THE AUSTRALIAN AND NEW ZEALAND ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

1993 ANZAAS CONGRESS

PERTH 29 SEPTEMBER 1993

CURTIN UNIVERSITY OF TECHNOLOGY

THE ANZAAS PUBLIC LECTURE 1993

THE HUMAN GENOME PROJECT - PROMISE OR PROBLEMS?

THE AUSTRALIAN AND NEW ZEALAND ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

1993 ANZAAS CONGRESS

PERTH 29 SEPTEMBER 1993

CURTIN UNIVERSITY OF TECHNOLOGY

THE ANZAAS PUBLIC LECTURE 1993

THE HUMAN GENOME PROJECT - PROMISE OR PROBLEMS?

The Hon Justice Michael Kirby AC CMG*

THE PAST IS WITHIN US

A week ago they laid her to rest. Kath Walker. Oogerdoo of the Nunnucal Tribe. She was one of the finest of Australia's poets. A good poet can make the most of the precious gift of human consciousness. The poet can see old things in new combinations. A cadence of words, like music, can play upon an idea. And then there is the special insight.

One of my favourite poems of Oogerdoo is *The Past*:

> *"Let no one say the past is dead.*
> *The past is all about us and within.*
> *Haunted by tribal memories, I know*
> *This little now, this accidental present*
> *Is not the all of me, whose long making*
> *Is so much of the past."*[1]

The past indeed is within us. We bear in this generation, and project into the next, the genetic messages which we carry within us. In this lecture, I want to speak about the scientific advances in molecular biology. They are probably the most

important scientific advance of this scientific century. I refer to the unravelling of our genetic inheritance, laid down in the deoxyribonucleic acid (DNA) found in the nucleus of each cell of our bodies. I want to describe once again the discovery of the double helix, forty years ago this year. I will sketch the consequences of this discovery - including the establishment of the Human Genome Project, which aims to map and describe the structure, and to discover the functions, of all the genes of the human body - approximately 100,000 of them.

Hardly a month goes by without the announcement of important discoveries concerning the operation of genes upon human disorders. I will describe some of the ethical and legal problems which genomic research is presenting. I will finish with a critique of the rôle - or lack of rôle - in the Human Genome Project, of Australian and New Zealand science. I will contrast this with the advances being made in other countries, both in the scientific aspects of genomic research and in the ethical and legal responses to it.

My authority to speak on these subjects is quite modest. As chairman of the Australian Law Reform Commission in the 70s and 80s, I was involved in a number of early projects of that commission concerned with the interface of scientific developments and the law. The work of that Commission on human tissue transplants law[2] found expression in legislation on that topic throughout Australia. It also illustrated how complex and controversial scientific developments may be submitted, through public scrutiny, to informed law-making.

Perhaps because of this work in the Law Reform Commission, I became involved in a number of international agencies relevant to the subject matter of this lecture. In the Organisation for Economic Cooperation and Development (OECD), I chaired two committees concerned with the social implications of informatics - the marriage of computers and telecommunications. In the World Health Organisation, I was appointed to the Global Commission on AIDS. This latter post brought me into contact with some of the foremost biological scientists, working against the clock to isolate the viral causes of this devastating pandemic, and to present options for

treatment and vaccines to arrest its spread. In the International Commission of Jurists, where I am chairman of the Executive, the future agenda for human rights on our planet has been expanded to include the implications for human rights of genetic engineering and the human rights consequences of the Human Genome Project.

We have reached a point in human history where it is difficult, even for educated and intelligent people, to know or keep in their minds the vast sum of information about science. But most difficult of all is it to see scientific developments in their relations with each other and with ourselves. In his recent book *Dreams of a Final Theory,* Nobel laureate Steven Weinberg continues his search for the fundamental laws of nature. He predicts that we are in sight of a solution described as "a theory of everything". He believes that this may be based on the suggestion that everything is built of "strings", "tiny rips" or "glitches in space-time". Weinberg denies the charge levelled at him by the evolutionist Ernst Mayr that he is "an uncompromising reductionist". Instead, he accepts the description that he is a "compromising reductionist".[3]

On the more humble human plane, it is important to relate the developments of informatics and genetics to one another. They come together, on a global scale, in the Human Genome Project. My eyes were opened to the importance of this enterprise by a conference which I attended in Bilbao in the Basque Country, Spain in May 1993. The conference was sponsored by the BBV Foundation - a major research institute, established by one of Spain's largest banks. This was, in fact, the third conference organised by the BBV Foundation on this subject in five years. The first, in 1988, explored the scientific issues. The second, in 1990, examined ethical questions. This conference, in 1993, examined the legal implications of genomic research.

In order to ground the legal reflections in solid data, the conference was equally composed of distinguished scientists and lawyers from around the globe. Four of the scientists had been honoured with the Nobel Prize for their work. As well, in the audience, were several Nobel aspirants. In the presence of so many fine intellects, at the cutting edges of research of such importance to our species and beyond, it was

difficult not to feel humble. But as I sat there and observed the advances of science described one after another, my mind turned with an increasing sense of anxiety to the ethical and legal questions posed. What are we doing to address those questions? What are we in Australia and New Zealand doing to participate in this scientific enterprise of global significance?

