The Unholy Alliance

Dr. Mae-Wan Ho

The Ecologist, Vol.27, No.4, July/August, 1997

Genetic engineering biotechnology is inherently hazardous. It could lead to disasters far worse than those caused by accidents to nuclear installations. In the words of the author, "genes can replicate indefinitely, spread and recombine." For this reason the release of a genetically engineered micro-organism that is lethal to humans could well spell the end of humanity. Unfortunately the proponents of this terrifying technology share a genetic determinist mindset that leads them to reject the inherently dangerous nature of their work. What is particularly worrying at first sight is the irresistible power of the large corporations which are pushing this technology.

Suddenly, the brave new world dawns

Suddenly, as 1997 begins and the millennium is drawing to a close, men and women in the street are waking up to the realization that genetic engineering biotechnology is taking over every aspect of their daily lives. They are caught unprepared for the avalanche of products arriving, or soon to arrive, in their supermarkets: rapeseed oil, soybean, maize, sugar beet, squash, cucumber ... It started as a mere trickle less than three years ago - the BST-milk from cows fed genetically engineered bovine growth hormone to boost milk yield, and the tomato genetically engineered to prolong shelf-life. They had provoked so much debate and opposition; as did indeed, the genetic screening tests for an increasing number of diseases. Surely, we wouldn't, and shouldn't, be rushed headlong into the brave new world.

Back then, in order to quell our anxiety, a series of highly publicized "consensus conferences" and "public consultations" were carried out. Committees were set up by many European governments to consider the risks and the ethics, and the debates continued. The public were, however, only dimly aware of critics who deplored "tampering with nature" and "scrambling the genetic code of species" by introducing human genes into animals, and animal genes into vegetables. Warnings of unexpected effects on agriculture and biodiversity, of the dangers of irreversible "genetic pollution", warnings of genetic discrimination and the return of eugenics, as genetic screening and prenatal diagnosis became widely available, were marginalized. So too were condemnations of the immorality of the "patents on life" - transgenic animals, plants and seeds, taken freely by geneticists of developed countries from the Third World, as well as human genes and human cell lines from indigenous peoples.

By and large, the public were lulled into a false sense of security, in the belief that the best scientists and the new breed of "bioethicists" in the country were busy considering the risks associated with the new biotechnology and the ethical issues raised. Simultaneously, glossy information pamphlets and reports, which aimed at promoting "public understanding" of genetic "modification" were widely distributed by the biotech industries and their friends, and endorsed by government scientists. "Genetic modification", we are told, is simply the latest in a "seamless" continuum of biotechnologies practiced by human beings since the dawn of civilization, from bread and wine-making, to selective breeding. The significant

advantage of genetic modification is that it is much more "precise", as genes can be individually isolated and transferred as desired.

Thus, the possible benefits promised to humankind are limitless. There is something to satisfy everyone. For those morally concerned about inequality and human suffering, it promises to feed the hungry with genetically modified crops able to resist pests and diseases and to increase yields. For those who despair of the present global environmental deterioration, it promises to modify strains of bacteria and higher plants that can degrade toxic wastes or mop up heavy metals (contaminants). For those hankering after sustainable agriculture, it promises to develop Greener, more environmentally friendly transgenic crops that will reduce the use of pesticides, herbicides and fertilizers.

That is not all. It is in the realm of human genetics that the real revolution will be wrought. Plans to uncover the entire genetic blueprint of the human being would, we are told, eventually enable geneticists to diagnose, in advance, all the diseases that an individual will suffer in his or her lifetime, even before the individual is born, or even as the egg is fertilized *in vitro*. A whole gamut of specific drugs tailored to individual genetic needs can be designed to cure all diseases. The possibility of immortality is dangling from the horizons as the "longevity gene" is isolated.

There are problems, of course, as there would be in any technology. The ethical issues have to be decided by the public. (By implication, the science is separate and not open to question.) The risks will be minimized. (Again, by implication, the risks have nothing to do with the science.) After all, nothing in life is without risk. Crossing roads is a risk. The new biotechnology (i.e. genetic engineering biotechnology) is under very strict government regulation, and the government's scientists and other experts will see to it that neither the consumer nor the environment will be unduly harmed.

