MORAL OBLIGATIONS AND THE FALLACIES OF "GENETIC CONTROL"

MARC LAPPÉ

Institute of Society, Ethics and the Life Sciences

CHANCE EVENTS AND THE MYTH OF GENETIC CERTAINTY

The sciences of molecular biology and human genetics emerged within my own lifetime. Partly as a consequence of the development of these two sciences, my generation was the first to become swept up in what we now recognize as "The Biological Revolution." What made genetics "revolutionary" is that it was transformed from a science whose content was discernible only by inference, to one which seemingly could be known with certainty: the discovery which made the unknown knowable was made the year I was born.

In 1943, Oswald Avery wrote his brother Roy to describe his findings about a physiological principle which appeared to be able to confer the properties of virulence to a bacterium. The excited tone of his letter reflected the utter incredulity that Avery must have felt upon learning the outcome of his experiments: a *chemical* had made it possible to induce predictable and hereditable changes in living cells. Genes were molecules! As such they were subject to human control and manipulation. Avery wrote: "This is something which has long been the dream of geneticists.... [Up until now] the mutations they induced... are always unpredictable and random and chance changes."[1]

Although Avery was mistaken in his assumption that this knowledge would allow us generally to control where and when mutations occur, he was correct in concluding that his discovery revolutionized our ability potentially to control what specific genetic information a cell contained or expressed. Thus, when he discovered the molecular basis for a "transforming principle," he simultaneously acquired the ability to effect genetic transformations. The phenomenon by which the acquisition of knowledge per se changes that which has become known (or affords the potential for such change) represents a subtle mechanism by which genetic information (as well as much other knowledge in science) escapes the moral scrutiny of its possessors. Hans Jonas perceptively observed:

> Effecting changes in nature as a means and as a result of knowing it are inextricably interlocked, and once this combination is at work it no longer matters

[1] Letter from Oswald Avery to Roy Avery, May 17, 1943, in *Readings in Heredity*, ed. John A. Moore (New York: Oxford Univ. Press, 1972) pp. 249–51.

whether the pragmatic destination of theory is expressly accepted... or not. The very process of attaining knowledge leads through manipulation of the things to be known, and this origin fits of itself the theoretical results for an application whose possibility is irresistible... whether or not it was contemplated in the first place.[2]

In Avery's case, he might well have foreseen that transformation could be used to confer virulence to normally nonpathogenic bacteria, but he certainly could not have anticipated that his principle, in conjunction with the later to be discovered "R" factors, would be used to make potent, antibiotic resistant biological warfare agents![3] But the prospect of nefarious application is *not* what makes genetic knowledge unique. Rather, its uniqueness lies in the manner in which "knowing" the genetics of something changes it.

For example, the simple act of acquiring prenatal genetic information about a fetus—whether or not he is carrying a particular gene, or if he will develop a genetically determined disease later in his life—automatically sets into motion a train of events which themselves change that individual's future. At the very moment you acquire a "bit" of genetic information about a fetus (or any person, for that matter), you have begun to define him in entirely novel terms. You tell him (and sometimes others) something about where he came from and who is responsible for what he is now. You project who he may or may not become in the future. You set certain limits on his potential. You say something about what his children will be like, and whether or not he will be encouraged or discouraged to think of himself as a parent. In this way the information you obtain changes both the individual who possesses it, and in turn the future of that information itself.

In addition to the potential for individual stigmatization, there is also sufficient ambiguity in genetic "facts" themselves to seriously question the judiciousness of massive operations designed to ascertain the genetic composition of whole populations. In contrast to the simplistic view of genetics in Avery's time, we now know that genetic information, by its very nature, tends to confound rational analysis. It is *redundant*, such that a flaw in replication or a mutational event need not irrevocably distort or destroy (as had previously been assumed) the information contained in the genetic material. It is *self-correcting*, containing enzymes whose sole function is to recognize damaged segments of DNA molecules, excise them, and faithfully reconstruct the

[2] Hans Jonas, *The Phenomenon of Life* (New York: Harper & Row, 1966) p. 205.

[3] See Marc Lappé, "Biological Warfare," in *Social Responsibility of the Scientist*, ed. Martin Brown (Berkeley: Free Press, 1970).

whole (thereby compelling reconsideration of estimations of mutation rates and their causes). It is *heterogeneous*, with most seemingly "single" genes being in fact clusters of genes with related functions ("pleiotrophy") or products ("alleles," or "pseudalleles"), each gene having the potential property of producing different effects in different organs at different times in development (frustrating any simplistic analysis of whether or not a single gene or many is responsible for a given complex constellation of developmental defects).

