-Andrew Kimbrell, Executive Director of the International Center of Technology Assessment

"Information provided to governments and food suppliers by the biotechnology industry is not fully representative of the technical limitations of genetic engineering, and therefore does not give a complete picture of the potential dangers in is use."

"Once released into the environment, unlike a BSE epidemic or chemical spill, genetic mistakes cannot be contained, recalled or cleaned up, but will be passed on to all future generations indefinitely."

-Dr. Michael Antoniou, senior lecturer in molecular pathology from London

"There are still hungry people in Ethiopia, but they are hungry because they have no money, no longer because there is no food to buy …we strongly resent the abuse of our poverty to sway the interests of the …public."

-Tewolde Berhan Gebre Egziabher of the Institute of Sustainable Development in Addis Ababa

"At the moment, as is so often the case with technology, we seem to spend most of our time establishing what is technically possible, and then little time trying to establish whether or not it is something we should be doing in the first place."

-HRH the Prince of Wales

"My worry is that other advances in science may result in other means of mass destruction, maybe more readily available even than nuclear weapons. Genetic engineering is quite a possible area, because of these dreadful developments that are taking place there."

-Joseph Rot blat, British physicist and winner of the 1995 Nobel Prize after years of battling against nuclear weapons

"We do not believe that such companies or gene technologies will help our farmers to produce the food that is needed in the 21st century. ON the contrary, we think it will destroy the diversity, the local knowledge and the sustainable agricultural systems that our farmers have developed for millennia an that it will thus undermine our capacity to feed ourselves."

-Statement by 24 leading African agriculturalists and environmental scientists representing their countries the UN in response to claims by Monsanto that GM crops will help fee the world's growing population.

"Today the vast majority of foods in super markets contain genetically modified substances whose effects on our health are unknown. As a medical doctor, I can assure you that no one in the medical profession would attempt to perform experiments on human subject without their consent. Such conduct is illegal and unethical. Yet manufacturers of genetically altered foods are exposing us to one of the largest uncontrolled experiments in modern history."

-Dr. Martha R. Herbert, pediatric neurologist

"An ecosystem-you can always intervene and change something in it, but there's no way of knowing what all the downstream effects will be or how it might affect the environment. We have such a miserably poor understanding of how the organism develops from its DNA that I would be surprised if we don't get one rude shock after another."

-Richard Lewontin, Professor of Genetics, Harvard University

"[A] complacent attitude toward the risks of GM foods and crops arises from an approach which tends to equate 'no evidence' with 'no risk'…the complex interactions which take place in the environment and the difficulties of 'managing' or 'controlling' them in the real world are not fully acknowledged by the current risk culture."

-Julie Shepherd from the UK Consumers Association

"We are confronted with what is undoubtedly the single most potent technology the world has ever known - more powerful even than atomic energy. Yet it is being released throughout our environment and deployed with superficial or no risk assessments - as if no one needs to worry an iota about its unparalleled powers to harm life as we know it - and for all future generations."

-Nathan B. Batalion

"When the day arrives- and it's likely to come sooner rather than later- 'genetic pollution' will take its place alongside petrochemical and nuclear pollution as a grave threat to the Earth's already beleaguered environment…We are flying blindly into a new era of agricultural biotechnology with high hopes, few constraints, and little idea of the potential outcomes."

-Jeremy Rifkin

"I have the feeling that science has transgressed a barrier that should have remained inviolate…you cannot recall a new form of life…It will survive you and your children and your children's children. Anirreverasble attack on the biosphere is something so unheard of, so unthinkable to previous generations, that I could only wish that mine had not been guilty of it."

Erwin Chargaff, Professor Emeritus of Biochemistry, Columbia University

"Genetic engineering of food has far outrun the science that must be its first governing discipline. Many unknowns attend the insertation of genes across species, from ecological risks to food allergies. These unknowns beg for investigation. About 90 percent of the public wants labeling of genetically engineered foods…[We need] mandatory labeling of all foods containing genetically modified organisms (GMOs) as well as comprehensive safety testing to be carried out by the FDA and USDA…The regulatory budget for environmental and human health safety assessments has been tiny in comparison to research and other monies budgeted to aid industry aims…This decision [to have inadequate regulation] represents a staggering failure by the [Food and Drug] Administration to recognize the precautionary principle and protect human health and the environment…[Biotechnology] is the least regulated, most tumultuous technology ever unleashed on the planet…We have to impose the precautionary principle, and you need a

public body to do that in Washington…[We also need to] free our scientific…colleagues so they can speak freely without having confidentiality agreements and proprietary restrictions…A new science that has such a pretentious impact on the world has to have free exchange of scientific peer review…[Biotechnology] involves issues of privacy invasion, enormous databases on genetic profiles…can be whirling around the world…[and] can be used…to the disadvantage of the people…Are we ready for the government misuse…of this information? Are we ready for…a new form of genetic determination or discrimination? We don't have an ethical, legal, or regulatory framework, and we don't have free scientific peer review…Let's put a higher burden of proof on the industry before it's allowed to go forward."

-Ralph Nader

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