Then came the relaxation of regulation on genetically modified products, on grounds that over-regulation is compromising the "competitiveness" of the industry, and that hundreds of field trials have demonstrated the new biotechnology to be safe. And, in any case, there is no essential difference between transgenic plants produced by the new biotechnology and those produced by conventional breeding methods. (One prominent spokesperson for the industry even went as far as to refer to the varieties produced by conventional breeding methods, *retrospectively*, as "transgenics".(1) This was followed, a year later, by the avalanche of products approved, or seeking, approval marketing, for which neither segregation from non-genetically engineered produce nor labelling is required. One is left to wonder why, if the products are as safe and wonderful as claimed, they could not be segregated, as organic produce has been for years, so that consumers are given the choice of buying what they want.

A few days later, as though acting on cue, the Association of British Insurers announced that, in future, people applying for life policies will have to divulge the results of any genetic tests they have taken. This is seen, by many, as a definite move towards open genetic discrimination. A few days later, a scientist of the Roslin Institute near Edinburgh announced that they had successfully "cloned" a sheep from a cell taken from the mammary gland of an adult animal. "Dolly", the cloned lamb, is now seven months old. Of course it took nearly 300 trials to get one success, but no mention is made of the vast majority of the embryos that failed. Is that ethical? If it can be done on sheep, does it mean it can be done for human beings? Are we nearer to cloning human beings? The popular media went wild with heroic enthusiasm at one extreme to the horror of Frankenstein at the other. Why is this work only coming to public attention now, when the research has actually been going on for at least 10 years?(2)

The public are totally unprepared. They are being plunged headlong, against their will, into the brave new genetically engineered world, in which giant, faceless multinational corporations will control every aspect of their lives, from the food they can eat, to the baby they can conceive and give birth to.

(Continues after box)

I should, right away, dispel the myth that genetic engineering is just like conventional breeding techniques. It is not. Genetic engineering bypasses conventional breeding by using the artificially constructed vectors to multiply copies of genes, and in many cases, to carry and smuggle genes into cells. Once inside cells, these vectors slot themselves into the host genome. In this way, transgenic organisms are made carrying the desired transgenes. The insertion of foreign genes into the host genome has long been known to have many harmful and fatal effects including cancer; and this is borne out by the low success rate of creating desired transgenic organisms. Typically, a large number of eggs or embryos have to be injected or infected with the vector to obtain a few organisms that successfully express the transgene.

The most common vectors used in genetic engineering biotechnology are a chimeric recombination of natural genetic parasites from different sources, including viruses causing cancers and other diseases in animals and plants, with their pathogenic functions 'crippled', and tagged with one or more antibiotic resistance 'marker' genes, so that cells transformed with the vector can be selected. For example, the vector most widely used in plant genetic engineering is derived from a tumor-inducing plasmid carried by the soil bacterium *Agrobacterium tumefaciens*. In animals, vectors are constructed from retroviruses causing cancers and other diseases. A vector currently used in fish has a framework from the Moloney marine leukemic virus, which causes leukemia in mice, but can infect all mammalian cells. It has bits from the Rous Sarcoma virus, causing sarcomas in chickens, and from the vesicular stomatitis virus, causing oral lesions in cattle, horses, pigs and humans. Such mosaic vectors are particularly hazardous. Unlike natural parasitic genetic elements which have various degrees of host specificity, vectors used in genetic engineering, partly by design, and partly on account of their mosaic character, have the ability to overcome species barriers, and to infect a wide range of species. Another obstacle to genetic engineering is that all organisms and cells have natural defense mechanisms that enable them to destroy or inactivate foreign genes, and transgene instability is a big problem for the industry. Vectors are now increasingly constructed to overcome those mechanisms that maintain the integrity of species. The result is that the artificially constructed vectors are especially good at carrying out horizontal gene transfer.

Let me summarize why rDNA technology differs radically from conventional breeding techniques:

- 1. Genetic engineering recombines genetic material in the laboratory between species that do not interbreed in nature.
- 2. While conventional breeding methods shuffle different forms (alleles) of the same genes, genetic engineering enables completely new (exotic) genes to be introduced with unpredictable effects on the physiology and biochemistry of the resultant transgenic organism.