These observations begin to explain why at the human level, for example, medical researchers have been at a loss to explain why some individuals who by all measurements have the defective genes for phenylketonuria[4] do *not* in fact show the physical stigmata of the condition. If, as appears likely, this genetic "defect" (and perhaps the one responsible for the related condition galactosemia) is not an "all or none" phenomenon, but can actually be compensated for by the operation of other genes, all of our assumptions about the nature of such genes, *and* our moral decisions of what should be done in the event that an individual is discovered with them, have to be seriously reassessed. The fact that this reassessment is *not* currently going on reflects, I believe, an underlying cultural bias that affects our analyses of genetic problems. It is not just that we want simple answers to complex questions; it is that we would like to be able to *control* a material whose nature eludes our dominion.

INTOLERANCE FOR UNCERTAINTY AND THE QUEST FOR GENETIC CONTROL

If genetic systems are so inherently difficult to understand, why do we feel impelled to seek to control them? The problem appears to be rooted in our Western psyche and philosophical assumptions about the use of knowledge. Avery's letter gives us a sense of the deep-seated aversion most Western scientists (and philosophers) feel towards the chance events that appear to govern genetic systems. (Recall Avery's mistaken assumption that he had discovered the means to *control* the class of events we call "random mutations," when in fact he had merely discovered an analogue for one specific mutational event.)

Joseph Fletcher, an ethicist, echoes this profound disquiet towards uncertainty in genetic systems when he states: "We cannot accept the 'invisible hand' of blind chance or random nature in genetics."[5] An

[4] A condition resulting from an enzymatic defect in the ability to metabolize phenylalanine which is usually associated with mental retardation.

[5] Joseph Fletcher, "Ethical Aspects of Genetic Controls," *New England Journal of Medicine* 285 (1971) 776–83.

implicit assumption in Fletcher's remarks is that the reduction of uncertainty is equivalent to progress, a view widely held in the West.[6] In genetic systems, the paradox is that progress (in this sense evolutionary progress) is accomplished *because of* genetic instability and susceptibility to chance events, not in spite of it.

James Crow, a renowned population geneticist, has described the operation of chance in sexual reproduction by pointing out that "In a sexual population, genotypes are formed and broken up by recombination every generation, and a particular genotype is therefore evanescent: what is transmitted to the next generation is a sample of genes, not a [whole] genotype."[7] It is difficult to reconcile evolutionary progress with this image alone, since Crow omits (by intention, I am sure) discussion of the mechanisms by which variation is introduced into sexual populations. Faced with the reality of incessant fluctuation and change of genetic systems, the Nobel laureate geneticist Joshua Lederberg asked at one point: "If a superior individual . . . is identified, why not copy it directly, rather than suffer all the risks of recombinational disruption, including those of sex? . . . Leave sexual reproduction for experimental purposes; when a suitable type is ascertained, take care to maintain it by clonal propagation."[8]

If from Avery's day scientists believed they had discovered the means to control the transmission of hereditary information, why does Joshua Lederberg believe that the only real means of control for man would be to clone him? The answer in part is that the kinds of control which were possible in bacteria thirty years ago remain an illusive quest for human organisms today. Not only is cloning a distant and limited prospect for man, but so is the much-vaunted genetic engineering which would precede it. Mammalian cells, unlike bacterial ones, appear to be extraordinarily resistant to the introduction of most forms of genetic information. Although reports have appeared indicating that bacterial viral genes will function after being introduced into human cells in tissue culture[9] (a feat proving difficult to replicate), enormous difficulties

[6] See the discussion by Carl Jung in the Introduction to the *I Ching*, tr. Richard Wilhelm (Princeton: Bollingen Series XIX, 1967) p. xix, where he begins: "An incalculable amount of human effort is directed to combating the nuisance and danger represented by chance . . . ."

[7] J. F. Crow, "Rates of Genetic Changes under Selection," *Proc. National Academy of Sciences* 59 (1968) 655–61.

[8] J. Lederberg, "Experimental Genetics and Human Evolution," *American Naturalist* 100 (1966) 519–26. (Clonal propagation means using the nucleus of a single cell to propagate a whole organism genetically identical with it.)

[9] Carl R. Merril, Mark R. Geier, and John Petricciani, "Bacterial Virus Gene Expression in a Human Cell," *Nature* 233 (1971) 398–400.

remain in attempting to use the same techniques actually to treat individuals with the genetic defect that the virus appears to correct. Another technique for correcting "defective genes" also appears to pose currently insuperable problems for human application. It entails fusing or "hybridizing" a cell lacking a particular gene with one containing the active equivalent.[10] This technique may prove to be limited to tissue-culture studies, since the number of cells needed to correct the same defect in a person would be astronomically large and the problem of immunologic acceptance of the cells a thorny one.

