

research was the pursuit of gene maps as scientific tools to conquer disease, but economic development was an explicit, if subsidiary, goal.

The genome project results from the confluence of tributaries that course through many provinces. The technical conception of the genome project derives mainly from precedents in molecular biology, but the story contains other major elements — the advance and dissemination of information technology, restructuring of the science bureaucracy, and increasing participation by commercial organizations. One way to trace these origins is to recount phases in the development of the genome project: how it got started, how it was redefined, and how it is now progressing. The history can be roughly divided into four stages: origins of the idea for a human genome project (the genesis), redefinition of its goals (a period of ideological conflict never completely resolved), emergence into a bureaucracy in the United States and several other nations (the Watson era), and transformation into a government-industry enterprise (still in progress).

### **Origins of the Idea**

The genome project now embraces three main technical goals: (1) genetic linkage maps to trace the inheritance of chromosome regions through pedigrees; (2) physical maps of large chromosome regions, to enable the direct study of DNA structure in search of genes; and (3) substantial DNA sequence information, enabling the correlation of DNA changes with alterations in biological function. If history were logical, then the genome project would have grown from a discussion of each in turn, and how to bring them together into a coherent plan. History is not logical, however, and it was DNA sequencing technology rather than genetic linkage mapping that gave rise to the idea of a human genome project.

Three individuals independently came upon the idea of sequencing the human genome, that is, deriving the order of DNA bases comprising all human chromosomes. (Actually, this will, like other biological maps, be a composite or reference genome, as there is inherent variation