• 3. Gene multiplications and a high proportion of gene transfers are mediated by vectors which have the following undesirable characteristics:

• a. many are derived from disease-causing viruses, plasmids and mobile genetic elements - parasitic DNA that have the ability to invade cells and insert themselves into the cell's genome causing genetic damages.

• b. they are designed to break down species barriers so that they can shuttle genes between a wide range of species. Their wide host range means that they can infect many animals and plants, and in the process pick up genes from viruses of all these species to create new pathogens.

• c. they routinely carry genes for antibiotic resistance, which is already a big health problem.

• d. they are increasingly constructed to overcome the recipient species' defense mechanisms that break down or inactivate foreign DNA.

(Continued)

Isn't it a bit late in the day to tell us that? you ask. Yes and no. Yes, because I, who should, perhaps, have known better, was caught unprepared like the rest. And no, because there have been so many people warning us of that eventuality, who have campaigned tirelessly on our behalf, some of them going back to the earliest days of genetic engineering in the 1970s - although we have paid them little heed. No, it is not too late, if only because that is precisely what we tend to believe, and are encouraged to believe. A certain climate is created - that of being rapidly overtaken by events - reinforcing the feeling that the tidal wave of progress brought on by the new biotechnology is impossible to stem, so that we may be paralyses into accepting the inevitable, No, because we shall not give up, for the consequence of giving up is the brave new world, and soon after that, there may be no world at all. The gene genie is fast getting out of control. The practitioners of genetic engineering biotechnology, the regulators and the critics alike, have *all* underestimated the risks involved, which are *inherent* to genetic engineering biotechnology, particularly as misguided by an outmoded and erroneous world-view that comes from bad science. The dreams may already be turning into nightmares.

That is why people like myself are calling for an immediate moratorium on further releases and marketing of genetically engineered products, and for an independent public enquiry to be set up to look into the risks and hazards involved, taking into account the most comprehensive, scientific knowledge in addition to the social, moral implications. This would be most timely, as public opposition to genetic engineering biotechnology has been gaining momentum throughout Europe and the USA.

In Austria, a record 1.2 million citizens, representing 20 per cent of the electorate, have signed a people's petition to ban genetically engineered foods, as well as deliberate releases of genetically modified organisms and patenting of life. Genetically modified foods were also rejected earlier by a lay people consultation in Norway, and by 95 per cent of consumers in Germany, as revealed by a recent survey. The

European Parliament has voted by an overwhelming 407 to 2 majority to censure the Commission's authorization, in December 1996, for imports of Ciba-Geigy's transgenic maize into Europe, and is calling for imports to be suspended while the authorization is re-examined. The European Commission has decided that in the future genetically engineered seeds will be labelled, and is also considering proposals for retroactive labelling. Commissioner Emma Bonino is to set up a new scientific committee to deal with genetically engineered foods, members of which are to be completely independent of the food industry. Meanwhile, Franz Fischler, the European Commissioner on Agriculture, supports a complete segregation and labelling of production lines of genetically modified and non-genetically modified foods.

In June this year, President Clinton imposed a five-year ban on human cloning in the USA, while the UK House of Commons Science and Technology Committee (STC) wants British law to be amended to ensure that human cloning is illegal. The STC, President Chirac of France and German Research Minister Juergen Ruettgers are also calling for an international ban on human cloning.

Like other excellent critics before me (3), I do not think there is a grand conspiracy afoot, though there are many forces converging to a single terrible end. Susan George comments, "They don't have to conspire if they have the same world-view, aspire to similar goals and take concerted steps to attain them."(4)

I am one of those scientists who have long been highly critical of the reductionist mainstream scientific world-view, and have begun to work towards a radically different approach for understanding nature.(5) But I was unable, for a long time, to see how much science really matters in the affairs of the real world, not just in terms of practical inventions like genetic engineering, but in how that scientific world-view takes hold of people's unconscious, so that they take action, involuntarily, unquestioningly, to shape the world to the detriment of human beings. I was so little aware of how that science is used, without conscious intent, to intimidate and control, to obfuscate, to exploit and oppress; how that dominant world-view generates a selective blindness to make scientists themselves ignore or misread scientific evidence.