While tantalizing in the control that such techniques appear to promise for the future, there is a danger in their seductiveness in the present. In the first place, they obfuscate the need for solving current problems which do not need novel technical solutions, such as general health care. Secondly, they pose the threat of dehumanization that Jacques Ellul identifies with technique per se. Ellul observes that "When technique enters into every area of life, including the human, it ceases to be external to man and becomes his very substance. It is no longer face to face with man but is integrated with him, and it progressively absorbs him."[11] In the context of the above examples, Ellul would envision man's existence becoming dependent upon and inevitably indistinguishable from the vast array of artificially engineered genes and tissue-culture support systems needed to sustain him. More importantly, such techniques do not offer permanent solutions to human problems but merely transiently replace one technique (e.g., insulin for treating diabetes) with another (genetic engineering of Islets of Langerhans cells in the pancreas) for coping with man's medicogenetic dilemmas. Since none of these projected genetic techniques offer the prospect of the permanent change that can only be accomplished by changing the germ plasm itself, they offer only the illusion of changing man.

THE "NEW" EUGENICS AND THE "OLD"

In presenting a scenario of genetically "engineering" man,[12] Lederberg and Fletcher believe that current knowledge of genetics mandates a new eugenics to meet pressing human needs. There are two points to be made about any such proposal: (1) Concern about effecting widespread genetic changes in a population is unwarranted, given existing

[10] A. G. Schwartz, P. R. Cook, and Henry Harris, "Correction of a Genetic Defect in a Mammalian Cell," *Nature New Biology* 230 (1971) 5–7.

[11] Jacques Ellul, *The Technological Society* (New York: Vintage, 1964) p. 11.

[12] See J. Lederberg, "Unpredictable Variety Still Rules Human Reproduction," *Washington Post*, Sept. 30, 1967.

demographic trends; but (2) the general *motivation* for proposing cloning or other engineering of man must be taken seriously, because it reveals a tacit approval by some of the best minds of the country for both the legitimacy and the need for introducing genetic controls.

To some geneticists, the recrudescence of a social concern for applied human genetics is mandated by an assumed or projected deterioration of the genetic quality of the species. They frankly admit that this concern must be properly construed as a "eugenic" one, but insist that it is based on hard facts. They maintain that their concern is not tainted with the racial connotation that irrational eugenicists had applied in the past. Nevertheless, both the basis for this concern—a progressive "genetic deterioration" of man—and the proposed remedy—a humane form of "genetic counseling" or at an extreme "negative eugenics"—actually are synonymous with the analyses of a hundred years ago.

While Galton is the name usually associated with the "eugenics" movement of the late 1800's, it is actually Darwin whose ideas have endured. Galton described the aim of eugenics[13] (a word he coined) in blatantly racist, class-society terms. Its purpose was "to give the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable [races] than they otherwise would have had."[14] Darwin, not Galton, represented the more representative and "morally enlightened" tone of the eugenics movement:

> With savages, the weak in body or mind are soon eliminated; and those that survive commonly exhibit a vigorous state of health. We civilized men, on the other hand, do our utmost to check the process of elimination; we build asylums for the imbecile, the maimed, and the sick; we institute poor-laws; and our medical men exert their utmost skill to save the life of everyone to the last moment. There is reason to believe that vaccination has preserved thousands, who from a weak constitution would formerly have succumbed to small pox. Thus the weak members of civilized society propagate their kind. No one who has attended to the breeding of domestic animals will doubt that this must be highly injurious to the race of man. It is surprising how soon want of care, or care wrongly directed leads to the degeneration of a domesticated race; but excepting in the case of man himself, hardly anyone is so ignorant as to allow his worst animals to breed....
>
> The aid which we feel impelled to give to the helpless is mainly an incidental result of the instinct of sympathy, which was originally acquired as part of the social instincts, but subsequently rendered, in the manner previously indicated,

[13] Eugenics is defined as "an applied science that seeks to maintain or improve the genetic potentialities of the human species" (Gordon Allen, in *International Encyclopedia of the Social Sciences* 5 [1968] 193).

[14] Francis Galton, *Hereditary Genius* (London, 1870).

more tender and more widely diffused. Nor could we check our sympathy, even at the urging of hard reason, without deterioration in the noblest part of our nature . . . if we were to neglect the weak and helpless, it could only be for a contingent benefit, with an overwhelming present evil. *We must therefore bear the undoubtedly bad effects of the weak surviving and propagating their kind; but there appears to be at least one check in steady action, namely that the weaker and inferior members of society do not marry so freely as the sound; and this check might be indefinitely increased by the weak in body or mind refraining from marriage, though this is more to be hoped for than expected.*[15]

"Expecting" the weak to refrain from marriage may strike us as a quaint nineteenth-century idea; but it faithfully echoes some contemporary statements of the value of "quasi-coercive" genetic counseling. These are some today who no longer "hope" but "expect" the weak in body and mind to refrain from marriage or its genetic equivalent childbearing. A growing number of people use moral arguments to urge those who are genetically "handicapped" (and this may only mean individuals who *carry* but do not express aberrant genes) to fulfil their social responsibility by refraining from procreation.[16] This moral suasion is mistakenly based on the assumption that genetic deterioration of the species will be the inevitable consequence of the "unbridled" procreation of the unfit.

