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Human Evolution by Voluntary Choice of Germ Plasm

This procedure should be more acceptable and effective than differential control over family size.

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For some decades the term *eugenics* has been in such disrepute, as a result of its spurious use in support of the atrocities committed by those with class and race prejudices, that few responsible students of evolution or genetics have dared to contaminate themselves by mentioning it, much less by dealing with the subject except in condemnation. However, it is now high time to take new stock of the situation. For the odious perversions of the subject should not blind us longer to a set of hard truths, and of genuine ethical values concerning human evolution, that cannot be permanently ignored or denied without ultimate disaster. On the other hand, if these truths are duly recognized and given expression in suitable policies, they may open the way to an immeasurable extension and enhancement of the potentialities of human existence.

In view of the signal defeat in World War II of the leading exponents of racism—a defeat which is still gathering momentum—and the declining prestige afforded in the Western world to the claims of aristocratic or bourgeois class differentiations, it at last becomes feasible to return, in a more reasonable spirit, to the theme of prospective human biological evolution. Moreover, for this job of reexamination we are now provided not only with a better understanding of genetic and evolutionary principles but also with a considerably reformed structure in most Western societies, liberalized mores, a heightened freedom of discussion, and a marked improvement in technologies, all of which combine to make possible approaches that earlier would have seemed out of the question.

It was Darwin who pointed out that modern culture is causing a relaxation and perhaps even a reversal of selection for socially desirable traits, and he expressed himself rather pessimistically about the matter, although in his time this process must have been much less pronounced than it is nowadays. His cousin Galton, impressed by Darwin's arguments concerning evolution in general as well as by those pertaining to man, but unwilling to accept defeat or frustration for humanity on this score, proposed the idea that the trend might be counteracted consciously. For this course of action he coined the term *eugenics*, included within which he understood all measures calculated to affect the hereditary constitution in a favorable way. As he pointed out, these measures might be of very diverse kinds, lying not only in such fields as medicine but also in education, economics, public policy in general, and social customs, although he did not contemplate drastic changes from the mores of that Victorian age.

Unfortunately, although Galton realized to some extent the influence of the social and familial environment in the shaping of people's psychological traits, he was not sufficiently aware of the profundity of the environmental control. He therefore made the naive mistake, so widespread in his day, of looking upon the performances of different ethnic, national and social groups as indicative of their genetic capabilities and inclinations, although there were plenty of object lessons of the comparatively rapid transference of cultures that should have taught him better. Later, it was the madness of such out-and-out racists and so-called "social Darwinists" as Madison Grant, Lothrop Stoddard, Eugen Fischer, Lenz (*1*), and the Hitlerites which, carrying these prejudices much further, brought such odium upon the whole concept of eugenics as to run it into the ground.

Meanwhile, a large group of psychologists, represented by the Watson school, and of other social scientists, social reformers, socialists, and communists, all of them persons of egalitarian sympathies, impressed by the enormous potency of educational and other cultural influences, and regarding all eugenics as a dangerous kind of reaction that threatened their own roads to progress, popularized the idea that differences in human faculties are of negligible consequence not only as between different peoples and social classes but even as between individuals of the same group. They held that genetics in man could be allowed to take care of itself. And even where some genetic defects were admitted to exist, it was maintained that improved medical, psychological, and other cultural ministrations would provide sufficient remedies for them. Moreover, added the many Lamarckians among these groups, the improvements thereby acquired would eventually pass into the hereditary constitution. In this way, not only would all men become equalized but they would rise to ever higher

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biological as well as cultural levels. By about 1936 it had become a dire heresy among the official communists to dispute this line of argument, and the word *eugenics* had become a favorite symbol of all that is vile.

It is no wonder that earnest students of evolution and genetics, confronted by the mighty currents of these contending movements, which had advanced into the area of power politics, seeing how intertwined truth and error had become, and aware that their own views would almost certainly be misconstrued, tended to withdraw into their ivory towers and to refuse to discuss seriously the possible applications of genetics to man. It is to their credit, however, that only a few floated with the current that happened to be around them. But even fewer tried to contend with that current by raising the voice of reason, for that way lay the path to martyrdom.