The point, however, is not that *science* is bad - but that there can be *bad science* that ill-serves humanity. Science can often be wrong. The history of science can just as well be written in terms of the mistakes made than as the series of triumphs it is usually made out to be. Science is nothing more, and nothing less, than a system of concepts for understanding nature and for obtaining reliable knowledge that enables us to live sustainably with nature. In that sense, one can ill-afford to give up science, for it is through our proper understanding and knowledge of nature that we can live a satisfying life, that we can ultimately distinguish the good science, which serves humanity, from the bad science that does not. In this view, science is imbued with moral values from the start, and cannot be disentangled from them. Therefore it is bad science that purports to be "neutral" and divorced from moral values, as much as it is bad science that ignores scientific evidence.

It is clear that I part company with perhaps a majority of my scientist colleagues in the mainstream, who believe that science can never be wrong, although it can be misused. Or else they carefully distinguish science, as neutral and value-free, from its application, technology, which can do harm or good. (6) This distinction between science and technology is spurious, especially in the case of an experimental science like genetics, and almost all of biology, where the techniques determine what sorts of question are asked and hence the range of answers that are important, significant and relevant to the science. Where would molecular genetics be without the tools that enable practitioners to recombine and manipulate our destiny? It is an irresistibly heroic view, except that it is totally wrong and misguided.

It is also meaningless, therefore, to set up Ethical Committees which do not question the basic scientific assumptions behind the practice of genetic engineering biotechnology. Their brief is severely limited, often verging on the trivial and banal - such as whether a pork gene transferred to food plants might be counter to certain religious beliefs - in comparison with the much more fundamental questions of eugenics, genetic discrimination and, indeed, whether gene transfers should be carried out at all. They can do nothing more than make the unacceptable acceptable to the public.

The debate on genetic engineering biotechnology is dogged by the artificial separation imposed between "pure" science and the issues it gives rise to. "Ethics" is deemed to be socially determined, and therefore negotiable, while the science is seen to be beyond reproach, as it is the "laws" of nature. The same goes for the distinction between "technology" - the application of science - from the science. Risk assessments are to do with the technology, leaving the science equally untouched. The technology can be bad for your health, but not the science. In this article, I shall show why science cannot be separated from moral values nor from the technology that shapes our society. In other words, bad science is unquestionably bad for one's health and well-being, and should be avoided at all costs. Science is, above all, fallible and negotiable, because we have the choice, to do or not to do. It should be negotiated for the public good. That is the only ethical position one can take with regard to science. Otherwise, we are in danger of turning science into the most fundamentalist of religions that, working hand in hand with corporate interests, will surely usher in the brave new world.

Bad science and big business

What makes genetic engineering biotechnology dangerous, in the first instance, is that it is an unprecedented, close alliance between two great powers that can make or break the world: science and commerce. Practically all established molecular geneticists have some direct or indirect connection with industry, which will set limits on what the scientists can and will do research on, not to mention the possibility of compromising their integrity as independent scientists.(7)

The worst aspect of the alliance is that it is between the most reductionist science and multinational monopolistic industry at its most aggressive and exploitative. If the truth be told, it is bad science working together with big business for quick profit, aided and abetted by our governments for the banal reason that governments wish to be re-elected to remain in 'power'.(8)

Speaking as a scientist who loves and believes in science, I have to say it is bad science that has let the world down and caused the major problems we now face, not the least among which is by promoting and legitimizing a particular world-view. It is a reductionist, manipulative and exploitative world-view. Reductionist because it sees the world as bits and pieces, and denies there are organic wholes such as organisms, ecosystems, societies and community of nations. Manipulative and exploitative because it regards nature and fellow human beings as objects to be manipulated and exploited for gain; life being a Darwinian struggle for survival of the fittest.

