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HUMAN RIGHTS AND SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS

The human rights implications of the genetic manipulation of microbes

Report by the Secretary-General

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INTRODUCTION

1. The present report has been prepared in connexion with the studies on human rights and scientific and technological developments requested by General Assembly resolution 2450 (XXIII) of 18 December 1968 and subsequent resolutions of the General Assembly and the Commission on Human Rights, most recently resolution 11 (XXXII) of 5 March 1976 of the Commission on Human Rights, which requests the Secretary-General to continue collecting documentation on the development of new technology as it pertains to human rights. 1/

2. An international group of experts, convened by the Secretary-General, met in Geneva from 15 to 19 September 1975 to discuss "The Balance which should be established between scientific and technological progress and the intellectual, spiritual, cultural and moral advancement of humanity", the study of which was required by paragraph 1 (d) of General Assembly resolution 2450 (XXIII). The Group adopted under its own responsibility a statement in the course of which certain scientific and technological advances were said to pose risks to individual human rights, the welfare of society or the global condition of mankind. Among the advances mentioned are three which had not previously been reported upon by the Secretary-General and which appeared to be appropriate for study: (a) the use of artificial organs; (b) genetic manipulation of microbes; and (c) potential modifications of human genome. 2/

3. On 14 May 1976 the Secretary-General invited Governments to contribute information and views on (a) the use of artificial organs; (b) genetic manipulation of microbes; and (c) potential modifications of human genome, insofar as these scientific and technological advances affect the enjoyment and protection of human rights. Appropriate enquiries were also sent to United Nations Educational, Scientific and Cultural Organization and the World Health Organization. The Secretary-General sought also the co-operation of a number of institutes of learning and other institutions and of individual scholars.

4. Substantive replies were sent to the Secretary-General by the following governments on the dates indicated: Australia (16 August 1976), Brazil (27 September 1976), Burma (31 August 1976), India (26 August 1976), Madagascar (21 July 1976), Mexico (10 August 1976), New Zealand (9 August 1976).

5. A substantive reply was sent to the Secretary-General by the World Health Organization on 3 September 1976, and by UNESCO on 15 November 1976.

6. Substantive replies were sent to the Secretary-General by the following non-governmental organizations on the dates indicated: American Association for the Advancement of Science (23 June 1976); Council for International Organizations of Medical Sciences (3 August 1976); Institute on Man and Science (2 June 1976); International Association of Microbiological Societies (19 July 1976); International Federation for Medical and Biological Engineering (16 July 1976);

1/ See further the references to resolutions which appear in paragraph 2 of E/CN.4/1237.

2/ For the full text of the Group's statement see E/CN.4/1199, para. 4.

International Medical Association for the Study of Living Conditions and Health (21 July 1976); Commission of the Churches on International Affairs (10 June 1976); International Planned Parenthood Federation (8 July 1976); and International Union of Biological Sciences (17 June 1976).

7. Substantive replies were sent by the Population Research Branch of the Atomic Energy of Canada Ltd., Canada (27 September 1976); the European Council of Environmental Law, Federal Republic of Germany (21 May 1976); the Finnish National Fund for Research and Development (16 June 1976); the International Union of Pure and Applied Physics, Sweden (28 May 1976); the Institut National d'Etudes Démographiques, France (3 August 1976); the International Association of Human Biologists, Department of Genetics, Brazil (2 September 1976); and the Standford University Medical Centre, United States (23 July 1976).

8. An analysis of the information received and an examination of the available literature revealed that almost no consideration has been given to the human rights implications of the use of artificial organs. In the information received, concern was expressed about potential modification of human genome, and, although it was generally felt that this is a field that merits continuing attention in the future, insufficient data and opinions of substance were obtained for the treatment of the subject at this time. The question of the human rights implications of genetic manipulation of microbes - a process which is currently being carried out - has elicited some comments from governments and the World Health Organization. The subject has also been examined by various institutions and experts. Although not exhaustive, this report is intended to reflect some current views and opinions on the subject.

9. Further material was collected for the present report by research independent of these replies and from contributions of individual scholars.

I. THE NATURE OF THE PROBLEM

10. The revolution in modern biology may be dated to 1944 when deoxyribonucleic acid, commonly known as DNA, was shown to be the carrier of the genetic message of inheritable characteristics. Other experiments confirmed these findings and by mid-century it was generally accepted that the nucleic acid DNA was the final source of instructions for building a new cell and a new organism. 3/

11. In 1953, the structure of the DNA molecule was discovered; it is composed of two threads loosely entwined around each other in a double helix like a long spiral staircase. "The strands are held apart (rather, linked together) at thousands of points, like steps in the stairs... [T]he stairsteps... comprise the information in the genetic code... When a cell divides, the molecule untwists and unzips down the middle as though a carpenter were to saw through the stairsteps