Perhaps the last attempt made, up until the past few months, to present an appraisal of eugenics undistorted by extremist politics was the drafting of the "Geneticists' Manifesto" (*2*) of 1939, signed by about a score of participants at the International Genetics Congress held in Edinburgh just as the curtain began to rise on World War II. In this document it was pointed out that by far the greatest causes of differences between human groups in regard to psychological traits were environmental, predominantly cultural, whereas in the causation of such differences between individuals within the same group, both environmental and genetic factors were very powerful, and often comparable in their potency of action. The need for far-reaching reforms—for affording more nearly equal opportunities to all groups as well as to all individuals and for removing biases—was stressed in this document, not only for the sake of persons directly concerned but also to provide a groundwork for the truer assessment of genetic differences, in the interest of more soundly based eugenics.

These reforms in society were also needed, it was pointed out, for the attainment by the population of a sounder set of values, applicable equally to eugenic and to cultural purposes: values by which active service and creativity would be regarded more highly than either passive submissiveness or self-aggrandizement. The "Geneticists' Manifesto," far from discarding the concept of eugenics per se, acknowledged that it afforded, when rightly used, a means of making far-reaching human progress of a kind that must complement purely cultural advancement. Beyond that, genetic improvement was even affirmed to be a right which future generations would consider those of the past who were aware of the situation as having been obligated to accord them, just as they in turn would consider themselves as being similarly obligated to their own successors. This obligation would not be regarded as a burden, however, but rather as a high privilege and a challenge to their creativity. At the same time, it was recognized that adequate implementation of eugenic policies also required a clearing away of the ancient heritage of superstition and taboos that hitherto had so obstinately enshackled human usages and preconceptions in matters of sex and reproduction.

It is true that our own world of today is still grievously beset with the old inequalities, prejudices, and mummeries. However, all peoples have by now seen the handwriting on the wall that spells the end of these irrationalities. For modern technologies have, on the one hand, made it too dangerous for the world to remain divided. They have, on the other hand, provided the means for achieving an unparalleled interdiffusion of techniques, ideas, personnel, education, and socioeconomic organization, and for raising standards of living. In the process, provincialisms are at last being ground down, though not without much friction. Opportunities, educational, economic, and social, are being extended ever more effectively to the more depressed social classes and ethnic groups in our own country and elsewhere. A real effort is being made to bring the viewpoint of science home to the general population. The battles that superstition is still winning take place ever closer and closer to its heartland, as was so well depicted in the moving picture on the Scopes trial, *Inherit the Wind*. And it is even becoming permissible to debate seriously matters that in the days before nuclear weapons, space ships, Kinsey, and the Darwin centenary were taboo among all nice people.

Thus the scene has at last been shifted to such an extent as to make it fitting to re-examine even such a scandalous subject as eugenics, with a view to preparing the new forces now arising in the world to deal with it both realistically and humanistically. For, as we shall see, cultural progress of the kinds mentioned has already proceeded far enough here and there to make the beginnings of a new approach to the subject possible, and the attitudes now formed and the preparations now made may presently lead, when the time is riper, to more salutary developments in this field than could ever before have occurred.

Contradictions in the Traditional Eugenic Methods

Let us first examine the methods by which it has hitherto been thought that eugenics might operate. These methods have taken their cue from the natural selection of the past. All evolution has had its direction determined in some way by the force of selection. Selection chooses among the materials available to it, namely, diverse mutations, which occur in a manner that is fortuitous so far as their adaptation to the needs of the organism in the given situation is concerned. Selection acts entirely through differential multiplication, but this process can be conceptually divided into two parts, namely, unequal rates of survival (or, conversely stated, of mortality), on the one hand, and unequal rates of reproduction of the survivors, that is, differential fertility (or, conversely stated, differential infertility), on the other hand.