These are the two issues which bring me to Perth and to this lecture. I hope that they will be considered appropriate to the public lecture of this foremost Australasian meeting of scientists and the laity. To the scientist and to the laity goes out the same question - what do you know about this and what are you doing about it? Is there to be an Australasian contribution? Or are we simply bound to the chariots of the big scientific players: doomed for the future to pay for their research and hostage to their decisions on the ethical and legal questions which that research turns up?

THE DOUBLE HELIX FORTY YEARS ON

These are, I suggest, important questions. One reason for reflecting upon them this year is that this is the fortieth anniversary of Watson and Crick's breakthrough discovery of the double helix.

I wonder how many of you read Gunther Stent's essay on that discovery in the *New Scientist*, released in April 1993, shortly before I went to Bilbao for my conference?[4] It is a fascinating story of how, in science, each generation stands on the shoulders of its predecessors. Stent told of how he and the young James Watson were sent by Max Delbrück to Copenhagen to work on the chemistry of DNA. The existence of DNA had been known for more than eighty years. Delbrück conceived the idea that it might have something to do with how genetic messages were passed for replication from one generation to the next. As it happened, Delbrück knew so little about DNA that it did not realise that the scientist in Copenhagen (Kalckar) was specialising in a nucleotide which had nothing whatever to do with DNA. But, by chance, a visitor to the Danish Royal Society turned up soon after Watson and Stent arrived at Kalckar's laboratory. He was Lawrence Bragg, who, with his father William

Bragg, had invented X-ray crystallography and made Britain the home of molecular structures in biology.

In 1951 in California, Linus Pauling, drawing on Bragg's work, determined that proteins in DNA contained helical structures. Pauling relied largely on guess-work and model building rather than on conventional crystallography. But his thesis sparked many new ideas, including those in the mind of the young Watson sitting in Lawrence Bragg's lecture in Copenhagen. Generous person that he was, Bragg threw away his own lecture notes. He devoted his talk to a tribute to Pauling's then unpublished discovery.. As he left Bragg's lecture, Watson told Stent that he was going to try to work out the three dimensional structure of DNA:

> *"I thought he had lost his wits: How was he, knowing even less about X-ray crystallography than I, going to find the structure of DNA."*[5]

The rest is history. Watson went to Cambridge University. He mastered X-ray crystallography. He there met Francis Crick, a PhD student who had also conceived that the three dimensional structure of DNA would be likely to provide insights into the nature of the gene. These two young scientists collaborated. In the April 1953 issue of *Nature* they brought together the hitherto separate schools of informationists and structurists giving the offspring the name "molecular biology". This was an important watershed for science in our century - perhaps the most important. Biologists, interested in the mechanisms of heredity, quickly perceived that the time had come to think about genetics in terms of molecules carrying the crucial information, the vital codes of human variety.

Stent rejects the critics. He describes as "fabulous intuition" the insight which Watson and Crick brought to the formulation of the central dogma which, he says, "ranks with the Darwinian theory of evolution as one of the few successful achievements of theoretical biology."[6] Sir Peter Medewar, in his review of Watson's book *The Double Helix* said:

> *"The great thing about [their] discovery was its completeness, its finality ... If Watson and Crick had been seen groping towards an answer ... if the solution had come out piecemeal instead of in a blaze of understanding, then it still would have been a great episode in biological history."*

But it would not, concludes Stent, have been the dazzling achievement that in fact it was.[7]

It took a couple of decades for the industrial and financial potential of Watson and Crick's discovery to begin to be realised.[8] We are still at an early phase of that development. There have been sad failures, as with the millions of dollars testing sCD4 in patients with HIV. There have been spectacular flops, as with the monoclonal antibody known as centoxin - a hope for a magic bullet for treatment of septic shock. But the journey to identify genetic causes of human conditions and disorders would never again be the same.[9] The economic potential, and the smell of big money, began to attract big investment. The process of heredity, which has mystified humans for millennia, has begun to unravel.

It was in this context that the Human Genome Project was conceived. Its global nature was what first caught my attention. Here, after all, is a scientific development affecting the human and other species, and thus the entire planet. The urgency of finding international means of addressing the problems presented by information technology and nuclear fission takes on an even greater priority when we are talking of the basic mechanisms of genetic information.

A great feature of the age we are living in is the process of internationalisation which has accompanied, and been stimulated and facilitated by, this scientific century. We see it in the primitive machinery of world government provided by the United Nations and other international and regional bodies. We see it in the development of international human rights principles which increasingly influence our domestic laws. In Australia, we see this movement illustrated most recently in the *Mabo* decision[10] of

the High Court of Australia and in the decisions which struck down the ban on paid political advertising as offensive to basic principles of free speech.[11] We see it in the global concern about the world's environment and in international efforts to contain the explosion of the human population which presents such a threat to that environment.[12] We see it in the response to the AIDS epidemic.