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3/ Joshua Lederberg, DNA Research: Uncertain Peril and Certain Promise (Manuscript of article "DNA splicing: Will fear rob us of its benefits?", published in Prism 3:33-37, November 1975); See also, Henry Still Man-Made Men or, was that your liver I saw on TV? Hawthorn Books, Inc. New York 1973, pp. 122-129.

from top to bottom. Each half then finds additional materials in the chemical soup of the cell nucleus to form another like the original. In this fashion all the information in the genetic code is passed on to each new cell." 4/

12. Although scientific understanding of the cell has undergone this revolution in the past 30 years, we have yet to witness practical applications of molecular biology of nearly comparable importance. This has in no way eroded the belief that these discoveries will be instrumental in obtaining far-reaching advances in medical technology. 5/

13. The current focus, for many scientists, law-makers and the lay public is on a form of genetic engineering called Recombinant DNA - a process developed about 4 years ago. Scientists have now been able to transplant segments of DNA from one form of life - such as bacteria - to other forms - such as viruses or animals. 6/ It thereby becomes possible to modify the hereditary characteristics of the organism. 7/

14. The development of this technique has been viewed as a formidable stride in scientific endeavour, one which may be expected in future to result in numerous beneficial applications. 8/ Simultaneously, however, there has been vigorous discussion of the dangers that might accompany the new power to manipulate DNA, and thereby, heredity.

15. Consideration of the damage that might result if harmful molecules escaped from the laboratory occasioned a research moratorium, unique in the history of science. In July 1974, at the time the moratorium had been called by scientists at Stanford University (USA), genetic engineering studies were being made in approximately 80 laboratories in the USA, the USSR, the UK and other parts of Europe. 9/ In February 1975, an international group of scientists met at Asilomar, California, and voted to lift the moratorium provided that certain general safety principles were met. It was decided that, pending the enactment in each country of specific guidelines incorporating these principles, the moratorium would effectively remain in force. The discussion of these problems, it has been said, is one "which non-scientists need to follow, and ultimately join responsibility; for the issues at stake may be as vital for humanity's future as the issues in the debate over proliferation of nuclear weapons". 10/

4/ Henry Still, op. cit., p. 128

5/ Joshua Lederberg, op. cit.

6/ Stuart Auerbach, "Young scientists press for caution in new research", International Herald Tribune, 16 June 1976, p.7.

7/ Information furnished by the Government of Mexico on 10 August 1976.

8/ Joshua Lederberg, op. cit.

9/ "Scientists told not to 'play' with viruses", The Australian, 24 August 1974, furnished by the Government of Australia.

10/ Editorial, New York Times, reprinted in the International Herald Tribune, 16-17 October 1976, p.4.

II. POTENTIAL BENEFITS AND POSSIBLE DANGERS

A. Potential benefits

16. At present, recombinant DNA experimentation is solely a laboratory technique being carried out in the realm of basic research. Its perfection and control, however, promises application in a variety of fields. One authority has described some of the future benefits that may be derived:

> "This technique of gene implantation can ... be used to transfer the genetic information for a given product from one species of cell to another; and this is the direction that, in my own view, leads to an early chance for a technology of untold importance for diagnostic and therapeutic medicine: the ready production of an unlimited variety of human proteins. Analogous applications may be foreseen in fermentation processes for cheaply manufacturing essential nutrients, and in the improvement of microbes for the production of antibiotics and of special industrial chemicals." 11/

17. While cognisant of the risks involved in this type of advanced scientific research, the Government of Brazil also recognizes "the potential value of studies and research in these fields for the well-being of the human species... [and]... considers that they should be encouraged and strengthened by governments". 12/

18. The Government of Mexico has pointed out some of the positive results that may flow from the pursuit of this type of research:

> "Apart from the advancement of scientific knowledge for its own sake, the potential benefits deriving from this technology may have incalculable practical applications in agriculture; in the manufacture of such pharmaceutical products as vitamins, hormones and antibiotics; in medicine, through the therapeutic use of controlled genes, as well as in other fields." 13/

19. Although in New Zealand no research on the genetic manipulation of microbes in the human or animal field is currently being carried out, the Department of Scientific and Industrial Research and the Medical Research Council in that country have formed committees to consider and advise on any future projects involving this procedure. The Government has advised that "work is under way in the area of plant production, where it is recognized that equal care is necessary. It is felt that genetic engineering techniques are justifiable for use in attempting to produce improved strains of saprophytic 14/ organisms for use in industrial processes. Such organisms are not released until suitable safety tests have been satisfactorily passed". 15/

11/ Joshua Lederberg, "DNA Splicing...", op.cit., p. ...

12/ Information furnished by the Government of Brazil on 18 August 1976.

13/ Information furnished by the Government of Mexico on 10 August 1976.