Eugenists have therefore distinguished between two conceivable methods—differential control over mortality, and differential control over reproductive rate. The first method, however, although practiced by the Spartans and by primitive tribes who destroyed infants regarded as undesirable, is universally acknowledged to be inconsistent with the respect for human beings that forms an essential part of civilization. It might be contended that artificial abortion is an intermediate method, but everyone recognizes this also to be an undesirable means where other procedures are available. Essentially, then, this has left for eugenics the second alternative: that of a qualitatively differential control over reproduction prior to or at conception.

In Galton's time, before the advent of modern contraceptive techniques, it was indeed rather visionary to conceive of people's reproduction being governed in the interests of the progeny. For this could be done only

by the drastic method of surgical sterilization, of a type that interfered with the sexual life, or by such consummate self-control as voluntary abstention from intercourse, or from its completion.

The development of techniques for cutting or ligating the tubes that conduct the mature reproductive cells afforded less objectionable means of sterilization, but this procedure was still usually regarded by most people —rightly or wrongly—as too irrevocable, except, perhaps, for persons who were mentally or morally hopelessly irresponsible. For them, enforced operations of this type were legalized in some regions, although it was rightly pointed out that there was grave danger of abuse of the practice unless it were confined to the most extreme cases. For attitudes that seem wrong in one place or setting may seem right elsewhere, and nonconformists may at times have moral standards superior, in a longer perspective, to those of the majority who condemn them. Thus, the amount of sterilization resulting from legal applications of an advisable kind would be so minute as to have very little eugenic influence.

However, the invention of fairly practicable artificial means of voluntary contraception opened up much wider possibilities for the control of reproduction in economically developed countries. As we all know, advantage has been taken of these techniques on a large scale, and they have become one of the indispensable procedures whereby the general standard of living has been so greatly raised. Still more practicable means of contraception seem at last to be on the way, thanks to the efforts of a handful of devoted scientists, and they cannot come too soon, for it is imperative to make similar benefits possible in the less developed regions.

But although contraception that is used for the enhancement of cultural benefits through the control of population quantity is at the same time a *potential* instrument for the improvement of genetic quality, such improvement does not occur unless the contraception is specifically aimed in this direction. To be sure, this purpose might be achieved if the individual couples concerned were to reach their decisions about how many children to have in a highly idealistic spirit, one guided by almost heroic self-criticism and wisdom. We shall presently consider whether or not it is realistic to expect this. A second proposal has been that of altering the economic and social system in such a way that people of higher gifts and greater natural warmth of fellow feeling—that is, the genetically more highly endowed—would be normally led into occupations and modes of life more conducive to having a large family. Conversely, the organization of society which this view would hold to be ideal would tend to lead persons less well endowed to choose, of their own accord, situations in life that would encourage them to expend their energies in other pursuits than reproduction, and would give them less inducement for raising families.

These two approaches, the individual and the societal, are, of course, not mutually exclusive, and most 20th-century eugenists have advocated a combination of the two. But let us examine each of them more closely. First, as regards the individual approach, which is supposedly to be adopted by people in general once they have been well educated in matters of evolution and genetics, it should be acknowledged that people in general can in fact be taught to take pride in making great sacrifices for what they recognize to be a great cause, especially when they win social approval thereby. This has often happened in times of war as well as after social revolution. However, it seems asking almost too much to expect those individuals who are *really* less well equipped than the average, in mentality or disposition, to acknowledge to themselves that they are genetically inferior to their neighbors in these respects, and then to publicly admit this low appraisal of themselves by raising no family at all or a smaller one than normal, especially since at the same time they would often be thwarting a natural urge to achieve the deep fulfillments, accorded to their neighbors, that go with having little ones to care for and bring up. Moreover, those with physical impairments would likewise tend to rationalize the situation, by thinking that they possessed some superior psychological qualities that more than compensated for their physical defects.

In fact, then, the ones most likely to comply with the idea of restraining their own reproduction would be those who had such strong social feelings, such a sense of duty, so high a standard of what is good, so little egotism, and such an urge for objectivity, as actually to lean over backward and so underrate themselves. Thus we would be likely to lose for the next generation much of what might have been its best material.