With the unravelling of the DNA's double helix, biologists were no longer mere onlookers, reporters, and curious chroniclers of the tale of biology. Now, they could identify, and even seek to alter or manipulate, what they found. It was this potential of alteration and manipulation - having unpredictable consequences for future generations of the species - which presented the most acute ethical and legal problems still to be answered. Coinciding with the propulsion to modification and manipulation came the global initiative of cartography - with the bold objective to map the human genome. From this was born the Human Genome Project. The time has come to describe what it is.

THE HUMAN GENOME PROJECT

The Human Genome Project was launched in 1988. It is a coordinated world-wide research effort. Its goal is to determine the location of the estimated 100,000 human genes as well as a large part of the intervening sequences. It is the largest concerted biological project ever attempted. It has attracted multi-million dollar funding. It has also attracted extensive criticism in the scientific community, not the least because of its emphasis on ascertaining the structure of the entire human genome. Some critics assess that it would be preferable to spend the limited funds available to determine the complete structure and function of individual genes of medical importance.

The daunting scope of the project can be seen in the following data. Here we are plunging down from the stars and the human exploration of other worlds into the infinitesimally tiny basic life forms that exist in each living creature.

Almost all human cells, except red blood cells, contain genetic information about the person's entire being. Each carries an identifiable set of the body's genes estimated, as I have said, at up to 100,000. Egg and sperm cells ("germ cells") are different in that they only carry one copy of each gene on 23 single chromosomes.

The genes are contained in the DNA present in these cells. The DNA is the basic bearer of the genetic information contained in the body. Visually conceived, DNA looks like a spiral ladder. The DNA contained in each cell would be about 2.7 metres long if unravelled. The DNA is composed, in part, of four chemical sub-units called bases. These bases normally pair with one another in predictable ways. The pairing of these bases gives the DNA its "double helix" structure described by Watson and Crick. Some genes may contain relatively few base pairs (for example only a few thousand). Other genes may consist of over a million. In total, human DNA contains about 3.3 billion base pairs. The 3.3 billion base pairs do not just make up the genes, but a great deal of non-coding DNA as well. The entire set of genetic material (ie the 3.3 billion base pairs making up about 100,000 genes) is called the human genome[13]. The Human Genome Project has accepted the daunting task of mapping, ie locating the gene, and sequencing, ie identifying the code, of all of this genetic material. Because of the vast number of components of the human genome, it is virtually inconceivable that it could possibly have been mapped and sequenced before the advent of informatics - ie computers linked by telecommunications.

Some writers have likened the mapping of the human genome to earlier censuses and inventories in less complex times. One participant at the Bilbao conference described it as the Domesday Book of the 21st Century: the most complete inventory of humanity.[14] Other Spanish participants drew analogies between the early Iberian maps of the world, consequent upon the journeys of Vasco da Gama and Columbus. Here was to be map of a vastly more complex, though invisibly small, and unknown world. Yet, it is part of the living world which we inhabit. Its cartography is just as important as that of the early global explorers.

So far, two international bodies have been involved to a high degree in the Human Genome Project. Most closely engaged is HUGO, the Human Genome Organisation established in 1989 in Geneva, Switzerland. It has no formal decision-making powers. But its recommendations carry moral weight. It is a consultative and coordinating arrangement, not between governments or institutions but between people involved in the Project. It describes itself as an "enabler" rather than a "provider" or rule-setter. It does not fund research, judge its results or have any financial control. It does not judge; nor does it arbitrate on ethical issues. It simply creates networks and channels of information to assist the flow of data. It promotes global cooperation and the idea of mutual benefit. It is a non-profit making organisation. In legal terms, it is a non-government organisation appointed by participants. It derives its legitimacy from the status of the leading scientists involved in it. Its system of election ensures that only scientists of high standing are admitted to its ranks.[15]

When HUGO was established, it was contemplated that the Human Genome Project would be completed in about twenty years, ie by 2005. Whether this will be so, and whether the functions of the primary body of the Human Genome Project will be complete by that time, remains to be seen. The project is apparently well on schedule, and possibly even ahead of schedule. The first five years have been spent mapping the genes and developing technologies to increase the speed and decrease the cost of sequencing. The remainder of the project is to be spent sequencing. Chromosome 21 and the Y chromosome have already been completely mapped, and mapping the others is well underway.

The other international body which has been involved in consideration of genomic research is UNESCO in Paris. Its activities have been relatively limited, although they have stimulated regional and national explorations of the ethical and legal issues. The chairman of the UNESCO committee (Professor Santiago Grisolia) was the proponent of the three BBV Foundation conferences in Spain which included the conference on legal issues in Bilbao which I attended.

