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Genetic Engineering: How Great Is the Danger?

Public concern over the potential dangers of genetic engineering in man now seems likely to be activated again, since a recent statement of a committee of the National Academy of Sciences* has brought to public attention the definite dangers of genetic engineering in bacteria.

Two major categories of genetic engineering in man may be envisaged. One, aimed at replacing defective genes, has given rise to fear that the technique would be used not only to cure disease but also to modify peoples' natures. Indeed, the prospect of parents shopping in a genetic supermarket, or of a tyrant specifying the genes in his subjects, would be harrowing. But for a realistic assessment of these dangers the distinction between single-gene traits and polygenic traits is crucial. The former depend on a single definable gene, with a recognizable qualitative effect (for example, the presence or absence of particular protein, such as sickle cell hemoglobin). In contrast, polygenic traits (for example, size and shape, strength and dexterity, intelligence and special talents, features of temperament), which are socially much more interesting, show a continuous range of variation, because they depend on the sum of the small contributions of many genes interacting with many environmental factors.

The contrast in our knowledge of these two classes of traits is enormous. The success of molecular genetics has been confined to single-gene traits. For any behavioral trait we know only that many genes are involved: we have no idea how their products contribute to the circuitry of the 10 billion cells of the developing human brain. Moreover, we cannot identify *one* gene or protein whose variation contributes to the normal range of behavior, though we would need such information for many genes before we could try to modify behavior by manipulating DNA.

This vast ignorance about polygenic traits protects us against the main possibilities of harm from gene replacements. On the other hand, the possibilities for good are enormous, with increasing recognition of single genes that influence many aspects of man's health (such as specific immune responses). Hence it would be tragic to discourage efforts to overcome the technical obstacles—and these are still large.

The other major category of gene manipulation is the production of an exact gene copy of an individual. Such cloning, already accomplished with frogs, seems likely to become feasible in mammals fairly soon, and in a world facing severe food shortages the incentive to clone prize cattle will be strong. Extension to humans would indeed have grave and novel moral implications. But the dangers are hardly terrifying. If human cloning becomes feasible, and if it is then proscribed, an occasional violation would not shake the heavens. Moreover, if a tyrant wished to develop a particular kind of population he would not need cloning but could employ selective breeding, as used in animal husbandry since neolithic times.

Genetic engineering presents quite different problems in man and in bacteria. With bacteria the moral issues are simple. With man the moral issues are novel, and the problem is a general one for society. But since we cannot predict when a particular kind of manipulation may become feasible, and since moral standards and social needs change with time, it would be presumptuous for us to try to guide future generations by our present wisdom.

It seems important for scientists to help the public to sort out these complex issues and avoid anxiety over improbable or distant developments. Such anxiety could lead to pruning of valuable major limbs on the tree of knowledge, rather than of branches with dangerous fruit.

—BERNARD D. DAVIS, *Bacterial Physiology Unit, Harvard Medical School, Boston, Massachusetts 02115*

* P. Berg, D. Baltimore, H. W. Boyer, S. N. Cohen, R. W. Davis, D. S. Hogness, D. Nathans, R. Roblin, J. D. Watson, S. Weissman, N. D. Zinder, *Science* **185**, 303 (1974).