MORAL OBLIGATIONS IN THE FACE OF GENETIC REALITIES

Darwin's focus on the moral dilemmas facing those who think they recognize a genetic basis for human suffering and feel impelled to act on this assumption has a contemporary ring. Theodosius Dobzhansky assessed the eugenic situation in 1961 in this Darwinian tradition: "We are then faced with a dilemma—if we enable the weak and the deformed to live and to propagate their kind, we face the prospect of a genetic twilight; but if we let them die or suffer when we can save them, we face the certainty of a moral twilight. How to escape this dilemma?"[17] Thus ten years ago, the moral problems were not posed in terms of the need for genetic improvement, but rather in terms of the need for societal protection against genetic deterioration. The genetic information which made such an analysis valid thirty or even ten years ago has been substantially amended today.

[15] Charles Darwin, *The Descent of Man and Selection in Relation to Sex* (1871; New York: Random House Modern Library Edition) pp. 501–2 (italics mine).

[16] See in particular Fletcher, *art. cit.*, and Bentley Glass's letter in reply to Leon R. Kass, *Science*, Jan. 8, 1971, p. 23.

[17] Theodosius Dobzhansky, "Man and Natural Selection," *American Scientist* 49 (1961) 285–99.

In the recent past, the chief proponent of the need for eugenic practice was Hermann Muller. In 1959 he stated: "If we fail to act now to eradicate genetic defects, the job of ministering to infirmities would come to consume all the energy that society could muster for it, leaving no surplus for general, cultural purposes."[18] Other, more contemporary authors have voiced similarly concerned if not alarmist views.[19]

While no one can conclusively refute the contention that *sometime* in the future we may have to come to grips with an increased incidence of genetically disabling disorders, it would have been extremely difficult to have made the case, even in 1959, for our moral obligations to act to anticipate them. As Martin Golding, in a review of genetic responsibility to future generations, concluded: "We are thus raising a question about our moral obligation to the community of the remote future. I submit that this relationship is far from clear, certainly less clear than our moral obligations to communities of the present. . . ."[20]

What actually is the "threat" posed to future generations (or, for that matter, to our very own children) by the specter of genetic deterioration? Golding and others appear to believe that current trends in medical treatment and protection of the "genetically unfit" condemn the future to suffer the weight of our omissions. He states, for example, that "the tragedy of the situation may be that we will have to reckon with the fact that the amelioration of short-term evils . . . and the promotion of good for the remote future are mutually exclusive alternatives."[21]

Part of the fallacy of this form of pessimism is the assumption that genes and genes alone are the only means by which we project ourselves into the future. Certainly, most anthropologists, when faced with the question of the most important way in which we influence the future, would emphasize the primacy of *cultural* factors in establishing human societies through time, because purely genetic trends are highly uncertain in fluctuating and migrating human populations.

[18] H. J. Muller, "The Guidance of Human Evolution," *Perspectives in Biology and Medicine* 1 (1959) 590.

[19] W. T. Vukovich, "The Dawning of the Brave New World—Legal, Ethical and Social Issues of Eugenics," *Univ. of Illinois Law Forum* 2 (1971) 189–231; B. Glass, "Human Heredity and Ethical Problems," *Perspectives in Biology and Medicine* 15 (1972) 237–53; R. Gorney, "The New Biology and the Future of Man," *UCLA Law Review* 15 (1968) 273–356.

[20] M. Golding, "Our Obligations to Future Generations," *UCLA Law Review* 15 (1968) 443–79.

[21] Golding, *ibid.*, p. 463.

THE FALLACY OF A GENETIC APOCALYPSE

The other part of the fallacy is the assumption that we actually do face a genetically deteriorating situation. In the ten years since Dobzhansky originally posed the dilemma of a "genetic twilight," we have acquired enough information to enable us to draw back from the vision of a genetic apocalypse. Imminent "genetic deterioration" of the species is, for all intents and purposes, a red herring. The officers of the American Eugenics Society acknowledged this in a six-year report ending in 1970. In spite of the fact that they reaffirmed the long-range objective of the society to pursue the goal of maintaining or improving genetic potentialities of the human species, they stated that "neither present scientific knowledge, current genetic trends, nor social value justify coercive measures as applied to human reproduction." In fact, the officers wrote, "at this stage the need is for better identification of present and potential directions of changes rather than action to alter these trends in any major way."[22]