14/ Pertaining to any vegetable organism living on dead or decaying organic matter.

15/ Information furnished by the Government of New Zealand on 9 August 1976.

20. A writer in the United States foresaw the practical applications as ranging from equipping plants with nitrogen-fixing genes - rendering nitrogen fertilizer unnecessary - to construction of micro-organisms capable of synthesizing some products now obtained from petroleum. 16/

21. In a summary of a report of the Council of the Academy of Science (Australia) the following point was made:

> "These techniques offer the prospect of increasing our understanding of gene action in animal, plant and bacterial cells. Aspects such as bacterial and viral virulence, drug resistance, and the role of foreign DNA in oncogenesis (the initiation and growth of tumours) are obvious examples." 17/

22. DNA segmentation and splicing may allow the large-scale production of human proteins, including human antibodies:

> "[Genetic] failures or errors in production of antibody globulin are quite prevalent, and are known to play a major role in (1) defense against infectious diseases, (2) autoimmune and allergic disease, and (3) perhaps also in cancer.
>
> ...
>
> "The most comprehensive role of biosynthetic proteins would be in passive immunization against infectious diseases. Animal antisera were once used but had to be abandoned because of the anti-animal antibody that they provoked in man. Priority targets for passive globulin therapy are those diseases where either technical or social factors may lead to gaps in protection by active immunization. They include influenza, hepatitis, smallpox, encephalitis virus, rubella, herpes, rabies and perhaps also trypanosomes, malaria, schistosomes, tuberculosis and leprosy and many others.
>
> "I believe there is reason for special urgency to develop a backup capability of passive immunization to prevent a global catastrophe that may result from our becoming too complacent about active immunization against diseases like smallpox and polio, and the technical inadequacy of vaccines like rubella and hepatitis. Our general posture of defense against viral pandemic is a feeble one. We have no assurance that the next influenza epidemic will not be slightly more virulent and cost a million lives for lack of a ready defense.
>
> "A broader need applies to polyvalent prophylaxis for infants. The principal medical argument for breast-feeding is the provision of colostrum and of a continuing supply of maternal mixed globulins in the milk. There

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16/ Nicholas Wade, "Recombinant DNA: NIH sets strict rules to launch new technology", Science, vol. 190, No. 4220, 19 December 1976, p. 1175.

17/ Search, vol. 6, No. 7, July 1975, p. 251, furnished by the Government of Australia.

would be a huge and valid market for polyvalent gamma globulin supplements to infant dietaries both in industrialized and in poorer countries. An analogous veterinary demand speaks to further efficiency in food production." 18/

23. Writing about research in this field being carried out in that country, the Government of Mexico has commented that "[t]he studies... have been useful in identifying genetic material... which determines resistance to antibiotics... and in isolating new resistance factors... [R]esistant germs have been on the increase, giving rise to large-scale epidemics such as those of Shiga 1 in 1969-70 and typhoid fever in 1972." 19/

24. The introduction of desirable DNA segments into "domesticated" strains of viruses is foreseen as a method for vaccination of patients lacking a critical metabolic function. This function would then be restored under the influence of the added DNA. 20/

25. It has also been suggested that this experimentation could produce a new method of contraception:

"Passive antibody directed against sperm flagella is demonstrably able to interfere with fertilization simply by the immobilization of the sperm and should have a minimum of other side-effects. Such immunizations would be reversible by the spontaneous decay of passive immunity over periods of from 3 to 6 months. Comparable possibilities exist for the immunization of women against sperm." 21/

26. An authority has viewed the potential application of techniques in the field of human genetic engineering in this manner:

"Advances in molecular biology promise to enlarge our technical capacity to intervene in genetic problems. Social and ethical factors are, therefore, likely to play an increasingly important role in determining the application of new scientific advances in man. This is no cause for great alarm, for the same principle already applies to the use of surgery and of other medical interventions that could, in theory, also be applied for extraordinary 'renovations' of human nature.

18/ Joshua Lederberg, "DNA Splicing...", op. cit., p. 5.

19/ Information furnished by the Government of Mexico on 10 August 1976.

20/ Joshua Lederberg, "Biological innovation and genetic intervention", American Institute of Biological Sciences 25th Anniversary Volume, Oxford University Press, New York, 1972, p. 26.

21/ Joshua Lederberg, "DNA Splicing...", op.cit., p. 7.