It is by no means coincidental that the economic theory currently dominating the world is rooted in the same *laissez-faire* capitalist ideology that gave rise to Darwinism. It acknowledges no values other than self-interest, competitiveness and the accumulation of wealth, at which the developed nations have been very successful. Already, according to the 1992 United Nations Development Programme Report, the richest fifth of the world's population has amassed 82.7 per cent of the wealth, while the poorest fifth gets

a piddling 1.4 per cent. Or, put in another way, there are now 477 billionaires in the world whose combined assets are roughly equal to the combined annual incomes of the poorer half of humanity - 2.8 billion people.(9) Do we need to be more "competitive" still to take from the poorest their remaining pittance? That is, in fact, what we are doing.

The governmental representatives of the superpowers are pushing for a "globalized economy" under trade agreements which erase all economic borders. "Together, the processes of deregulation and globalization are undermining the power of both unions and governments and placing the power of global corporations and finance beyond the reach of public accountability."(10) The largest corporations continue to consolidate that power through mergers, acquisitions and strategic alliances. Multinational corporations now comprise 51 of the world's 100 largest economies: only 49 of the latter are nations. By 1993, agricultural biotechnology was being controlled by just (11) giant corporations, and these are now undergoing further mergers. The OECD (Organization for Economic Co-operation and Development) member countries are at this moment working in secret in Paris on the Multilateral Agreements on Investment (MAI), which is written by and for corporations to prohibit any government from establishing performance or accountability standards for foreign investors. European Commissioner, Sir Leon Brittan, is negotiating in the World Trade Organization, on behalf of the European Community, to ensure that no barriers of any kind should remain in the South to dampen exploitation by the North, and at the same time, to protect the deeply unethical "patents of life" through Trade Related Intellectual Property Rights (TRIPS) agreements.(11) So, in addition to gaining complete control of the food supply of the South through exclusive rights to genetically engineered seeds, the big food giants of the North can asset-strip the South's genetic and intellectual resources with impunity, up to and including genes and cell lines of indigenous peoples.

There is no question that the mindset that leads to and validates genetic engineering is *genetic determinism* - the idea that organisms are determined by their genetic makeup, or the totality of their genes. Genetic determinism derives from the marriage of Darwinism and Mendelian genetics. For those imbued with the mindset of genetic determinism, the major problems of the world can be solved simply by identifying and manipulating genes, for genes determine the characters of organisms; so by identifying a gene we can predict a desirable or undesirable trait, by changing a gene we change the trait, by transferring a gene we transfer the corresponding trait.

The Human Genome Project was inspired by the same genetic determinism that locates the "blueprint" for constructing the human being in the human genome. It may have been a brilliant political move to capture research funds and, at the same time, to revive a flagging pharmaceutical industry, but its scientific content was suspect from the first.

Genetic engineering technology promises to work for the benefit of mankind; the reality is something else.

- It displaces and marginalizes all alternative approaches that address the social and environmental causes of malnutrition and ill-health, such as poverty and unemployment, and the need for a sustainable agriculture that could regenerate the environment, guarantee long-term food security and, at the same time, conserve indigenous biodiversity.
- Its purpose is to accommodate problems that reductionist science and industry have created in the first place - widespread environmental deterioration from the intensive,

high-input agriculture of the Green Revolution, and accumulation of toxic wastes from chemical industries. What's offer now is more of the same, except with new problems attached.

• It leads to discriminatory and other unethical practices that are against the moral values of societies and community of nations.

• Worst of all, it is pushing a technology that is untried, and, according to existing knowledge, is inherently hazardous to health and biodiversity.

Let me enlarge on that last point here, as I believe it has been underestimated, if not entirely overlooked by the practitioners, regulators and many critics of genetic engineering biotechnology alike, on account of a certain blindness to concrete scientific evidence, largely as a result of their conscious or unconscious commitment to an old, discredited paradigm. The most immediate hazards are likely to be in public health - which has already reached a global crisis, attesting to the failure of decades of reductionist medical practices - although the hazards to biodiversity will not be far behind.