On the other hand, for many of the really gifted there are often unusual opportunities for achievement, for rich experiences, and for service along other lines than those of bringing up a large family. Hence it would be only human of them, even though they were in sympathy with eugenic ideals, to expend a larger share of their energies in these other ways than does the average man or woman, for whom the home is often both a refuge and the chief stage on which to express leadership. In view of these considerations, it is not at all surprising that eugenic practices of this intentional, personal type, that require a correlation between the size of one's family and one's realistically made appraisal of one's genetic endowments, have made so little headway, even where they were approved theoretically. Thus, even among eugenists themselves, one seldom finds much evidence that these principles are being acted upon.

What, then, about the proposal that our society should introduce features into its structure whereby the more gifted, the abler, and the more socially minded would find conditions more conducive to their raising a large family, while those less capable or relatively antisocial would tend automatically to be deflected from family life? Surely we would not want a dictatorship to institute such a system, for dictators are oftener wrong than right in their decisions. Moreover, their subjects are not able to become truly men, in the all-round sense, and those who shine under such circumstances are not likely to be the wise and the responsible.

Under a democracy, on the other hand, is it not likely that "the common man" will refuse to subject himself to such manipulations? Certainly if the proposal took some such crude form as a subsidy for the raising of children, allotted to those who already occupied better positions or who had scored higher on certain tests, it would rightly be resented and defeated as discriminatory by the great majority. And even if subtler forms of influence were used, such as special aids to family life for those in occupations requiring greater skills, responsibility, or sacrifice, there would soon be a clamor on all sides to have these advantages extended to

every responsible citizen. No, we can hardly use democracy to support any kind of aristocracy. To be sure, ways might eventually be found to reduce the present strong negative correlation between educational or social achievement and size of family, and these would be all to the good. But no major formula is in sight for restoring the greater family size of the fitter, while retaining that most essential feature of our culture—the extension to all of mutual aid based on the most advanced technologies available.

It might seem to follow that we have now, as a result of our improved techniques for living, reached an inescapable genetic cul-de-sac. It might be concluded that we should therefore confine ourselves entirely to the immediate job on hand—the pressing and rewarding one of all social reformers and educators — that of making the best of human nature as it is, the while allowing it to slide genetically downhill, at an almost imperceptible pace in terms of our mortal time scale, hoping trustfully for some miracle in the future.

The New Approach: Germ-Cell Choice

However, it is man who has made the greatest miracles of any species, and he has overcome difficulties arising from his technologies by means of still better basic science, issuing in still better technologies. And so in the case of the genetic cul-de-sac of the present day, he has even now possessed himself of the means of breaking through it. For he is no longer limited, like species of the past which had the family system, to the two original methods of genetic selection applying to them: that of differential death rate on the one hand, and differential birth rate or family size, on the other hand. He has now given himself, in addition, the possibility of exerting conscious selection by making his own choice of the source of the germ cells from which the children of his family are to be derived (*3–5*). At present, this choice is confined to the male germ cells, but there are indications that with a comparatively small amount of research it might in some degree be extended to those of the female as well.

It is pretty common knowledge nowadays that some tens of thousands of babies have already been born, in the United States alone, that were derived by "AID," that is, by artificial insemination with sperm obtained by the physician from a donor chosen by him, but whose identity was kept unknown to all others, including even the parents. In the great majority of these cases the husband had been found to be irremediably sterile. And although, in view of the prevalence of the traditional mores, the whole matter was kept secret from the children themselves, both members of the couple had in these cases been eager to avail themselves of this opportunity to have one or more children. This method has, of course, been allowed only to those likely to make good parents—or, shall we say, good "love parents," as distinguished from "gene parents"? Moreover, follow-up studies have shown that these parents did truly love their children, as the children did their parents. It is noteworthy that this proved to be as much the case for the father as for the mother, and that the marriage was strengthened thereby.