Most of the work relevant to the Human Genome Project is taking place in the United States of America. The government in that country has, over the past five years, actively encouraged close ties between industry, research scientists and the medical community in the Project. Significant funding has been provided by the United States Government for the Human Genome Project. The 1992 US budget allocated no less than $AUD220 million to be shared with the National Institutes of Health ($AUD141 million) and the Department of Energy ($AUD79 million). The United Kingdom has also committed $AUD29 million over the three years from 1989 to 1992. Several European countries have likewise devoted specific government funds to the project. Canada has allocated $AUD25 million over the next five years.

In Australia, there is no specific funding for the Human Genome Project. It does not even rank a mention as a "special initiative area" in the report of the Australian National Health and Medical Research Council. That Council allocated a one-off grant of $100,000 over two years to HUGO. But in Australia, our work on the Project basically comes down to work being performed at the Department of Cytogenetics and Molecular Genetics at the Adelaide Children's Hospital (on chromosome 16) and the establishment of the Australian National Genome Information Service (ANGIS) within Sydney University.

The work in Adelaide, under Dr Grant Sutherland, is actually funded from the United States of America by the Department of Energy of that country. Its aim is to break up the 100 million base pairs of DNA present in chromosome 16 into small manageable pieces. The Adelaide contribution involves the construction of a high resolution physical map of the chromosome by incorporating different segments of chromosome 16 into mouse/human sematic cell hybrids. The hope is that, by the use of markers, it will be possible to isolate the DNA of any region of particular interest.

Such research is not of purely theoretical concern. For example, Batten's Disease, a neurological degenerative disease of children prone to juvenile onset, has been mapped to chromosome 16. An international collaborative effort, directed from London, links studies of children in many countries presenting with this insidious

disease. Work is now underway, including in Adelaide, in the hope of isolating and identifying the gene which is involved in the presence of Batten's Disease. Obviously, its identification will have implications for future treatment and possible future genetic manipulation to remove the offending gene (including from progeny) and prevention (including by antenatal screening and termination of pregnancies where the offending gene appears).[16]

When the Human Genome Project was instituted, it was hoped that the genetic developments would be accompanied by new information technology which would allow the faster sequencing of the vast array of DNA components in the human genome. Although there have been significant improvements in the information technology, the radical break-throughs which were expected have not occurred. They rarely arrive on time and on demand. This has led to some shift of attention in recent times towards select sequencing of the coding of genes representing only 5% of the total amount of DNA.

One of the most hotly contested developments which has occurred during the life of the Human Genome Project has been the initiative of the United States National Institutes of Health to attempt to patent randomly isolated partial gene sequences of unknown function. Concern about this development, which appears to undermine the principle of international cooperation that lay at the heart of the initiation of the Human Genome Project, divided participants of the Bilbao conference. It led to many an angry clash there, as it has earlier done in other parts of the world.

THE PROMISE IS GREAT

During the course of this year, it has been difficult to escape the media reports which laud the potentiality of research on the human genes: to identify the causes of human disorders as the first step towards their prevention or cure.

Thus, in March 1993, the *Bulletin*[17] described the advances in genetic diagnosis. Genetically inherited or determined disorders - such as cystic fibrosis, Tay-Sachs Disease, Down Syndrome and Thalassaemia were shown to derive from specific

genes. They can be identified genetically before they manifest themselves physically. At present, the major application of genetic diagnosis of this kind is to permit termination before birth, either by embryo wastage (if IVF is involved), or by abortion, in the aspiration of "better luck next time". But for the future, beyond such screening, the hope beckons that intervention may prevent the physical manifestation of the particular gene and its communication through the germ line to future generations.

Amongst the work performed by Professor Sutherland's unit in Adelaide has been that which has helped to locate a gene responsible for the second most common cause of mental retardation, called Fragile X syndrome. So far, it is not known how the Fragile X gene causes the retardation; just that it does.[18]

In May 1993 there were announcements of the discovery of the genes responsible for Huntington's chorea and for amyotrophic lateral sclerosis. At the same time came the claim that the gene responsible for colon cancer, which kills at least 300,000 persons each year and is the second leading cause of cancer death in the United States, had been isolated.[19] According to the commentators, if a person presents with the marker detected in a simple blood test there is a better than 95% chance that they will develop the cancer. Colon cancer is susceptible to early but not later surgical treatment. Early diagnosis may help early intervention and the saving of lives.

In June 1993 came the news that scientists would soon be able to pinpoint the genes responsible for height, weight, intelligence, skin pigmentation and other non-disease traits. This news prompted anxious questions about the potential for misuse of character traits deemed "unattractive or not useful". It is important at this stage to distinguish between scientific fact, for example, the identification of the Alzheimer's gene, and media hype, such as the alleged discovery of a supposed "gay" gene. Thus, in August 1993, *The Australian* editorial projected the frightening scenario that the discoveries of the Human Genome Project might lead to the Nazi-style eradication of individuals who were, for example, homosexuals. The editor remarked:

"If [homosexuality] were genetically inherited, no blame could attach, and laws made to punish offenders for their sexual preference or practices would be insupportable. On the other hand, opponents of decriminalisation of homosexuality might propose genetic correction in place of the failed diversion therapies of the past that relied on the belief that homosexuality was a behavioural problem."[20]

