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Genome Delight

This has been a busy year for the Human Genome Project. Increasingly, researchers sense that many of the project's goals, which seemed grandiose when they were first proposed, are now realistic. The research presented in this issue of *Science* exemplifies some of the best and most exciting advances in genome research.

The X chromosome is a focus of major research activity because it is the location of a myriad of genes responsible for disorders including muscular dystrophy and various forms of mental retardation. The current tally of disease-related genes mapped on this chromosome alone is 111. At the center of this issue is a wall chart that shows the progress that has been made in genetic and physical mapping over the entire X chromosome. The wall chart was prepared and reviewed by Jean-Louis Mandel and an international group of investigators. The table of disease-related genes on the X chromosome not only illustrates how much has been accomplished in cloning and characterizing such genes, but also points out some of the hot genes that are sure to be mapped in the near future. A second table, assembled by scientists at the Genome Data Base and GenBank, presents an update of research on all the human chromosomes. Strategies for mapping and their application to the isolation and characterization of disease-related genes on the X chromosome as well as to questions of chromosome inactivation and molecular evolution are discussed in the article by Mandel *et al.* that accompanies the chart.

For the Human Genome Project to proceed efficiently, there must be cooperation among a large and (not unexpectedly) competitive group of scientists. The article by the NIH/CEPH Collaborative Mapping Group (representing research coordinated by the National Institutes of Health in the United States and the Centre d'Étude du Polymorphisme Humain in France) provides the fruits of an extraordinary collaboration among more than 100 authors to generate genetic linkage maps for 23 chromosomes. The map of each chromosome represents the compilation of many independently generated maps in one accessible format. To provide the best resource for the scientific community, we are publishing, as an appendix at the back of the issue, a table summarizing characteristics and relevant citations for the markers used to build the maps.

The two Research Articles from David Page and his collaborators show that outstanding research accomplishments do not require enormous laboratories. They describe the physical mapping of the Y chromosome by deletion mapping and by assembly of large fragments of Y DNA. This landmark achievement will open a door to understanding human evolution, the development of the Y chromosome, and the basis for abnormalities in the Y. These articles and related scientific advances are explored by Leslie Roberts in the Research News section.

The genetic and physical maps being generated, and the sequence information that is to come, are tools that will be used to pry out the genetic components of complex diseases such as cancer and heart disease. The potential exists to develop preventive strategies and therapies for genetically inherited diseases.

Genome maps will also be used to answer fundamental biological questions. Once genes have been mapped along the chromosome it will be possible to determine the functional or evolutionary significance of their relative locations. Christine Farr and Peter Goodfellow have contributed a Perspective in which they explore the hidden messages that have already been found in genetic maps. The Reports section contains papers dealing with other applications of genome technology.

However, technological, economic, and political problems still must be faced before the potential of the project can be realized. An ongoing challenge is to handle the flood of data being generated in a manner that will allow a rapid, unimpeded flow of information in the most user-friendly form. Although technological advances are being made that will decrease the costs of the genome project, the global economic situation is influencing strategic planning. Peter Aldhous in the Research News section discusses some of the problems that have beset the genome project in France.

A banquet of genome-related research and issues has been laid out before you in the pages of *Science* this week. Enjoy!

Barbara R. Jasny