"The evolution of wise policies for the use of genetic advances, and the surveillance of existing practices for compliance with consensual ethical standards, and for the anticipation of social injury, of course, requires a widely disseminated understanding of the probable potentialities of various types of genetic intervention." 22/

27. While there has been concerned speculation on the use of recombinant DNA as a process for eugenics, the same authority has written:

"There is no immediate substance to the idea that these techniques are applicable to the 'genetic engineering of human beings'. (In the long run, the possibility of such technical capabilities cannot be denied in principle, no more than we can disprove the possibility of a peaceful world, or of a global morale capable of the wisest disposition of our existing powers for good and evil.)" 23/

28. The Advisory Committee on Medical Research of WHO, at its 18th annual session in June 1976, stated its conviction "that this subject area was of great relevance to the future of mankind, and that the potential benefits were enormous and the risks largely conjectural." 24/

B. Possible dangers

29. The following comment was made on the reservations of some scientists about the implications of recombinant DNA experimentation:

"It has the potential of benefiting mankind by improving plant growth, creating new forms of medical treatment and cutting the cost of important drugs. But the risks include the possible creation of new strains of drug-resistant germs and the possibility of unleashing new cancer-causing substances." 25/

30. In discussing the risks involved in the pursuit of this type of research, an authority analysed the situation as follows:

"At the present time, perhaps a half-dozen bacterial species are well enough understood to be prime vehicles for laboratory study of DNA-splicing. For safety and convenience, investigators have preferred not to use pathogenic forms wherever feasible. Significant concern arises from the possibility that the introduction of new genetic information may (inadvertently) generate a new pathogen for man, or its analogue, a source of ecological disruption at some other point in the biosphere. The most

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22/ Joshua Lederberg, "Biological innovation and genetic intervention", American Institute of Biological Sciences 25th Anniversary Volume, Oxford University Press, New York, 1972, p. 25.

23/ Joshua Lederberg, "DNA Splicing...", op. cit., p. 4.

24/ Information furnished by WHO on 3 September 1976.

25/ Stuart Auerbach, "Young U.S. scientists press for caution in new research", International Herald Tribune, 16 June 1976, p. 7.

likely, but not necessarily the only, source of such genes for pathogenicity are precisely the organisms that most urgently need further study - the subtle and insidious killers that are not now amenable to medical treatment and prevention. These include slow virus infections that may be involved in a wide range of chronic diseases and cancer, and more familiar viruses like herpes for which satisfactory vaccines are not now available." 26/

31. Despite the fact that experimentation with recombinant DNA is taking place, at present, in technologically sophisticated laboratories under the direction of highly qualified personnel, such conditions are not requisite. This point has been raised by one authority:

"Perhaps the most important single conclusion is that this technology is just in its infancy, but has already made great leaps; and that it is simple enough that it can be practised in any laboratory that can handle pure bacterial cultures. Just this simplicity, which makes for great convenience and rapidity of experimental advance, has been a source of concern about the proliferation of the methods in the hands of people with less than mature professional and ethical judgment and with deficiencies in the skills entailed in containing bacterial cultures in the laboratory." 27/

32. Discussing the work presently in progress in the field, the Government of Mexico drew attention to some of the dangers:

"The germ most widely used so far in this type of experimental work is Escherichia coli, because of its high rate of acceptance of or receptivity to foreign genetic material and the ease with which it mingles with other bacteria and develops in culture media. It has, for example, been possible to transfer to this micro-organism the genes of other bacteria which give resistance to antibiotics, determine the synthesis of toxins and codify the formation of enzymes, antibodies, etc.,

...

"If we consider that the natural habitat of this bacterium is the human intestine or the intestine of animals, where it proliferates with extraordinary ease, we immediately see the risk involved should such a germ, with the addition of sometimes highly dangerous foreign genetic material, accidentally infect the laboratory staff handling it or the animals used in experiments, or should it escape into the environment and propagate in nature without any possibility of control. Hence the need for control of such experiments to prevent, as far as possible, any kind of risk, without, however, over-reacting to the point of impeding scientific progress." 28/

26/ Joshua Lederberg, "DNA Splicing...", op. cit., p. 7.

27/ Joshua Lederberg, "DNA Splicing...", op. cit., p. 5.

28/ Information furnished by the Government of Mexico on 10 August 1976.

33. Information furnished by the Government of Australia included an enumeration of potentially harmful roles which might be played by hybrid DNA molecules produced by these new techniques:

"(a) conferring specific resistance to antibiotics;

(b) conferring general resistance to treatments designed to control the organism;

(c) conferring properties which extend the environmental range of the organism;

(d) conferring the power of making a toxic substance not normally made by the organism;

(e) conferring properties which turn the organism into a transforming agent.