Our contemporary population is in a unique situation. The "gene pool" is in fact undergoing a period of stabilization, not change. In an analysis of the demographic trends characterizing the current population in the United States, Dudley Kirk observed that while the tremendous relaxation in the intensity of selection accomplished by modern medical achievements may be inexorably increasing the load of mutations the population carries, the over-all demographic trends are such as to reduce the number of children born with serious congenital abnormalities. He summarized his paper in the following way:

> A relaxation of selection intensity of the degree and durability now existing among Western and American peoples has surely never before been experienced by man.... In the short run, demographic trends (in and of themselves) are reducing the incidence of serious congenital anomalies.... In the foreseeable future, the possibility of medical and environmental correction of genetic defects will far outrun the effects of the growing genetic load.[23]

Demographic trends such as lowered average age of childbearing, smaller number of children, and the reduction of consanguineous marriages *themselves* effect dramatic changes in the quality of life experienced by the next generation. In the thirteen years between 1947 and 1960 when Japan instituted a revolutionary (if misleadingly termed)

[22] T. Dobzhansky, D. Kirk, O. D. Duncan, and C. Bajema, *The American Eugenics Society, Inc. Six Year Report, 1965–1970* (published by the Society, New York).

[23] Dudley Kirk, "Patterns of Survival and Reproduction in the United States," *Proc. Nat. Acad. Sci.* 59 (1968) 662–70.

"Eugenic Protection Law," there was a ⅓ reduction in the number of children born with Mongolism and a 1/10 reduction in aggregate of all of the other major congenital abnormalities. This startling statistic was accomplished simply as a result of introducing legal abortion and encouraging smaller and earlier families.[24] A similar trend may well be expected in Western countries if we act to encourage the same *non*-genetic changes in our population. The data on the close relationship between higher maternal ages at birth, number of previous offspring, and the high incidence of such devastating congenital defects as anencephaly[25] and Mongolism make the moral imperative of recommending basic changes in childbearing patterns obvious. It is important to note that this kind of recommendation (for example, proscribing childbearing in women over thirty-five) has a universal basis, unlike proscriptions on individual childbearing for genetic reasons.

SOCIETAL VS. INDIVIDUAL COSTS OF GENETIC DISEASE

Statistics such as these do not, however, tell us what specific moral questions are at stake for the future childbearing of individuals who themselves are born with a genetically determined disorder. Society's interest in this question acquires legitimacy only if it is true that society is paying an increasing social (not just monetary) cost for the offspring of the genetically unfit.

The origin of the notion of "societal cost" is rooted in the assumption that the care extended by society to the "unfit," while morally desirable, cannot be accomplished without heavy burden. It is widely accepted, for example, that medical advances have contributed to our genetic load by permitting individuals who are born with genetically determined disorders to survive to childbearing age. Is this in fact the case? The answer appears to be that *some* advances in medicine may have this effect, but that on the whole medical practice is neither generating a race of Orwellian invalids requiring daily injections of insulin, enzymes, and other crucial but absent substances *nor* is it permitting a critical number of the truly "unfit" to procreate.[26] A key but unique case in point would be retinoblastoma, a treatable eye tumor which until recently was fatal. "Treatment" here is understood to entail enucleation of the eye, with an increased residual risk of

[24] *Ibid.*

[25] Jean Fredrick, "Anencephalus: Variation with Maternal Age, Parity, Social Class and Region in England, Scotland, and Wales," *Ann. Human Genetics* (London) 34 (1970) 31–38.

[26] Peter Brian Medawar, "Do Advances in Medicine Lead to Genetic Deterioration?" *Mayo Clinic Proceedings* 40 (1965) 23–33.

cancer elsewhere in the body even if initial surgery is successful. It is undeniable that the survival of individuals who can transmit the dominant mutant gene to their children poses grave moral problems to both the parents and society as a whole. Between 1930 and 1960 in the Netherlands, for example, the frequency of this dread cancer *doubled*, probably as a result of the procreation of survivors carrying the gene.[27] Another cogent example would be the legitimate societal interest in counseling or even in regulating childbearing in mothers with phenylketonuria, where there is grave danger of fetal damage and retardation. The moral issue becomes whether or not such statistics establish society's right to intervene in childbearing decisions by parents known to carry genes directly or indirectly causing grave disability in offspring.