Here, then, we see repeated what is typically found in those cases of early adoption in which the children have been genuinely desired. However, this "pre-adoption" (as Julian Huxley has termed it) is likely to prove even more binding and satisfying than "post-adoption." And the method of pre-adoptional choice, despite its relative crudity at the present time, has demonstrated its capability of producing a superior lot of children. Thus, the couples that practice it have made a virtue of necessity by inducing the genesis of children of whom they can usually be even prouder than of the children they would have had if they had been free from reproductive infirmity.

Recently, as more people have become alive to matters of genetics, an increasing number of couples have resorted to AID when the husband, although not sterile, was afflicted with some probably genetic impairment, or likely to carry such an impairment that had been found in his immediate family. Similarly, those with incompatabilities in blood antigens have also made use of the method with good results. In these ways a beginning has already been made in the conscious selection of germinal material for the benefit of the progeny. It is to be expected that many more people will seek such advantages for their prospective children when there are available for creating them the germ cells of persons who are decidedly superior in endowment to the normally healthy and capable persons that are commonly sought as donors by the physicians of today. For there is no physical, legal, or moral reason why the sources of the germ cells used should not represent the germinal capital of the most truly outstanding and eminently worthy personalities known, those who have demonstrated exceptional endowments of the very types most highly regarded by the couple concerned, and whose relatives also have tended to show these traits to a higher-than-average degree. How happy and proud many couples would be to have in their own family, to love and bring up as their own, children with such built-in promise.

Today, of course, most people have such an egotistical, individualistic feeling of special proprietorship and prerogative attaching to the thought of their own genetic material as to be offended at the suggestion that they might engage in such a procedure. No one proposes that they do so as long as they feel this way about the matter. However, they should not try to prevent others who would welcome such an opportunity from ordering their lives in accord with their own ideals. And as the prejudice against the practice gradually dwindles, the manifest value of the results for those who had participated in it would appeal to an increasingly large portion of the population.

In this connection it is important to bear in mind that there is no such thing as a paternal instinct in the sense of an inherent pride in one's own genetic material or stirps. Some primitive peoples, even including a few still in existence in widely separate regions, have had, strange as it may seem to us, no knowledge that the male plays a role in the production of the child, much less have they had any conception of genetic material or genes. Thus, among some of them the mother's brother has effectively filled the role of father in regularly caring for mother and children. Moreover, among some peoples, such as the Hawaiians, children are rather freely adopted at an early age into other families, into whose bosom they are warmly, fully, and unambiguously accepted as equals in every way to the natural children. It is "second nature," but not "first nature," for us in our society to exalt our own stirps.

It is, however, "first nature" for

men and women to be fond of children and to want to care for them, and more especially, those children with whom they have become closely associated and who are dependent on them. If the love of a man for his dog, and vice versa, can go to such happy lengths as it often does, how much stronger does the bond normally become between the older and younger generations of human beings who live together. And since, in the past, the children *have* usually been those of the parents' own stirps, it has been a natural mistake to suppose that these stirps, rather than the human associations of daily life, formed the chief basis of the psychological bonds that existed between parent and child. Yet, as our illustrations have shown, this view is incorrect, and a family life of deep fulfillment can just as well develop where it is realized that the genetic connection lies only in our common humanity.

The wider adoption of the method of having children of chosen genetic material rather than of the genetic material fate has chanced to confer on the parents themselves implies, of course, that material from outstanding sources become available by having it stored in suitable banks (*3, 6, 7*). It would be preferable to have it in that glycerinized, deep-frozen condition developed by modern technology, in which it remains unchanged for an unlimited period without deterioration. It is true that research is badly needed for finding methods by which immature germinal tissue can, after the deep-freezing which it is known to survive, be restored to a state where it will multiply in vitro and subsequently produce an unlimited number of mature reproductive cells. Even without this further development, however, the way is already open, so far as purely biological considerations are concerned, for gathering and inexpensively storing copious reserves of that most precious of all treasures: the germinal material that has formed the biological basis of those human values that we hold in highest regard.