It would therefore be irresponsible not to take steps to contain the spread of such molecules until more is known of their behaviour." 29/

34. The Government of Brazil has pointed out some of the potential risks involved in the genetic manipulation of microbes:

"The appearance of resistant or dependent pathogenous micro-organisms;

- The development of an ecological imbalance, with the appearance of pathologies due to opportunistic micro-organisms;

- The emergence of antigenic types which develop into immune micro-organisms;

- A risk to human defence mechanisms." 30/

35. Dr. Erwin Chargaff, in a letter to Science, wrote of some of the dangers he could foresee in recombinant DNA research:

"I shall start with the cardinal folly, namely, the choice of Escherichia coli as the host. Permit me to quote from a respected textbook of microbiology (1): "E. coli is referred to as the 'colon bacillus' because it is the predominant facultative species in the large bowel." In fact, we harbor several hundred different varieties of this useful micro-organism. It is responsible for few infections but probably for more scientific papers than any other living organism. If our time feels called upon to create new

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29/ Search, vol. 6, No. 7, July 1976, p. 252, furnished by the Government of Australia.

30/ Information furnished by the Government of Brazil on 18 August 1976.

forms of living cells - forms that the world has presumably not seen since its onset - why choose a microbe that has cohabited, more or less happily, with us for a very long time indeed? The answer is that we know so much more about E. coli than about anything else, including ourselves. But is this a valid answer? Take your time, study diligently, and you will eventually learn a great deal about organisms that cannot live in men or animals. There is no hurry, there is no hurry whatever.

...

... [A]nd who knows what is really being implanted into the DNA of the plasmids which the bacillus will continue multiplying to the end of time? And it will eventually get into human beings and animals despite all the precautions of containment. What is inside will be outside. Here I am given the assurance that the work will be done with enfeebled lambda and with modified, defective E. coli strains that cannot live in the intestine. But how about the exchange of genetic material in the gut? How can we be sure what would happen once the little beasts escaped from the laboratory?

...

The worst is that we shall never know. Bacteria and viruses have always formed a most effective biological underground. The guerilla warfare through which they act on higher forms of life is only imperfectly understood. By adding to this arsenal freakish forms of life - prokaryotes propagating eukaryotic genes - we shall be throwing a veil of uncertainties over the life of coming generations. Have we the right to counteract, irreversibly, the evolutionary wisdom of millions of years, in order to satisfy the ambition and the curiosity of a few scientists?

This world is given to us on loan. We come and we go; and after a time we leave earth and air and water to others who come after us. My generation, or perhaps the one preceding mine, has been the first to engage, under the leadership of the exact sciences, in a destructive colonial warfare against nature. The future will curse us for it." 31/

36. As to recombinant DNA, the Government of India has written:

"No manipulative work to produce strain of bacteria which have different properties, governed by genetic mechanisms, has been carried out in India. This is a highly controversial field to work with because in this process one may end up with production of strains which may create problems both from the point of view of identification as well as their virulence. There is always a danger of such strains going out of the laboratory to the population and thereby creating a situation where the exact etiologic agent will be difficult to be identified since an organism will have properties which are very different from the parent strain.

So, much manipulative work involving the genetically controlled behaviour of the organism should not be encouraged in the laboratories where facilities exist for genetic study of bacteria." 32/

31/ Science, vol. 192, No. 4243, 4 June 1976, pp. 939-940.

32/ Information furnished by the Government of India on 26 August 1976.

III. GUIDELINES AND CONTROLS

37. The moratorium self-imposed by scientists in 1974, referred to in paragraph 15 above brought the ethical, and social aspects of recombinant DNA research under public and political scrutiny. The public debate, focussed almost totally on the possible hazards of the escape of new forms of microorganisms, has been described as follows:

> "The most urgent source of concern has been for the prospect of introducing potential cancer-causing DNA into common bacteria. While it is recognized how speculative this hazard is, the general territory is so poorly understood that no one can argue against the need for cautious laboratory procedures.
>
> ...
>
> "Viewed as a rather public soul-searching and self-education, these discussions are invaluable. The main danger is that tentative questions will be incorporated by some political imperative into iron-clad regulations that will be with us long after anyone has forgotten why they were instituted. One can after all raise similar questions about the widest range of human activities: should it be lawful to keep domestic cats now that they are under suspicion of harboring toxoplasmosis, and possibly leukemia as well? The same kinds of questions that are asked of microbiology could be lodged against plant breeding: what positive assurance can there be against the next artificial pollination producing the weed that will ruin the wheat crop a decade from now? Closer to home, should we forbid international travel, given the certain knowledge that our quarantine procedures are quite unable to hinder the importation of exotic diseases?
>
> "For each of these cases, and many more, the apparently innocuous doctrine: 'As long as there is any risk, don't do it!' can only lead to a loss in human welfare. We must instead make every feasible effort to assess both the risks and the benefits of a given course of action -- only then are we in a position to weigh the optimal balance. This in no way may deny the rights of individuals to make voluntary decisions about their exposure to risk, even if for public benefit. But individuals can hardly make the best policy about their own future, including their expectations for what medicine will offer for the infirmities of their own later years, without expert assessment." 33/

38. The recognition of the need to examine the issues resulted in the convening of an international conference at Asilomar, California, in February 1975. The results of the Conference have been summarized:

> "The most important conclusion of the Conference was that most work in this field should proceed, but with appropriate safeguards. It was felt, however, that there were certain experiments which should not be carried out under any existing conditions of containment. Containment connotes precautionary steps which may be taken to confine the environmental spread of hybrid DNA molecules. Three types of containment were advocated:

33/ Joshua Lederberg, "DNA Splicing ...", op. cit., pp. 7-8.