This subject was taken up at the same time in the Jewish press in England. Lord Jakobovits, former Chief Rabbi of the British Commonwealth, was reported as saying:

"If we could by some form of genetic engineering eliminate those [homosexual] trends we should - so long as it is done for a therapeutic purpose."[21]

This comment evinced strongly antagonistic responses from the Union of Jewish Students in Britain:

"As Jews we find the idea of using genetic engineering to eliminate homosexuality an affront to human rights and dignity. It is disturbing to find Jews advocating something akin to that practised against our people by the Third Reich."[22]

In late September 1993, the *Economist* reported the work of scientists in Pennsylvania upon the identification of the genetic trigger for Kennedy's Disease - a degeneration of the nerves affecting muscles and another cause of mental retardation.[23] In September too came the news from Duke University of a claim that scientists had discovered a gene likely to cause the development of late onset Alzheimer's disease.[24]

Last week, the Sydney press ran the story of the upcoming opening of a Broadway play, no less, on genetic selection. A Jewish family, by prenatal screening, discovered that the foetus carries a genetic structure considered typical to homosexuals. The mother's brother, himself gay, is outraged when he learns that his

sister might abort the child. The author, Jonathan Tolins, puts these words in his mouth:

> *"What if you found out the kid was going to be ugly, or smell bad, or have an annoying laugh? Where do we stop? You know we have relatives who died for less. Now that we have this technology, what are we going to do with it?"*

What indeed! These are the questions which have confronted many ethicists and lawyers. They were at the forefront of the Bilbao conference. I now want to tell you something about them.

THE PROBLEMS OF GENOMIC INSIGHT

The basic problem of genomic insight was stated by James Watson himself at the meeting in 1990 in Spain, which examined the ethical quandaries. He said:

> *"[G]enetic injustice arise through throws of the genetic dice that operate when our sperm and egg are formed. This genetic variability between humans reflects the fact that the gene distribution process is not perfect and the new genetic mutations are constantly arising. There is no way to stop this process. Moreover, the variation has been the basis of our evolution. Without the differential of survival of more fit variants, we as human beings would not have our highly empowered brains that have led us to develop the languages ... that underlie the creation of our various civilisations. The question now faces us ... as to how we are going to deal with these differences between individuals. In the past, at the time of the eugenics movement ... and during the reign of racist thoughts in Nazi Germany, there was very little genetic knowledge. Most decisions were made without solid genetic evidence ... Now we have to face the fact that we soon will have real facts and how are we going to respond to them?"*[25]

Some speakers at the Bilbao meeting answered this question by expressing a deep sense of anxiety about the implications of genomic research for human freedom. Thus concern was expressed about the way in which the Human Genome Project itself

has been initiated and funded by governments and scientists with very little input from the public. Dr Frits Hondius of the Netherlands said:

> *"We expect that those who fund, administer and execute the Human Genome Project should make every effort to close the information gap between the genome scientists and the general public. If any survey or poll was carried out within a random section of the population with the following question: Have you ever heard of the Human Genome Project? I am afraid that, as matters stand now, the result will be zero."*[26]

The result would be no different in Australia and New Zealand. Yet it is impossible to see the introduction of human ethical values, reflected in human laws, if the community is basically unaware of - and indifferent to - what is going on and uninformed about its social implications.

The same thoughtful commentator in Bilbao questioned the implications of the Human Genome Project for the very rule of law upon which our societies are ostensibly based. If there is no law that effectively governs genomic research and development and if, notwithstanding this fact, such research and development has a potential crucial for the future of the species, an astonishing gap is revealed which we should hasten to fill in close harmony with an informed community. In Europe, an Intergovernmental Steering Committee on Bioethics within the Council of Europe has been developing a Bioethics Convention. A number of countries, including Australia, Canada, Japan and the United States have been observing this process. It may have implications far beyond Europe. The foundation of the Convention includes respect for basic human rights: for the dignity of each human being in all stages of biological development. It also includes prohibition of applications of biological research, contrary to the fundamental values of humankind. Perhaps more controversially, the European Convention will include provisions to guarantee equitable access to the benefits of biomedical sciences, prohibition of treating the human body, or parts of it, as a commercial commodity, and respect for the autonomy of persons undergoing

medical treatment which involves genetic testing, counselling and confidentiality of genetic data.[27]

Often unstated, but in the minds of every lawyer and most citizens, who consider a development such as genetic research, is the horrible aberration that occurred in the Nazi death camps, purportedly in the name of scientific experimentation.[28] These led to the trial of many of those involved at Nurbemburg in 1947. They also led to the acceptance, by the international community, that human beings should not be used without free consent and proper conditions for medical experiments. Drawing the line between research and experimentation, and crossing the line from discovery into action, presents acute ethical problems upon some of which each society would wish to establish its own binding rules.

