SCIENCE

5 JUNE 1987
VOLUME 236
NUMBER 4805

Frontiers in Recombinant DNA

A cartoon in the *New Yorker* shows an aristocratic dowager in a Chippendale chair looking up from her newspaper and saying to her patrician-looking husband, "Dear, are they tampering with *our* genes?" Such vague worry that the young Turks of DNA may not only inadvertently create pestilence, war, and famine but may even invade the regions of good taste is prevalent in the general public. To the cognoscenti these worries are remote but not absurd; yet they rush on. If there is even the remotest chance of some misuse, should one not slow down and proceed with great caution?

The answer is that, in fact, fuller understanding of the DNA methods has revealed the areas in which caution must be applied as well as the power of this research tool. The sweep of subjects in which recombinant DNA has provided breakthroughs is incredible. In this issue a few of many examples are selected to show how it has been applied to the understanding of learning, development, diagnosis of disease, stimulation of colony growth, generation of new plant foods, design of new catalysts, and the switching on of genes and viruses. Although the applications described here relate to these fundamental biological processes, the potential for practical applications is clear.

Maniatis *et al.* describe a research area that has moved with lightning speed, but still leaves many mysteries. The role of promoters and enhancers in turning on and turning off gene expression and the apparent crazy quilt pattern of upstream and downstream elements could never have been unraveled by classical genetics. Gehring illuminates a phenomenon that was initially revealed by classical genetics: the homeotic genes, mutations in which cause legs to grow out of the heads of flies. By recombinant DNA studies the homeo gene has led to new understanding of morphological development. Cocking and Davey describe the breach of a new barrier—the cereals—previously resistant to the techniques that allowed genetic engineering of other types of plants. Clark and Kamen discuss the application of recombinant DNA techniques to the elusive elements that stimulate cell growth, the colony-stimulating factors. Caskey outlines recombinant DNA procedures that can lead to the identification of molecular defects accounting for heritable diseases and acquired neoplasia in *Homo sapiens*, and Black *et al.* describe the application to one of the most difficult experimental challenges, the understanding of the molecular events in learning and memory. Knowles tells of the application of genetic engineering to the vital catalysts that control all dynamic biological processes—the enzymes.

The intellectual excitement of rapid progress in some of the most vital problems in biology is, by itself, an enormous stimulus; but in each case practical applications are almost at hand. The prospect of an age of designer catalysts, of quick medical diagnosis of genetic defects, of new cereals for starving millions, and of brain therapy in neurological diseases is another spur to progress in these already rapidly advancing areas.

Biologists asked for a moratorium to assess risks in the initial days of recombinant DNA. How is it, now that the tools appear to be more powerful than was expected then, that there can be confidence that these experiments no longer threaten humankind? The answer has two parts. First, much is now known about the events that lead to uncontrolled growth of cells and about the safe application of recombinant DNA. Second, experiments have revealed that genetic engineering has been occurring in nature for eons without catastrophic consequences. Recombination in vivo results in events such as attachment of the hind end of one protein to the front end of another. Nature's genetic engineering through selection is much slower than modern laboratory manipulation, but it has been going on for billions of years. That fact can not only induce some humility in molecular biologists but also ease some fears of onlookers.

Ecological and moral dilemmas created by these new technologies are appreciable and will require new ideas. Tampering with the mind is generally considered to be bad, but should genetic engineering to alleviate Alzheimer's disease be outlawed? To feed starving populations is desirable, but if new crops help add a billion people to a crowded globe, is that necessarily good? The powerful new methods are here. Applying them may well require the use of brain enhancers.—DANIEL E. KOSHLAND, JR.