Genetic engineering biotechnology is inherently hazardous

According to the 1996 World Health Organization Report, at least 30 new diseases, including AIDS, Ebola and Hepatitis C, have emerged over the past 20 years, while old infectious diseases such as tuberculosis, cholera, malaria and diphtheria are coming back worldwide. Almost every month now in the UK we hear reports on fresh outbreaks: *Streptococcus*, meningitis, *E. coli*. Practically all the pathogens are resistant to antibiotics, many to multiple antibiotics. Two strains of *E. coli* isolated in a transplant ward outside Cambridge in 1993 were found to be resistant to 21 out of 22 common antibiotics.(12) A strain of *Staphylococcus* isolated in Australia in 1990 was found to be resistant to 31 different drugs.(13) Infections with these and other strains will very soon become totally invulnerable to treatment. In fact, scientists in Japan have already isolated a strain of *Staphylococcus aureus* that is resistant even to the last resort antibiotic, vancomycin (14).

Geneticists have now linked the emergence of pathogenic bacteria and of antibiotic resistance to *horizontal gene transfer* - the transfer of genes to unrelated species, by infection through viruses, though pieces of genetic material, DNA, taken up into cells from the environment, or by unusual mating taking place between unrelated species. For example, horizontal gene transfer and subsequent genetic recombination have generated the bacterial strains responsible for the cholera outbreak in India in 1992,(15) and the Streptococcus epidemic in Tayside in 1993.(16) The *E. coli* 157 strain involved in the recent outbreaks in Scotland is believed to have originated from horizontal gene transfer from the pathogen, *Shigella* (17). Many unrelated bacterial pathogens, causing diseases from bubonic plague to tree blight, are found to share an entire set of genes for invading cells, which have almost certainly spread by horizontal gene transfer.(18) Similarly, genes for antibiotic resistance have spread horizontally and recombined with one another to generate multiple antibiotic resistance throughout the bacterial populations.(19) Antibiotic resistance genes spread readily by contact between human beings, and from bacteria inhabiting the gut of farm animals to those in human beings.(20) Multiple antibiotic resistant strains of pathogens have been endemic in many hospitals for years.(21)

What is the connection between horizontal gene transfer and genetic engineering? Genetic engineering is a technology designed specifically to transfer genes horizontally between species that do not interbreed. It is designed to break down species barriers and, increasingly, to overcome the species' defense mechanisms which normally degrade or inactivate foreign genes. (22) For the purpose of manipulating, replicating and transferring genes, genetic engineers make use of recombined versions of precisely those genetic parasites causing diseases including cancers, and others that carry and spread virulence genes and antibiotic resistance genes. Thus the technology will contribute to an increase in the frequency of horizontal gene transfer of those genes that are responsible for virulence and antibiotic resistance, and allow them to recombine to generate new pathogens.

What is even more disturbing is that geneticists have now found evidence that the presence of antibiotics typically increases the frequency of horizontal gene transfer 100-fold or more, possibly because the antibiotic acts like a sex hormone for the bacteria, enhancing mating and exchange of genes between unrelated species.(23) Thus, antibiotic resistance and multiple antibiotic resistance cannot be overcome simply by making new antibiotics, *for antibiotics create the very conditions to facilitate the spread of resistance*. The continuing profligate use of antibiotics in intensive farming and in medicine, in combination with the commercial-scale practice of genetic engineering, may already be major contributing factors for the accelerated spread of multiple antibiotic resistance among new and old pathogens that the WHO 1996 Report has identified within the past 10 years. For example, there has been a dramatic rise both in terms of incidence and severity of cases of infections by *Salmonella*, (24) with some countries in Europe witnessing a staggering 20-fold increase in incidence since 1980.

That is not all. One by one, those assumptions on which geneticists and regulatory committees have based their assessment of genetically engineered products to be "safe" have fallen by the wayside, especially in the light of evidence emerging within the past three to four years. However, there is still little indication that the new findings are being taken on board. On the contrary, regulatory bodies have succumbed to pressure from the industry to relax already inadequate regulations. Let me list a few more of the relevant findings in genetics.