It is here that the work of the Australian Law Reform Commission, and other like work, provides a model which should be kept in mind. By consulting the experts and informing and consulting the community in all parts of the country, laws were developed which squarely presented Parliaments with options for action. A high measure of uniformity was secured in the laws on human tissue transplants. But upon some issues the legislatures in different parts of Australia chose different options. Yet at least the hard questions were faced and answers were given by the democratic branch of government, accountable to the people.

The alternatives to these procedures will be that judges, doing their best upon materials presented by individual litigants, will provide the answers. Or the law will offer no answers and then scientists will rush on without any relevant legal constraints.

Amongst the specific topics examined in Bilbao were the following implications of genomic research:

* The right to confidentiality in the use of an individual's genetic information;
* The implications of genetic research for the culpability of criminal offenders;

* The developments of the law of patents and intellectual property for the protection of the investment of research and industrial organisations;
* The implications of genetic research for insurance and spreading the risks within society of genetic defects;
* The imposition of legal limits on genetic experimentation, deemed bizarre or unacceptable to the human community;
* The identification of human beings by genetic testing and the legal aspects of using the genetic identity as a unique and universal human identifier; and
* The implications of knowledge about workers' genetic conditions in the labour market.

The right to confidentiality presents the paradox of detailed human gene mapping at the very time of heightened demand for respect for individual privacy. The reconciliation of greater knowledge about the individual with demands for respect for the individual's control over his or her own information obviously require much legal attention.[29] The risk of genetic discrimination was raised by several participants in the Bilbao meeting. It was pointed out that many individuals would not wish to know their own genetic information, still less to have it known by others without very strong reason, individual consent or express authority of law giving in terms compatible with the requirements of a democratic society.

The session on criminal culpability explored the age-old problem of free will. If it were shown that, even to some extent, violence was the product of genetic inheritance, would it be just for the legal system to hold the subject personally responsible under the criminal law? Our criminal law operates upon assumptions of individual responsibility for behaviour causing harm to others. But what if it were shown that certain individuals had genetic predispositions which could be proved by genomic research? Would this be a basis for an excuse for the individual concerned who has simply acted out his or her genomic messages? Or should the law persist, in

the face of such discoveries, with the insistence that every individual is criminally responsible for conduct that adversely affects others in society?

The implications of patent law for genomic research stirred the greatest emotions at the Bilbao conference. A leading American scientists, Dr Craig Venter, pointed out that over 35,000 applications for patents of biological material had already been lodged in the United States compared with some 13,000 in Europe. It should be noted that, so far, none of Dr Venter's applications has yet been successful. The main apparent reason for the delay is that the sequences are of unknown function. Despite this, several speakers suggested that intellectual property law was not keeping pace with the nature of the problem presented by genomic research. What was needed was a new concept which afforded a measure of protection for the investments of the researchers but offered that protection for a shorter period and under different conditions. Those conditions would need to be more apt to sharing the beneficial break throughs in human genomic research so that, affecting the whole human species, they would be available on a global scale. And not just confined to benefit humans in the developed world.

A participant from Argentina captured the mood of many delegates. He pointed out that James Watson himself had refused to patent his major discovery of the double helix. Watson had said that it should be available for all humanity. The attempted patenting of human life forms was, in this participant's eyes, "completely immoral". The species and its genes did not belong to American corporations. This point was taken up by a professor from the famous Johns Hopkins University. He deplored the commercialisation of university research and regarded it as very short-sighted. These themes were developed by many participants from the floor of the Bilbao conference. Some described the patenting of the products of human genomic research as a new form of "neo-colonialism". It would result in gross delays in the spread of scientific knowledge relevant to medicine and the curing of disease to the people of the world, especially in developing countries.

The session on insurance examined the limits, if any, which should be placed on the use of genomic information by insurance companies. Insurance is a means of spreading the risk of disease and premature death amongst the policy holders. If a person suffers from an irrevocable condition, discoverable in the genes, should that not simply be accepted as part of the human variety covered by risk bearing insurance? Yet if insurers, to minimise their risk, can test proponents for heart conditions and can exclude smokers or others who enhance the risk of disease and death, why should they be forbidden from having access to wholly accurate and precise data which shows the presence of genetic conditions likely to affect a person's health and life expectancy? Insurance, being about actuarial risk, the facility of precise identification of risk would afford insurers, unless checked by law, with more scientific data upon which to judge the acceptance of insurance and the fixing of premiums to spread risks amongst their insureds.[30]

The limits on genetic experimentation require consideration of the various forms of regulation that could be invoked in this connection. These limits include criminal law, internal control in research institutes, peer review and individual self-regulation.[31] A recurring theme both at Bilbao and in most of the academic commentary on the Human Genome Project is the need for community superintendence and involvement. Another recurring complaint is the relative lack of community participation until now.