The high potential service to humanity represented by the pre-adoption of children should carry with it the privilege, for the parents, of having a major voice in choosing from what source their adopted material is to be derived. Surely, if they have ever had the right to produce, willy-nilly, the children that would fall to their lot as a result of natural circumstances, they should have the right of choice where they elect to depart from that haphazard method. They certainly would not wish knowingly to propagate manifest defectives, and, being idealistic enough to undertake this service at all, they would in most cases be glad to give serious consideration to the best available assessments of the genetic probabilities involved, as well as be open to advice regarding relative values and needs.

It would be made clear to parents that there is always an enormous amount of uncertainty concerning the outcome in the genetics of an organism so crossbreeding as man, especially since the most important traits of man are so greatly influenced by his cultural environment. Nevertheless, facing this, they would realize that the degree of promise was in any such case far greater than for those who followed the traditional course. It would be in full awareness of this situation that they would exercise their privilege of casting the *loaded* dice of their own choosing.

This kind of choice means that the physician can no longer be the sole arbiter of destiny in this matter. Clearly, if the couple are to accept their share of the responsibility and privilege here involved, the practice of keeping the donor unknown to them must be relinquished in these cases. Knowledge of the child's genetic lineage will also be needed later, so that sounder judgments may be reached concerning his genetic potentialities in the production of the generation to follow his own. This lifting of the veil of secrecy will become ever more practicable, and in fact even necessary, as the having of children by chosen genetic material becomes more widely accepted and therefore more frequent. Moreover, the attitude of others toward the couples who have employed this means of having their children will gradually become one of increasing acceptance and then of approbation and even honor.

Today's fear that knowledge by the mother of the identity of the gene father may lead to personal involvement between the two, to the detriment of normal family life, will recede when the gene source is remote in space or time, as when the germinal material has been kept in the deep-frozen state for decades. This procedure will also allow both the individual worth of those being considered as donors, and their latent genetic potentials, to be viewed in better perspective, and will reduce the danger that choices will be based on hasty judgments, swayed by the fads and fashions of the moment.

Let us see in what ways this method of reproduction from chosen material tends to avoid the difficulties that are encountered in attempting to reconcile traditional reproduction with the interests of genetic quality by somehow controlling the size of families. For one thing, as previously pointed out, most men would resist accepting and acting on the conclusion that they are below their next-door neighbor, or below average, in genetic quality. They would particularly resist the idea that they themselves are in that lowest fifth which would be required to refrain from having children if an equilibrium of genetic quality were to be maintained in the face of a 20-percent mutation rate. Yet most of these same people would willingly accept without resentment the idea that they are not among the truly exceptional who conform most closely to their own ideals. And so, when encouraged by the community mores, they would be glad and proud to have at least one of their children derived, by choices of their own, from among such sources. Thus they would continue to have families of a size more nearly conforming with their inclinations.

On the other hand, the worthy but humble, those who might otherwise, from overconscientiousness, limit their families unduly, would often be eager to serve as love parents. And although in that capacity they would tend to derive the germ cells from outside sources, they would be especially likely to have a well developed sense of values and so to choose sources even worthier than themselves. Finally, the really highly endowed but realistic would not be confronted with the sore dilemma of choosing between exercising their special gifts, on the one hand, or having the large family to which genetic duty seemed to obligate them, on the other hand. For their germinal material would tend to be sought by others, if not in their own generation, then later, and to a degree more or less in proportion to their achievements. Thus they would be freed to give their best services in whatever directions they elected.

In all these ways, the diverse ob-

stacles encountered by a eugenics that tried to function by means of a consciously differential birth rate—that is, by adjustment of family size—would be avoided. Thereby, a salutary separation would be effected between three functions that often have conflicting needs today. These are, first, the choice of a conjugal partner; this should be determined primarily by sexual love, companionability, and compatible mentality and interests. Second, there is the determination of the size of the family; this should depend largely on the degree of parental love that the partners have, and on how successfully they can express it. Third, there is the promotion of genetic quality, both in general and in given particulars; these qualities are often very little connected with the first two kinds of specifications. By thus freeing these three major functions from each other, all of them can be far better fulfilled. Under these circumstances the conjugal partners need not be chosen by criteria in which a compromise is sought between the natural feelings and considerations of eugenics. Neither need the family size be restricted or expanded according to eugenic forebodings or feelings of duty. Yet at the same time there can be a far more effective differential multiplication of worthy genetic material than in any other humanly feasible way.