We have been told that horizontal gene transfer is confined to bacteria. That is not so. It is now known to involve practically all species of animal, plant and fungus. It is possible for any gene in any species to spread to any other species, especially if the gene is carried on genetically engineered gene-transfer vectors. Transgenes and antibiotic resistance marker genes from transgenic plants have been shown to end up in soil fungi and bacteria. (25) The microbial populations in the environment serve as the gene-transfer highway and reservoir, supporting the replication of the genes and allowing them to spread and recombine with other genes to generate new pathogens. (26)

We have been assured that "crippled" laboratory strains of bacteria and viruses do not survive when released into the environment. That is not true. There is now abundant evidence that they can either survive quite well and multiply, or they can go dormant and reappear after having acquired genes from other bacteria to enable them to multiply.(27) Bacteria co-operate much more than they compete. They share their most valuable assets for survival.

We have been told that DNA is easily broken down in the environment. Not so. DNA can remain in the environment where they can be picked up by bacteria and incorporated into their genome. (28) DNA is, in fact, one of the toughest molecules. Biochemists jumped with joy when they didn't have to work with proteins anymore, which lose their activity very readily. By contrast, DNA survives rigorous boiling, so

when they approve processed food on grounds that there can be no DNA left, ask exactly how the processing is done, and whether the appropriate tests for the presence of DNA have been carried out.

The survival of "crippled" laboratory strains of bacteria and viruses and the persistence of DNA in the environment are of particular relevance to the so-called "contained" users producing transgenic pharmaceuticals, enzymes and food additives. "Tolerated" releases and transgenic wastes from such users may already have released large amounts of transgenic bacteria and viruses as well as DNA into the environment since the early 1980s when commercial genetic engineering biotechnology began.

We are told that DNA is easily digested by enzymes in our gut. Not true. The DNA of a virus has been found to survive passage through the gut of mice. Furthermore, the DNA readily finds its way into the bloodstream, and into all kinds of cell in the body. (29) Once inside the cell, the DNA can insert itself into the cell's genome, and create all manner of genetic disturbances, including cancer. (30)

There are yet further findings pointing to the potential hazards of generating new disease-causing viruses by recombination between artificial viral vectors and vaccines and other viruses in the environment. The viruses generated in this way will have increased host ranges, infecting and causing diseases in more than one species, and hence very difficult to eradicate. *We are already seeing such viruses emerging.*

- Monkeypox, a previously rare and potentially fatal virus caught from rodents, is spreading through central Zaire (31). Between 1981 and 1986 only 37 cases were known, but there have been at least 163 cases in one eastern province of Zaire alone since July 1995. For the first time, humans are transmitting the disease directly from one to the other.
- An outbreak of Hantavirus infection hit southern Argentina in December 1996, the first time the virus was transmitted from person to person (32). Previously, the virus was spread by breathing in the aerosols from rodent excrement or urine.
- New highly virulent strains of infectious bursal disease virus (IBDV) spread rapidly throughout most of the poultry industry in the Northern Hemisphere, and are now infecting Antarctic penguins, and are suspected of causing mass mortality (33).
- New strains of distemper and rabies viruses are spilling out from towns and villages to plague some of the world's rarest wild animals in Africa (34): lions, panthers, wild dogs and giant otter.

None of the plethora of new findings has been taken on board by the regulatory bodies. On the contrary, safety regulations have been relaxed. The public is being used, against its will, as guinea pigs for genetically engineered products, while new viruses and bacterial pathogens may be created by the technology every passing day.

The present situation is reminiscent of the development of nuclear energy which gave us the atom bomb, and the nuclear power stations that we now know to be hazardous to health and also to be environmentally unsustainable on account of the long-lasting radioactive wastes they produce. Joseph Rotblat, the British physicist who won the 1995 Nobel Prize after years of battling against nuclear weapons, has this to say. "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."(35)

The large-scale release of transgenic organisms is much worse than nuclear weapons or radioactive nuclear wastes, as genes can replicate indefinitely, spread and recombine. There may yet be time enough to stop the industry's dreams turning into nightmares if we act now, before the critical genetic "melt-down" is reached.

* * * * * * * * * * * * * * * * *

Dr. Mae-Wan Ho* heads the Bio-Electrodynamics laboratory at the Open University in Milton Keynes in the UK. Dr. Ho is the author of *The Rainbow and the Worm* on the physics of organisms and is co-author of the *Independent Report on Biosafety*, prepared by the Third World Network for the biosafety negotiations taking place under the Convention on Biological Diversity.