(i) Physical containment. This is achieved by laboratory discipline (no eating in the laboratory, wearing white coats, proper destruction of experimental materials, etc.) and laboratory design (negative-pressure rooms, the wearing of special clothes and gloves, shower facilities, etc.). (ii) Biological containment. This involves the development of fail-safe vectors, for example host bacteria which could not persist outside the artificial conditions available in the laboratory. This would reduce by many orders of magnitude the probability of their escape into the environment. (iii) The training of personnel in safety precautions." 34/

39. Following the Conference, action was taken in various countries to implement its conclusions.

40. In the United States, a committee of the National Institute of Health (NIH) prepared draft guidelines for consideration by the scientific community. The NIH guidelines were judged, however, by many scientists to be too lax. The Committee's problem was one of attempting to strike the delicate balance described by one writer:

"On the one hand, it was faced with mounting impatience among biological researchers to set rules that would allow research to begin. Had the committee postponed decision once again, or set rules that were indeed too restrictive, there are signs that the moratorium would have been flouted, and that the ubiquitous rumors of Saturday-night experiments would have rapidly turned out to be true.

"On the other hand, the rules had to be sufficiently tight to convince outsiders, particularly in Congress, that the scientific community was doing a reasonably disinterested job of self-regulation. That task is the harder because of the committee's obvious vested interest. Of its 15 voting members, all but the chairman are active biological researchers who may one day wish to use the technique, and at least three members ... are personally involved in recombinant DNA experiments of the limited type permitted by the Asilomar conference." 35/

41. In February 1976 a public hearing was held to review these draft guidelines. The hearing was reported upon as follows:

"The prime significance of the hearing was probably that it created the first opportunity for people other than scientists to comment on the rationales and procedures developed within the scientific community for handling the new technique. The reaction [to this public participation] was predominantly favorable." 36/

34/ Search, vol. 6, No. 7, July 1975, p.252, furnished by the Government of Australia.

35/ Nicholas Wade, "Recombinant DNA: NIH sets strict rules ...", op. cit., p.1176.

36/ Nicholas Wade, "Recombinant DNA: guidelines debated at public hearing", Science, Vol. 191, No. 4229, 27 February 1976, p. 834.

42. In an editorial in Science, another consideration, that of the scientist's right to freedom of enquiry was examined:

> "What degree of restriction on the recombinant DNA technique can reasonably be accepted without infringing the right to free inquiry? A suggestion that no such absolute right exists has been put forward by Robert Sinsheimer of Caltech. At the Asilomar conference, he noted in a recent lecture to the Genetics Society of America, 'there was no sustained discussion of ancillary issues such as the absolute right of free enquiry claimed quite vigorously by some of the participants .... To impose any limit upon freedom of inquiry is especially bitter for the scientist whose life is one of inquiry: but science has become too potent. It is no longer enough to wave the flag of Galileo.
>
> 'Rights are not found in nature. Rights are conferred within a human society and for each there is expected a corresponding responsibility.... Would we wish to claim the right of individual scientists to be free to create novel self-perpetuating organisms likely to spread about the planet in an uncontrollable manner for better or worse? I think not. This does not mean we cannot advance our science or that we must doubt its ultimate beneficence. It simply means that we must be able to look at what we do in a mature way ....
>
> "It is difficult for a scientist to conceive that there are certain matters best left unknown, at least for a time. But science is the major organ of inquiry for a society and perhaps a society, like an organism, must follow a developmental program in which the genetic information is revealed in an orderly sequence.'" 37/

43. The draft guidelines were subsequently rewritten by the NIH Committee, and these then found acceptance by the scientific community in the United States. They embody one of the essential principles laid down at Asilomar - that viruses and bacteria used in recombinant DNA experiments be genetically enfeebled types which cannot survive outside of the laboratory.

44. These guidelines provide for various degrees of laboratory security - a scale of four levels of physical containment - relating to the potential danger of the organism being experimented upon. The highest security category requires safeguards such as air-locks, protective clothing and showering on exit techniques used in handling the most dangerous known pathogens. Some critics contend that this highest level of stringency is incompatible with a university atmosphere. 38/

37/ Science, Vol. 190, No. 4216, 21 November 1975, p. 768.

38/ Nicholas Wade, "Recombinant DNA: NIH sets strict rules ...", op. cit., p. 1176-7.