Further Prospects

It is likely that the avoidance of the effects of sterility will not be the only door through which such a change of mores will be approached. Facilities for keeping germ cells, suitably stored below ground in a deep-frozen condition, in areas relatively free from radiation and chemical mutagens, may well be provided in our generation for an increasing number of people (*8*). Among these would be persons subject to the growing radiation hazards of industry, commerce, war, and space flight, and those exposed to the as yet unassessed hazards of the chemical mutagens of modern life. The same means would greatly retard the accumulation of spontaneous mutations which probably occurs during ordinary aging. Thus, wives may in time demand such facilities for the storage of their husbands' sperm. These facilities would be provided not only for the sake of reducing mutational damage but also as a kind of insurance in the event of the husband's death or sterility. In these ways great banks of germinal material would eventually become available. They would be increasingly used not only as originally intended but also for purposes of conscious choice. Moreover, some of these stocks might become recognized as especially worthy only after those who had supplied them had passed away.

The cost of storage is, relatively, so small that failure to make such a provision will eventually be considered gross negligence. As Calvin Kline (*7*) points out, this will be especially the case where (as in India today) voluntary vasectomy becomes more prevalent as the surest and, in the end, the cheapest means of birth control. For when vasectomy is complemented by stores of sperm kept in vitro, the process of procreation thereby achieves its highest degree of control—control not subject to the impulses of the moment but only to more considered decisions.

It is true that most people's values, in any existing society, are not yet well enough developed for them to be trusted to make wise decisions of the kind needed for raising themselves by their bootstraps, as it were (*9*). But this type of genetic therapy, of "eutelegenesis," as Brewer termed it when he advocated it in 1935 (*4*), is certainly not going to spring into existence full fledged overnight. It will first be taken up by tiny groups of the most idealistic, humanistic, and at the same time realistic persons, who will tend to have especially well developed values. This mode of origination of such practices was pointed out by Weinstein in "Palamedes" in 1932 (*10*). These groups will tend to emphasize the most basic values that are distinctive of man, those that have raised him so far already, but which still may be enormously enhanced. Foremost among these are depth and scope of intelligence, curiosity, genuineness and warmth of fellow feeling, the feeling of oneness with others, joy in life and in achievement, keenness of appreciation, facility in expression, and creativity.

Those who follow these lodestars will blaze the trail, and others will follow and widen this trail as the results achieved provide the test of the correctness with which its direction was chosen. Meanwhile, the world in general, through its reorganizations of society and education, is moving in the same direction, by a de-emphasis of its provincialisms and a consequent recognition of the supreme worth of these basic human values. For after all, these values have been prominent in the major ethical systems of the whole world.

At the same time, plenty of diversity will inevitably be developed. For each especially interested group will naturally seek to enhance its particular proclivities, and this is all to the good. But on the whole, the major gifts of man have been found to be not antagonistic but correlated. Thus we may look forward to their eventual union with one another in a higher synthesis. And from each such synthesis in turn, divergent branches will always be budding out, to merge once more on ever higher levels.

It may be objected that we have next to no knowledge of the genes for those traits we value most, and that their effects are inextricably interwoven with those of environment. As was acknowledged earlier, this is quite true. However, it has also been true in all the natural selection of the past and in the great bulk of artificial selection. Yet these empirical procedures, based entirely on the accomplishment of the individuals concerned, did work amazingly well. We can do a good deal better by also taking advantage of the evidence from relatives and progeny. Yet that evidence also is furnished mainly by accomplishments or output. Where those were high, the environment was, to be sure, usually favorable, but so was the heredity. And as, in our human culture, social reform proceeds and opportunities become better distributed, our genetic judgments will become ever less obscured by environmental biases, while at the same time our knowledge of genes will improve.