Perhaps it is on that footing that legislation has recently been proposed in France to control at least some of the developments of genomic research that are considered unacceptable. Amongst this legislation proposed in France are provisions which would, if enacted:

* Ban arrangements for surrogate motherhood with criminal penalties for intermediaries, although not for the pregnant women involved;
* Strictly limit in vitro fertilisation to heterosexual couples with fertility problems;

* Maintain permanently the anonymity of the donors of sperm and egg in cases of artificial insemination donor;
* Outlaw the sale of organs, tissue and blood;
* Forbid the manipulation of genes, except to improve the health of a particular patient and then sanction any interference with the patient's germ line;
* Restrict the provision of information from genetic tests, precluding its use by employers to screen job applicants or by insurance companies to assign risk categories; and
* Forbid patenting of human genes.[32]

Each and every one of these provisions would be highly controversial. For my own part I would want to confine or modify, every one of them. But at least the French legislature[33] has begun to address these issues. The Council of Europe, as I have said, is developing a Convention. But in most parts of the world, including Australia, these issues have been largely ignored, whilst politicians indulge themselves in the bread and circuses that occasion the deep cynicism which infects Western democracies at the very moment of the triumph of the liberal state.

I shall attach to this lecture, for those who are interested, copy of the Bilbao Declaration which was adopted at the close of the meeting which I have been describing. In ringing tones, it asserted that genetic variations, like social diversity, constitute attributes of free human beings. The idea of a monochrome genetic "perfection" and of eliminating the precious variety of humanity by genetic means was declared to be socially repulsive. The great Spanish painter, Goya, like Beethoven, became deaf; Milton became blind; Mahler died of a congenital heart complaint; and each one of us carries genetic features that add to the diversity of humanity. The greatest care is needed now as we face the possibility of stamping out, or even reducing, elements of this diversity.

Most of us would understand, even if we would not agree with, a decision, conscientiously taken, to terminate a pregnancy upon the discovery, by genetic testing,

of the presence of Down Syndrome or the Fragile X gene. But where then is the line to be drawn? For gender selection? To exclude homosexuals? To favour the tall, the blonde or the beautiful? To preselect skin pigmentation, eye colour or IQ? To exclude a propensity to obesity or a potential for ugliness? Even more perplexing is the question of interference in the human germ line with the risk of sending into new generations manipulated genes which may banish particular inherited conditions with consequences as yet unforeseen.

Do not think that this is purely hypothetical talk. One of the Nobel laureates in Bilbao was Dr Carleton Gajdusek, a good friend of Australia. It was he who co-discovered the Kuru's Disease in New Guinea, a viral condition sometimes transmitted through cannibalism. Now, a new variant of this condition has appeared in those patients treated decades ago for dwarfism by the use of human pancreatic product secured mostly from coroner's cadavers. In the business of genetics, we lay down problems for the future. The clock ticks away. The alarm bells may one day ring, even unto the future generations.

CONCLUSIONS & A CALL TO ACTION

There are two simple conclusions to this lecture. The Human Genome Project presents both promise and problems, as I hope I have demonstrated. It is not a choice of one or the other. With the one comes the other.

The first conclusion is that Australia and New Zealand must get aboard. I agree with the comments of Dr David Callen,[34] that Australia has so far failed to provide any specific funding on substantive research for the Human Genome Project. In this, we lag behind all of the other major developed countries. They have seen the huge potentiality of genomic research for future medical treatment and pharmaceutical development. These are areas where Australia has excellent basic science. The potential for cooperative activity, such as that achieved at the Adelaide Children's Hospital, should be replicated throughout our region. Putting it quite bluntly, this is an area of big bucks. If Australia and New Zealand are not involved, it will be just

another source of imported know-how to burden our balance of payment deficit. Assuming that our benighted country is not meanwhile consigned to the developing world and cut off from access to genomic tests and therapies that will come we will pay for genomic R & D with no offsetting income from contributions of our own. We must provide our own input to the Human Genome Project to earn our own place in the markets, as well as at the cutting edge of life sciences in the future. Excellence should be valued in Australia and New Zealand in things other than sport. But rarely is it so. We should have a vision of excellence beyond the Olympic Games - to the achievements that come from the disciplined mind - usually more enduring than the disciplined body. It is when I see a Premier leap for joy at an achievement of Australian science that I will feel we are truly ready for the new millennium.

I realise that these are hard times to be urging expenditure of government funds in a new field. But if the call of pure science is not beguiling to government, the potential for huge financial returns and costs might do the trick.

Secondly, it is essential, both nationally and internationally, that scientists should speak to ethicists and to lawyers and to citizens. There is a need for multi-disciplinary involvement as the Human Genome Project progresses and as its consequences are presented. This is one area where we in Australia have some techniques to export. We refined them in the Law Reform Commission. They remain as valid today. They present the means of confronting bioethical questions which will otherwise be consigned to the political too hard basket. They ensure that the accountable, democratic branches of government face up to the truly challenging issues of our time. They reinforce the rule of law. They help to protect and safeguard the new challenges to human rights which genomic research presents. It would be no bad thing if the Federal Attorney-General in Australia could be persuaded to refer to the Australian Law Reform Commission the consideration of the legal issues raised by human genomic research and associated developments. There is, after all, the French model. This is also now a German law. If we cannot always export scientific research, or contributions worth talking about to the Human Genome Project itself,

perhaps we can export a serious legal reflection upon the basic rules which should govern a common law country in its approach to the problems that are present, and will be present, as a result of genomic developments.