45. The Council of the Australian Academy of Science established a Committee on Recombinant DNA Molecules as one of its Standing Committees. Among the Committee's tasks was the preparation of a set of guidelines for physical and biological containment procedures commensurate with the risks involved in various classes of experiments. In addition the Committee would collect and disseminate information in this field, review research proposals and recommend under what conditions, if at all, these experiments be carried out, and maintain liaison with national committees in other countries as well as with appropriate international organizations. It was recommended that the membership of the Standing Committee include biologists not engaged directly in the field under scrutiny. 39/

46. Recognizing the risks and benefits that might flow from this type of research, the Government of Brazil has pointed out:

> "It is essential, ... that Governments ensure that such studies and research are directed towards useful goals. An alternative course might be to entrust the matter to experts, who would be instructed to assess the problem, work out a research policy designed to make use of the available potential (e.g. in food technology or in the attenuation of pathogenous micro-organisms, etc.,) and, above all, to draw up general ethical and technico-scientific rules to guide activities in this field.
>
> "In view of the importance and scope of the problem, research might be co-ordinated at the national level. Adequate resources should be made available for carrying out research and there should be periodic and systematic evaluation of research activity.
>
> "Since ethical rules must be developed for each particular case, it might be possible to prepare specific guidelines to supplement the general rules already in existence." 40/

47. The Government of Burma has voiced the opinion that "... [A]s they can cause danger to mankind, experiments on genetic manipulation of microbes should be carried out under strict controls ..." 41/

48. In the Netherlands, a Committee co-sponsored by the Royal Academy of Sciences and Arts and the Health Council has recently been established in connexion with research on DNA recombinants. 42/

49. The Government of New Zealand has written, with reference to adoption of controls, as follows:

> "Most New Zealand microbiologists and molecular biologists accept as guidelines the consensus of opinion given by the Asilomar Conference in February 1975. Both the Department of Scientific and Industrial Research and the Medical Research Council have formed committees to consider and advise on any projects in this field." 43/

39/ Information furnished by the Government of Australia on 16 August 1976.

40/ Information furnished by the Government of Brazil on 18 August 1976.

41/ Information furnished by the Government of Burma on 31 August 1976.

42/ Information furnished on 22 June 1976 by the Secretary-General of the Raad van Advies Voor Het Wetenschapsbeleid.

43/ Information furnished by the Government of New Zealand on 9 August 1976.

50. In the United Kingdom a government working party recommended the establishment of a Genetic Manipulation Advisory Group to screen experiments carried out in this field and to advise on safety precautions. It has been reported that "[c]hief among the proposals from the working party are that special 'disabled' organisms should be created for such experiments and be made widely available." 44/ It was further reported that the Group recommended that experiments in genetic engineering should be encouraged "as an exciting and important new field of science that offers great potential benefit." 45/

51. The World Health Organization has been concerned with the question of genetic manipulation for some time, and at its eighteenth annual session in June 1976 the Advisory Committee on Medical Research considered the question of developments relating to the problem of safety in the handling of microorganisms and cells employed in research - of which recombinant DNA constitutes a subsection. 46/

52. The group of international experts referred to in paragraph 2 above recommended that consideration be given to the possibility of drafting a Declaration on human rights and scientific and technological developments. Among the topics recommended for inclusion in the Declaration was the genetic manipulation of microbes. 47/

53. As demonstrated by action taken by various international professional societies, as well as by the self-imposed moratorium on recombinant DNA research in 1974, scientists themselves have taken the initiative for self-regulation. The International Council of Scientific Unions, whose membership represents groups from 100 countries, met at Schloss Laxenburg, Austria, in September 1975 and formed an Ad Hoc Committee "to study and advise on the implications and potential of research on recombinant DNA molecules ..." The Committee's terms of reference are:

"(a) To observe the development of public opinions and governmental actions in relation to this research. To serve as a support to national scientific groups in their efforts to ensure the drafting of appropriate guidelines for research in this area. This may initially be largely a 'watching brief' depending very much upon future developments in individual countries and areas. It is hoped that these developments will provide favourable precedents, but if not, there could be a need for strong and authoritative representation at the highest level possible.

(b) To disseminate information by:

(i) emphasizing the importance of research on recombinant DNA molecules;

44/ "British Issues Tight Curbs on Genetic Tests", International Herald Tribune, 26 August 1976.

45/ Quoted in Ibid.

46/ Information furnished by WHO on 3 September 1976.

47/ See E/CN.4/1199, para. 4.

(ii) stressing the need for such research to proceed under appropriate safeguards;

(iii) collating and relaying recommendations on safety measures;

(iv) ensuring the world-wide dispersal of technical details concerning availability and choice of organisms and materials;

(c) To encourage the universal availability of strains.