Meanwhile, the efforts of educators and the lessons of world affairs will serve to emphasize the same values for us. And these attitudes we will take over for our genetic judgments also. In this connection, another consideration deserves mention here. The preference which most parents will inevitably have for the genes of persons of truly remarkable achievement and character, rather than for those of the merely eminent or powerful, will at the same time serve to direct the stream of genetic progress toward the factors underlying creativity, initiative, originality, and independence of thought, on the one hand, and toward genuineness of human relations and affections, on the other hand. Otherwise the genetic movement might, as so often happens in other affairs of men, become directed

toward skill at conformity, showmanship, and the dignified hypocrisy that often brings mundane success and high position (*9*, *10*). This would have been a far greater danger in the case of the old-style eugenics.

But, it may be objected, does all this really represent conscious control in an over-all sense? Is it not merely a type of floating along in a chaotic manner, each straw making its own little movement independently of the rest, without a general plan or goal or stream? The answer is that humanity is as yet too limited in knowledge and imagination, too undeveloped in values, to see more than about one step ahead at a time. That step, however, can be discerned clearly enough, and by enough people, to give rise to a general trend in a salutary direction. And at the higher level to which each step taken will bring us we will be able to see an increasing measure of advance ahead. So we humans will achieve, not through dictation but through better general understanding and ever more clearly seen values, increasing mutual consent both concerning the means to be used and the aims toward which to orient. Thus an ever wider over-all view will emerge, and a surer, greater over-all plan, or rather, series of plans. To create them and to put them into effect will then enlist our willing efforts. And the very enjoyment of their fruits will bring us further forward in our great common endeavor: that of consciously controlling human evolution in the deeper interests of man himself (*11*).

References and Notes

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Optical Rotatory Dispersion

Investigation of the phenomenon 140 years after its discovery sheds light on problems of organic chemistry.

Carl Djerassi

The organic chemist, notably the investigator in the natural products field, has always been very ready to use new physical tools for the solution of his problems. Nowadays, it is difficult to conceive of modern organic chemical research being conducted without the use of ultraviolet, infrared, or nuclear magnetic resonance spectroscopy, and it is profitable to consider for a moment how these tools became acceptable to the organic chemist. Invariably, the initial discovery was made by the physicist or physical chemist, who was usually concerned only with the phenomenon itself, rather than with its application to the more mundane everyday problems of the organic chemical research laboratory. Application in the laboratory of the organic chemist occurred only when instrumentation became sufficiently advanced or simplified so that a relatively large number of measurements could be conducted on organic compounds. These measurements then lent themselves to empirical correlation with some structural feature of the organic molecule, and this invariably led to two developments—one, a rapid acceptance by other organic chemists, with a consequent enormous increase in the number of measurements and hence refinements in empirical correlation, and the other, a revival (or continuation) of interest in the theoretical aspects of this particular tool and a more fundamental explanation of the generalities uncovered by the semiempirical studies of the laboratory chemist.

This has been the history of virtually all physical methods which have found a temporary or a permanent place in organic and biochemical research; only the time lag between the initial physical discovery and the first widespread use by the organic chemist has differed. For instance, in the field of infrared spectroscopy, this interval amounted to approximately 40 years, while less than a dozen years intervened between the discovery of the nuclear magnetic resonance phenomenon and its extremely wide use in organic chemistry.

Early Studies

The development of optical rotatory dispersion followed precisely the same path, except that nearly 140 years elapsed between the original discovery by Biot (*1*) of the change of optical rotation of quartz with wavelength and the actual application of this general phenomenon to organic chemical problems (*2*). In the interval, a substantial amount of research in this area was conducted largely by physical chemists, and reviews (*3*) by three of the pioneers—Lowry, Levene, and Kuhn—show on the whole a rather understandable preoccupation with theoretical aspects of optical rotation and rotatory dispersion. During this entire period, up to around 1954, considerably less than 100 optical rotatory-dispersion curves had been recorded in the ultraviolet region of the spectrum, principally because of the instrumental difficulties involved in such studies. Indeed, between the 1930's—when experimental work by these three

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