With rare exception there is, in my opinion, no compelling case for societal restrictions on childbearing. I am profoundly disturbed by the advocacy of societal intervention in childbearing decisions for genetic reasons, denial of medical care to the congenitally damaged, or sterilization of those identified as likely to pass on the genetic basis for a constitutional disability. Such an advocacy is implicit in the tone of the following excerpt from a letter in *Science*: "Even elementary biology tells us that hereditary disease or susceptibility to disease which leads to death or diminished reproduction rids a population of genes which perpetuate these maladies. Yet modern medical practice is leading to the accumulation of such genes in the most highly advanced society of man."[28]

This statement, like the one of Darwin's one hundred years ago, miscasts the facts of natural selection in human populations. *The consensus of the best medical and genetic opinion is that whatever genetic deterioration is occurring as a result of decreased natural selection is so slow as to be insignificant when contrasted to "environmental" changes, including those produced by medical innovation.*[29] Even where we have identified a disease in which medical advances can be *shown* to have increased the over-all population incidence, as in schizophrenia,[30] few if any competent geneticists would advocate reducing the number of offspring schizophrenic individuals would be permitted to bear. The principal reason is ignorance. We simply do not

[27] Anonymous, "The Changing Pattern of Retinoblastoma," *Lancet* 2 (1971) 1016–17.

[28] "Biological Unsoundness of Modern Medical Practice," *Science* 165 (1969) 1313.

[29] James V. Neel, "Lessons from a 'Primitive' People," *Science* 170 (1970) 815–22. See also John R. G. Turner, "How Does Treating Congenital Disease Affect the Genetic Load?" *Eugenics Quarterly*, 1968, pp. 191–96.

[30] Walter F. Bodmer, "Demographic Approaches to the Measurement of Differential Selection in Human Populations," *Proc. Nat. Acad. Sci.* 59 (1968) 690–99.

know what (if any) intellectually desirable attributes are also transmitted with the complex of genes responsible for schizophrenia. Bodmer notes that the conditions which have led to an increase in the frequency of schizophrenia "may also conceivably increase the frequency of some desirable genetic attributes in other individuals."[31]

The variability that we (and geneticists with considerably more perceptivity) "see" in people represents the top of an iceberg of genetic diversity in human populations. Most of the variability which can be found at the genetic level is the result of spontaneous mutations which become fixed in the population. The traditional attitude of geneticists was that these mutations were in the main "undesirable," and the number of mutations and the extent to which a population as a whole was subjected to them constituted society's genetic load. Dobzhansky has been diligent in pointing out that the original definitions of "genetic load" tended to be spurious because they hypothesized a single "best" genotype, specifically one which was "homozygous" (i.e., having the same genes on each chromosome pair) for all of its genes. In Dobzhansky's estimation, this notion was inconsistent with the fact that the nature of human populations is to have a tremendous proportion of their genomes (perhaps as much as 30%) made up of "heterozygous" genes, and thus, to be consistent, geneticists would have to regard genetic uniformity beneficial and genetic heterogeneity inimical to the fitness of the population.[32]

It now appears that the term "genetic load" must be considered as almost synonymous with "genetic variability" and to be similarly bereft of utility. An appreciable portion of the expressed and even greater portion of the concealed variability that we can recognize in man consists of variants that—in most environments—are to some degree unfavorable to the organism.[33] In spite of the tendency to term this unfavorable, deleterious, ostensibly unadaptive part the genetic "load" or "burden" of the population, there is little evidence that it is deleterious to the population as a whole to carry so many variant genes. In fact, the opposite appears true. To be consistent, those who favor this definition must regard genetic uniformity as the *summum bonum*, an attitude incompatible with the adaptive value of genetic diversity

[31] Bodmer, *ibid.*, p. 699.

[32] T. Dobzhansky, *Genetics and the Evolutionary Process* (New York: Columbia Univ. Press, 1970) p. 191.

[33] Heterozygotes carrying a single dose of a recessive variant gene which is deleterious in the homozygous form are—contrary to popular belief—on the average *less* fit than the person who has both "normal" genes. The sickle-cell heterozygote, for example, is *only* at an advantage in malarial regions, having statistically less fitness than the normal in nonmalarial regions.

in nature. (A sophisticated analysis of the concept of genetic load is available.)[34]

While many would concur that the "load" imposed by novel or recurrent mutations should be minimized, the natural load of variant genes carried by a population is the result of forces exerted by natural selection. The "burden" of variant genes is a "load," according to Dobzhansky, only in the sense in which the expenditures a community makes to bring up and to educate its younger members are a "load" on that community. Genetic diversity is in one sense capital for investment in future adaptations. Since genetic variability represents evolutionary capability, it is a load we should be ready and willing to bear.

