

ceptions, will not yield to treatment with diets or drugs. In some of these cases gene therapy appears to be the only hope.

If foreign cells were not rejected, one could modify the genetic makeup of a tissue by transplanting cells or organs from a normal person into a person with a hereditary disease. Such transplantation of erythropoietic cells or whole organs has been successfully performed in inbred mice. In humans, however, transplants are rejected in almost all cases (except identical twins). But one could take cells from the sick person, genetically transform them (by reversion, isolated DNA, virus transduction, cell fusion, and so forth) into cells expressing the normal genetic information, grow a larger number of them in tissue culture, and then return them to the donor. One would hope that their surface antigens would not have changed by this manipulation. (For polygenic diseases replacement of one defective gene by a normal one may be sufficient.) Or one could use certain

artificial transducing viruses to treat the patient directly. Recent discoveries have made it probable that transfer of specific genetic information in humans will be feasible within one or two decades. This gene therapy would be initially useful only for mobile multiplying cells (such as those in bone marrow). But when more is known about the differentiation of cells, the replacement of other cell types, which can still multiply in the adult, may become feasible (for example, liver).

The possibilities and potential hazards of gene therapy were the subjects of the conference. Several speakers presented evidence indicating that human cells can express some genetic information contained in the DNA or RNA of animal or bacterial viruses and that the transferred information can be inherited from cell to cell. It is even feasible to link desirable genetic information to a nonpathogenic virus DNA and convey it by a virus into the cell. Furthermore, genetically normal human DNA can be taken up by human cells either di-

rectly or packaged into a virus coat, or whole chromosomes can be transferred via cell fusion. It is still not clear which conditions are necessary to allow the replication of the transferred DNA. Instead of transferring normal genetic information, one could possibly subject tissue cultures of deficient cells to mutations and isolate revertants that have regained the normal biochemical property. In principle, it would even be possible to manipulate eggs or sperms genetically, or to produce chimeras by mixing blastocysts, but these possibilities have been disapproved because they would create many new problems and possibly increase, or at least perpetuate, undesirable mutations in the population.

A detailed summary of the meeting will be printed by NIH and can be obtained from the Fogarty International Center, National Institutes of Health, Bethesda, Maryland 20014.

ERNST FREESE

*Laboratory of Molecular Biology,
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