It is vital that the human brain which has conceived, perceived and then described DNA, the double helix and the basic forms of life, should have the wisdom to construct rational rules for the global conduct of genetic research, experimentation and manipulation. Not to do so is to make a decision. Let there be no doubt of that. And it is a decision which has a potential to affect the future of our species. Indeed it may affect the very shape and form of our species. Even whether our species takes itself by these miraculous discoveries into a new and different form. Truly then humanity, like Prometheus, will have defied the Gods, stolen the fire of creation and given it to humans.[35] Let us hope that we have the courage to change that which needs changing in members of our species, by the brilliance of our discoveries; the strength to hold back from disturbance of the marvellous variety of humanity which is our genetic legacy; and the wisdom to know the difference between the occasions for change and for restraint.

I close, as I began, with Oogeroo's timeless words. They were my companions as I crossed our continental country today, and looked down at its inspiring grandeur. They will be with me tonight as I cross the continent again, in darkness - searching for the light of a new day - after this encounter with you at ANZAAS, at Curtin University:

"No walls about me
The stars over me
The tall surrounding trees that stir the wind
Making their own music,
Soft cries of the night coming to us, there
Where we are one with all old Nature's lives
Known and unknown ...
.. A thousand thousand camp fires in the forest
Are in my blood
Let no one tell me the past is wholly gone.
Now is so small a part of time, so small a part

Of all the race years that have moulded me."[36]

FOOTNOTES

* President of the Court of Appeal of New South Wales. Chairman of the Executive Committee of the International Commission of Jurists. One-time member of the Executive Board of the CSIRO. Chancellor of Macquarie University. I acknowledge assistance with materials provided by Dr G Sutherland, of the Women's and Children's Hospital, Adelaide, Dr A Reisner of the Australian National Genomic Information Service, Sydney and Professor Don Chalmers of the University of Tasmania Law School.

1. K Walker,, "The Past" in *The Dawn is at Hand*, Jacaranda, Brisbane, 1966, 25.
2. Australian Law Reform Commission, *Human Tissue Transplants*, ALRC 7, AGPS, Canberra, 1976.
3. S Weinberg, *Dreams of a Final Theory*, in *The Australian Weekend Review*, 31 July 1993.
4. *New Scientist*, (ANZ ed) 24 April 1993, 21.
5. *Ibid*, 22.
6. *Id*, 23.
7. *Loc cit.*
8. A Coghlan, "Engineering the Therapies of Tomorrow" in *New Scientist*, 24 April 1993.
9. *Id*, 30.
10. *Mabo v Queensland* (1992) 175 CLR 1.
11. See *Australian Capital Television Pty Limited v The Commonwealth [No 2]* (1992) 66 ALJR 695 (HC); *Nationwide News Pty Limited v Wills* (1992) 66 ALJR 658 (HC).
12. A Gore, *The Earth in Balance*, Earthscan, London, 1992.
13. D F Callen, "The Human Genome Project - Australian Scientists Must be Involved" (Opinion) in *Search*, vol 23, no 9, October 1992, 264.
14. F W Hondius, "Man's Freedom and the Human Genome" in *Papers of the International Workshop Human Genome Project: Legal Aspects*, Fundacion

BBV, Bilbao, 24-26 May 1993, to be reproduced in the Papers of the Conference.

15. *Ibid*, 9f.
16. The Adelaide project is described in Callen, above n 13, 265.
17. 2 March 1993, 40.
18. Deborah Smith, "The Gene Hunters", *Sydney Morning Herald*, 13 April 1993, 11.
19. *Newsweek*, 11 May 1993, 76.
20. 5 August 1993, 10.
21. In a letter to the *Jewish Chronicle*, July 1993.
22. Quoted the *Sun Herald*, 1 August 1993, 10.
23. *The Economist*, 28 August 1993, 72.
24. *Sydney Morning Herald*, 10 September 1993, 4.
25. J Watson, in Fundacion BBV, *Human Genome Project: Ethics*, 1990, Madrid, 27.
26. Hondius, above n 14, 4.
27. *Ibid*, 11.
28. G Annas and M A Grodin, *The Nazi Doctors and the Nuremburg Code*, OUP, New York, 1992.
29. Canada, Privacy Commissioner, *Genetic Testing and Privacy*, 1992.
30. United States, *Report of the Task Force on Genetic Information and Insurance*, May 1993.
31. P M McNeill, *The Ethics and Politics of Human Experimentation*, Cambridge, 1993. See also L Darvall, *Medicine, Law and Social Change*, Dartmouth, Aldershot, 1993.
32. R Herman, "France Defines the Ethics of High-Tech Medicine", *Washington Post* Health Report, 20 October 1992.
33. *Ibid.*
34. Callen, above n 13.

35. M Charlesworth, *Life, Death, Genes and Ethics*, ABC Boyer Lectures 1989, Sydney, 25.

36. See n 1 above.