It is indeed ironic that just as man is coming to realize the value of the immense genetic diversity of his species,[35] he has embarked in a direction which threatens to restrict or curtail that diversity. For example, it would be unfortunate if the move to reduce the frequencies of specific "deleterious" genes through identification of heterozygotes by carrier detection screening resulted in broad sanctions on the very mating combinations (heterozygous x normal) which tend to perpetuate genetic diversity. Even where the deleteriousness of a *specific* gene is unquestionable, as in the case of the Hemoglobin S gene responsible for sickle-cell anemia, and the "diversity value" of maintaining high frequencies of the gene largely unsubstantiated, I believe that it would *still* be morally unacceptable to restrict childbearing by those heterozygotes married to normals. Part of the conceptual problem underlying the focus on heterozygous individuals as those responsible for ladening us with our "genetic load" is the false assumption that this load is in fact imposed on society only by a select few individuals. Hermann Muller professed this view when he stated:

> A conscience that is socially oriented in regard to reproduction will lead many of the persons who are loaded with more than the average share of defects . . . to refrain voluntarily from engaging in reproduction to the average extent, while vice versa it will be considered a social service for those more fortunately endowed to reproduce to more than the average extent.[36]

Such a statement raises but fails to answer the profound moral question of how one identifies the "unfortunately" or "fortunately"

[34] Bruce Wallace, *Genetic Load: Its Biological and Conceptual Aspects* (Englewood Cliffs, N.J.: Prentice-Hall, 1970).

[35] L. C. Dunn, "The Study of Genetics in Man—Retrospect and Prospect," *Birth Defects Original Article Series* (The National Foundation, 1965).

[36] H. J. Muller, "The Guidance of Human Evolution," *Perspectives in Biology and Medicine*, 1959, p. 590.

genetically endowed. Today we realize that *each* individual bears a small but statistically significant number (variously estimated at 3-8) of deleterious genes. The moral attitude best fitted by our knowledge is that *a genetic burden is not something that a population is laden with, it is what a family is laden with.*

We now know that the very definition of the phrase "genetic load" is fraught with difficulty. As an alternative, Muller would ultimately have preferred to evaluate genetic load in man, as Sewall Wright did, in terms of the balance between the contribution that a carrier of a particular genotype makes to society and his "social cost."[37] Yet even this seemingly enlightened view suffers from the assumption that the worth of a man lies exclusively in his social utility. One quickly gets into the moral dilemma that Robert Gorney proposes when he attempts to assess the relative social worth of mentally defective people on the basis of their mother instincts, or dwarfs on the basis of their "court jestering."[38] Do not individuals have value unto themselves and their own families?

PROTECTING THE GENE POOL OR SUPPORTING GENERAL WELL-BEING?

What then are the positions of geneticists themselves on the issue of how genetic knowledge should be used to guide human actions? Virtually all geneticists agree with James Crow that the principal hazard facing the human population stems from the introduction of new mutations through environmental agencies. Thus both James Neel and Joshua Lederberg feel that it is the geneticists' primary obligation to "protect the gene pool against damage." (Presumably, this would mean principally reducing the background levels of radiation and population exposure to mutagens.) However, they differ dramatically in their secondary concerns. Neel emphasizes the importance of stabilizing the gene pool through population control, realizing the genetic potential of the individual, and improving the quality of life through parental choice based on genetic counseling and prenatal diagnosis.[39] In contrast, Lederberg speaks of the crucial need for the detection and "humane containment" of the DNA lesions (*sic*, mutations) once they are introduced into the gene pool.[40]

There is a profound danger in discussing the need for "containment" or "quarantine," for purportedly genetically "hygienic" reasons, of in-

[37] Dobzhansky, *Genetics and the Evolutionary Process*, p. 191.

[38] Gorney, *art. cit.*, pp. 308–9.

[39] Neel, *art. cit.*

[40] Joshua Lederberg, "The Amelioration of Genetic Defect—A Case Study in the Application of Biological Technology," *Dimensions* 5 (1971) 13–51.

dividuals who by no fault of their own carry genes which place their offspring in jeopardy.[41] The case for society's concern for the genetic welfare of the population and its rights in opposing sanctions on individuals hinges on the demonstration of a clear and present danger of genetic deterioration, which, as I have indicated, is still forthcoming. Yet, a letter I received from a government official rhetorically equated the potential societal threat of genetic disease with that of a highly contagious bacterial one. An individual carrying a deleterious gene was, according to this analysis, analogous to a "Typhoid Mary." Such an attitude is at best naive, and at worst ominously coercive. To equate a genetic disease with one which can be transmitted from person to person is to fail to recognize the salient difference between the two: genetic diseases are transmissible only to offspring of the same family. Contagious diseases not only enjoy a much wider and rapid currency, but also an often fateful degree of anonymity, as in the faceless patrons of Typhoid Mary's restaurant. Only in the case of *genetic* disease do affected siblings and relatives serve as constant reminders of the fate of a subsequent affected child. Those who would argue that legal sanctions are necessary to protect society against genetic disease fail to recognize the basic reality of the deep and enduring bonds that draw a parent to his child. As Montaigne put it, "I have never seen a father who has failed to claim his child, however mangy or hunchbacked he might be. Not that he does not perceive his defect... but the fact remains the child is his."[42] A father bearing a heritable disorder himself or having experienced a lifetime of suffering in the genetic disability of his child would be the best judge to make the decision to deny life to his subsequent offspring. I know of no such situation (including retinoblastoma) where the decision to procreate or bear children should be the choice of other than the parents. The moral obligations of parents faced with genetic disease are to conscientiously weigh and act based on the prospects for their *children*, not for society at large. Genetic knowledge does not now justify enjoining any family with the societal obligation to refrain from procreation.