(d) To foster international scientific exchange by personal visits, training courses, symposia and workshops." 48/

54. Sir John Kendrew, Secretary-General of the Council, said that the Committee on Genetic Experimentation "would try to do internationally what some governments are doing alone - that is, to see that such research is conducted safely and for the benefit, not the detriment, of mankind". 49/

55. The International Association of Microbiological Societies has addressed its Member Societies on the hazards of genetic engineering and has written as follows with respect to controls:

"Genetic Engineering is a justifiable and potentially beneficial scientific activity if pursued under the rigorous safeguards exemplified in codes of practice. Such codes are properly the responsibility of the appropriate authority in the country concerned. They should be flexible, and adaptable to all foreseeable circumstances, including those in fields of microbiology (e.g. ecological, industrial and agricultural) not explicitly dealt with in the Ashby and the Asilomar reports. They should be supplemented by facilities for training, and where necessary re-training, of personnel in the skills of containment, with emphasis on the need for adopting procedures adequate for the hazard of the particular organism and type of experiments to be undertaken.

"Rigid statutory control of experimentation is neither desirable nor likely to be practicable. But the authorities concerned may find it necessary to establish quality control of both the competence of laboratory staffs in containment, and the suitability of the equipment used for the purpose.

"If they can be devised for a given piece of work, bacterial strains and vectors made unable to survive in natural environments ('safe' or 'disarmed' strains) are potentially useful for decreasing hazards. However, in view of the natural prevalence of wild type alleles of any gene that can be mutated, and the many recombination mechanisms that might eliminate disarmed strains, they should not necessarily be relied upon to mitigate the rigours of programmes of containment proper for unsafe organisms." 50/

48/ International Union of Biological Sciences Newsletter, No. 8, December 1975.

49/ "Worldwide unit to keep eye on genetic research", International Herald Tribune, 16-17 October 1976, p. 3.

50/ "The hazards of genetic engineering", News Letter, April 1976, International Association of Microbiological Societies, Marseilles, pp. 2-3.

56. Assessment of the risk/benefit value of any type of research may be difficult and controversial. Where hazards are merely conjectural, high security precautions may be burdensome, as well as unnecessarily expensive. One authority has written also about the limited effectiveness of regulatory sanctions:

> "[A] partly voluntaristic approach will not satisfy a demand for absolute assurance that no foolish experiment is ever attempted. But the history of human institutions should suffice to show that NO system of sanctions can have such a perfect outcome. The human species is constantly and inevitably attended by contaminating and parasitic microbes -- the person suffering from an enteric infection who fails to wash his hands, or the influenza victim who insists on going to work is behaving unethically, and to the peril of his fellows. But we would scarcely invoke serious regulatory sanctions in preference to public education except where there is an unusual public risk, and some evidence that an enforced quarantine was likely to yield a positive gain." 51/

57. Dealing with the question of whether there should be "forbidden areas" in the realm of basic research, a report of the American Association for the Advancement of Science states the following in connexion with experiments in the area of genetic engineering:

> "The suggested threats, in these matters, are not so much to health as to human integrity, dignity, and individuality. It seems to us that we should be on the alert for such possible threats, but we see no justification, at the present time, for any attempt to impose restrictions on the freedom of such research in genetics. The dangers, if they exist, are remote and in our opinion are decisively outweighed by the great benefits that such research can bring to mankind." 52/

58. In a letter to Science a medical doctor has commented as follows on the controls on recombinant DNA research:

> "It is not surprising, but it is regrettable that the groups that entrusted themselves with the formulation of 'guidelines' as well as the several advisory committees, consisted exclusively, or almost exclusively, of advocates of this form of genetic experimentation. What seems to have been disregarded completely is that we are dealing here much more with an ethical problem than with one in public health, and that the principal question to be answered is whether we have the right to put an additional fearful load on generations that are not yet born. I use the adjective 'additional' in view of the unresolved and equally fearful problem of the disposal of nuclear waste. Our time is cursed with the necessity for feeble men, masquerading as experts, to make enormously far-reaching decisions. Is there anything more far-reaching than the creation of new forms of life?
>
> ...

51/ Joshua Lederberg, "DNA Splicing ...", op. cit., p. 9.

52/ Scientific Freedom and Responsibility, American Association for the Advancement of Science, Washington D.C. 1975, p. 14.

"But beyond all this, there arises a general problem of the greatest significance, namely, the awesome irreversibility of what is being contemplated. You can stop splitting the atom; you can stop visiting the moon; you can stop using aerosols; you may even decide not to kill entire populations by the use of a few bombs. But you cannot recall a new form of life. Once you have constructed a viable E. coli cell carrying a plasmid DNA into which a piece of eukaryotic DNA has been spliced, it will survive you and your children and your children's children. An irreversible 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. The hybridization of Prometheus with Herostratus is bound to give evil results." 53/

53/ Erwin Chargaff, Science, vol. 192, No. 4243, 4 June 1976, p. 939.