* * * * * * * * * * * * * * * * *

Notes and References

1. The first time I heard the word "transgenic" being used on cultivars resulting from conventional breeding methods was from Henry Miller, a prominent advocate for genetic engineering biotechnology, in a public debate with myself, organized by the Oxford Centre for Environment, Ethics and Society, in Oxford University on February 20, 1997.
2. "Scientists scorn sci-fi fears over sheep clone" The Guardian, February 24, 1997, p.7. Lewis Wolpert, development biologist at University College London was reported as saying, "It's a pretty risky technique with lots of abnormalities." Also report and interview in the Eight O'clock News, BBC Radio 4, February 24, 1997.
3. As for instance, Spallone, 1992.
4. George, 1988, p.5.
5. My colleague Peter Saunders and I began working on an alternative approach to neo-Darwinian evolutionary theory in the 1970s. Major collections of multi-author essays appeared in Ho and Saunders, 1984: Pollard, 1981: Ho and Fox, 1988.
6. Lewis Wolpert, who currently heads the Committee for the public Understanding of Science, argues strenuously for this 'fundamentalist' view of science. See Wolpert, 1996.
7. See Hubbard and Wald, 1993.
8. This was pointed out to me by Martin Khor, during a course on Globalization and Economics that he gave at Schumacher College, February 3-10, 1997.
9. See Korten, 1997.
10. Korten, 1997, p.2.
11. See Perlas, 1994; also WTO: New setback for the South, Third World Resurgence issue 77/78, 1997, which contains many articles reporting on the WTO meeting held in December 1996 in Singapore.
12. Brown et al., 1993.

13. Udo and Grubb, 1990.
14. "Superbug spectre haunts Japan", Michael Day, New Scientist 3 May, 1997, p.5.
15. See Bik et al, 1995; Prager et al., 1995; Reidl and Makalanos, 1995.
16. Whatmore et al., 1994; Kapur et al., 1995; Schnitzler et al., 1995; Upton et al., 1996.
17. Professor Hugh Pennington, on BBC Radio 4 News, February 1997.
18. Barinaga, 1996.
19. Reviewed by Davies, 1994.
20. Tschape, 1994.
21. See World Health Report, 1996; also Garret, 1995, chapter 13, for an excellent account of the history of antibiotic resistance in pathogens.
22. See Ho and Tappeser, 1997.
23. See Davies, 1994.
24. WHO Fact Sheet No. 139, January 1997.
25. Hoffman et al., 1994; Schluter et al., 1995.
26. See Ho, 1996a.
27. Jager and Tappeser, 1996, have extensively reviewed the literature on the survival of bacteria and DNA released into different environments.
28. See Lorenz and Wackernagel, 1994.
29. See Schubert et al., 1994; also New Scientist January 24, p.24, featured a short report on recent findings of the group that were presented at the International Congress on Cell Biology in San Francisco, December 1996.
30. Wahl et al., 1984; see also relevant entries in Kendrew, 1995, especially "slow transforming retroviruses" and "Transgenic technologies".
31. "Killer virus piles on the misery in Zaire" Debora MacKenzie, New Scientist April 19, 1997, p.12.
32. "Virus gets personal" New Scientist April 26, 1997, p.13.
33. "Poultry virus infection in Antarctic penguins" Heather Gardner, Knowles Kerry and Martin Riddle Nature 387, May 15, 1997, p.245.
34. See Pain, 1997.
35. Quoted in "The spectre of a human clone" The Independent, February 26, 1997, p.1.

By Permission - Feature Article from The Ecologist, Vol.27, No.4, July/August, 1997

http://www.orpheusweb.co.uk/john.rose/ho.html

---

*Dr. Mae-Wan Ho co-founded the Institute of Science in Society in 1999. In March 2016, the website was no longer actively publishing due to the passing of Dr. Mae-Wan Ho on March 24, 2016. Since then, website is archived by the British Library as UK national documentary heritage.