THE PERIL OF A GENETIC IMPERATIVE

In spite of the weight of evidence which shows that we do not have sufficient information to predict any but the grossest genetic changes

[41] Margery Shaw, "*De jure* and *de facto* Restrictions on Genetic Counseling," *Proceedings of the Airlie House Conference* on "Ethical Issues in the Application of Human Genetic Knowledge," Oct. 10–14, 1971 (Plenum Press, in preparation).

[42] Michel de Montaigne, "On the Education of Children," *Selected Essays*, tr. D. M. Frame (New York: Van Nostrand, 1943) chap. 26, p. 5.

following individual or population shifts in childbearing habits, the latent fear remains that to do *nothing* will itself lead to an increase in detrimental genes and thereby compound the genetic problem for future generations.[43] Joshua Lederberg has argued that we are so locked into a genetic double bind that we *should* in fact do nothing. He states:

> Our problem is compounded by every humanitarian effort to compensate for a genetic defect, insofar as this shelters the carrier [of the defective gene] from natural selection. So it must be accepted that medicine, even prenatal care which may permit the fragile fetus to survive, already intrudes on the questions of "Who shall live." . . .
>
> It is so difficult to do only good in such matters that we are best off putting our strongest efforts in the prevention of mutation, so as to minimize the heavy moral and other burdens of decision making once the gene pool has been seeded with them.[44]

Certainly, any decision to act or not to act in the face of the dilemmas posed by human genetics is a moral choice. But one does not escape the moral burden of choosing by rationalizing that intrinsic contradictions in relative goods freeze one into inaction.

As Lederberg rightfully observes, the moral contradictions in choices of this sort are never more clearly visible than in the protection of the "fragile" and by inference damaged fetus. In fact, developments in prenatal and postnatal care now make it possible to ensure the survival of infants burdened with spina bifida and meningomyelocoele, spinal abnormalities which were life-limiting before this decade. To the extent that such abnormalities (like cleft palate or harelip) are heritable, there is an ethical question in encouraging the survival and successful procreation of the affected individuals. What is too often ignored in simplistic analyses of this sort is that the increased survival of the defective and deformed is *not* the result of special and sometimes "precious" care of the weak, but rather is usually accomplished as an indirect result of dramatic improvements in health care to *all* infants. As a recent editorial in the British Medical Journal observed, "Indiscriminate lowering of early mortality may impose terrible burdens on the survivors. But for the overwhelming majority of infants, the normal and healthy, there is hope and increasing evidence that the measures which lower mortality tend to produce a corresponding improvement in the quality of life offered them."[45]

Lederberg's course of nonaction is effectively a course of action, and

[43] Bentley Glass, *art. cit.*

[44] Lederberg, "The Amelioration of Genetic Defect," p. 15.

[45] Anonymous, "Early Deaths," *British Medical Journal*, 1971, pp. 315–16.

one which is as morally inacceptable today as bringing newborns to the *Lesch* for sorting and disposal in ancient Sparta. Improvement in prenatal and postnatal care may well encourage the survival of more of those "fragile" and presumably genetically defective fetuses and newborns who would normally succumb, but, as the experience in Britain shows, the cost of that type of action may well be worth paying. Would not mothers in a society which offered the promise of nondiscriminative prenatal and postnatal care feel more secure than one (as in ancient Sparta) in which they knew that their children would be subjected to a test of normalcy? If selective care of only the genetically fit leads to a decrease in the survival of the specific few who are congenitally handicapped, it will be at the cost of a general *increase* in the damage wrought by uterine and early environmental deprivation (e.g., cerebral palsy and mental retardation). That would seem a high price for society to pay for its genetic well-being.

SUMMARY

Our knowledge of genes and genetic systems in man shows them to be too complex to readily lend themselves to controlled manipulation. Deep-seated psychologic needs to reduce uncertainty appear to drive our search for genetic control in spite of this complexity. The need for genetic intervention is today justified on the basis of the same unsubstantiated analysis of "genetic deterioration" that characterized the eugenics movement in the late nineteenth century. The notion of a genetic "burden" imposed on society by individuals carrying deleterious variant genes is a misleading concept: the "burden" of deleterious genes is borne by families, not society. Decisions to have or not have children are best made by parents who have experienced genetic disease in their own families, not by society. Society's obligation is to provide universal maternal and postnatal care, even at the cost of survival of the congenitally handicapped. To do less is both to deprive the healthy of the optimum conditions for their development and to jeopardize the moral tone of society itself.