BOOK REVIEWS

Fervors, Fears, and Manageable Realities

The Code of Codes. Scientific and Social Issues in the Human Genome Project. DANIEL J. KEVLES and LEROY HOOD, Eds. Harvard University Press, Cambridge, MA, 1992. x, 397 pp., illus. $29.95.

The Human Genome Project (HGP) was initially promoted as an American enterprise designed to revitalize the biological branch of the Department of Energy. Though it encountered wide opposition from within the scientific community, its promise of dramatic benefits and a definite timetable proved politically irresistible, and the criticisms have gradually become muted. This collection of essays expounds the project for a general audience and addresses some of the criticisms, though not all.

After starting with a history of eugenics—a movement whose possible revival haunts the book—Kevles describes some interesting details in the evolution of the HGP. These include the role of Senator Pete Domenici, "worried about the fate of [the DOE national weapons] laboratories should peace break out"; the negotiations with the NIH; and the growing international involvement, with a strong influence of the Green political parties on ethical issues. Historian Horace Judson reviews succinctly the progression from classical through biochemical and microbial genetics to molecular genetics. Other chapters by experts describe the current techniques, prospects, and challenges of DNA mapping and sequencing and the medical and forensic applications.

Walter Gilbert's extremely reductionist view of the future of biology is further expounded here in a chapter entitled "The vision of the grail." The other authors (except for Kevles) do not use this metaphor for the HGP—though the chapter by James Watson conveys a similar fervor in other rhetoric. But such a dismissive attitude of molecular geneticists toward other fields is not new.

Gilbert subsequently offers interesting predictions about various features of the genome and about the revolutionary impact of the project on the nature of future research. He speculates that comparison of enough protein sequences and structures will solve the problem of protein folding within a few years. Moreover, similar comparative studies will do the same for the problems of deducing the place, time, and regulation of gene function from sequence. (He does not, however, consider the possibility that in the latter project imbalance in supporting research at the two levels could delay success.) Finally, Gilbert calls attention to what will surely be one of the most important eventual consequences of understanding the human genome: the detailed specification of the genetic diversity within our species, in behavioral as well as in other traits. The inevitable resistance to such socially touchy information is seen elsewhere in this volume.

Watson's chapter is for me the most important one in the book, for it recommends substantial changes in the program. For example, early criticisms have emphasized that the real goal of the HGP is not sequence per se but sequence related to function, and many scientists have wondered why research proceeding from sequence to function should be funded so much more generously than that proceeding in the opposite direction, starting from a copy DNA (cDNA) whose site of action is already known. Watson states that the HGP will now fund grants for detection of rare cDNAs. Similarly, in an entity as large as the genome it is not obvious why identifying the last nucleotide should be regarded as a major scientific goal; and Watson now expresses ambivalence. He states that getting 98% of the functional regions will probably be the end of the project, and it would be wasteful to sequence things that probably contain little information. But he doubts that the cDNA approach will be able to find most of the genes, and so it will be necessary to sequence the whole genome.

Another statement by Watson, in the candid tradition of *The Double Helix*, throws a good deal of light on a major source of controversy, the 15-year deadline. The rationale is no longer the need to give those slaving on its repetitive tasks the chance to see the final fruits. Instead, "to me it is crucial that we get the human genome now rather than twenty years from now, because I might be dead then and I don't want to miss out on learning *how life works*" (emphasis added).

After the chapters on the science, over one-third of the book is devoted to issues of ethics, law, and society. These chapters reflect the frequent differences in the attitudes of natural and of social scientists. In their contributions, human genetics advocate Nancy Wexler and law professor Henry Greely consider in a balanced way how we can use detailed information about health risks without jeopardizing human rights. Other authors, however, present definite conclusions or grave apprehensions based on personal values or ideological convictions. In particular, Ruth Schwartz Cowan builds on a feminist ethics, expounding concerns about prenatal diagnosis, and Dorothy Nelkin mistrusts the use of any tests in our society. Evelyn Fox Keller, rebutting the reductionism of Gilbert, sees deep and threatening cultural currents and motives arising from medical applications of our growing knowledge of genetics. But I am sure most scientists see mostly problems that we will have to manage—as we have done in the past with new concepts and technologies.

In a reflective final chapter the editors summarize accurately the main criticisms of the HGP. Rejecting the charge that it competes excessively with the funding of new NIH grants, they note that several additional factors contributed heavily to the crisis in this funding, which unfortunately arose just when the HGP was expanding explosively. These factors include the longer-term grants awarded in recent years, the increasing cost of research, a doubling in the number of Ph.D.s in biology in a decade, and the $800-million appropriation for AIDS research in 1991.

Responding also to the charge that the HGP is "Big Science," the editors note that it awards many individual grants and is a coordinated program focusing heavily on interdisciplinary approaches and on developing methods, quite different from the big science in physics centered on a big instrument. Nevertheless, by my calculation the initial goal for the HGP (including the DOE part), $200 million a year, is about 5% of the total NIH extramural budget—approximately the budget of the National Institute of General Medical Sciences, which funds much of the most basic biomedical research.

The editors suggest that the real issues threatening the project are economic—at the moment mostly patents—and social. They blow hot and cold about eugenic temptations and the danger of public reactions, and Watson expresses even deeper concern about public fear of the information we will find. But he may be excessively apprehensive. We have seen that the prophets of doom have slowed, but not stopped, the applications of genetic engineering of lower organisms in industry and agriculture. The benefits of the HGP for

health, with greater emotional appeal, will no doubt provide an even stronger bulwark. Meanwhile, Watson's decision to devote 3% of the NIH portion of the HGP (and perhaps even more) to studies on ethics is admirable and politically shrewd—though support on this scale may soon exhaust the number of philosophers with fresh ideas to add.

Where do we now stand? The main issue is one of scale, at a time when many promising young investigators cannot be funded to start independent careers—including those in studies of gene function that complement the sequencing program. And for the future, it may be an unfortunate precedent to have any group of scientists lobbying for such a rapid expansion on the basis of an arbitrary deadline. Surely there are ways to allocate funds that will better promote both the advancement of science and harmony in the scientific community.

On a minor note: the book is not as well edited, either for language or for accuracy, as one might have hoped. For example, Watson reports the cost of locating the cystic fibrosis gene at $10 to $50 million, whereas Hood uses the oft-quoted figure of $150 million—which I have found was the cost of *all* preceding research on the disease in this country. And one of the editors identifies "junk" DNA with introns, when the term refers in fact to tracts of DNA that cannot now be identified with genes or regulatory regions. On the whole, however, this book provides much valuable information on a program that has become international rather than provincial, but whose perceived urgency may exceed its justification.

Bernard D. Davis
Department of Microbiology,
Harvard Medical School,
Boston, MA 02115

■

Vignettes: Tales of Invention

At MIT my salary in 1946 was $7000 a year and the house I bought cost $22,000, so I had to find a way of earning a living . . . .

So Jerry Wiesner and I—we joined forces for quite a while—we talked to Lawrence Marshall who was then president of Raytheon and he offered to pay us $5000 a year as consultants—each—which was pretty good. And one day we were out there, we had dragged Ed Purcell along, don't ask me why, and they were trying to make something called a microwave oven, at 12.5 cm wavelength. And they kept getting the chicken toasted too much in one place and not enough in another. The nodes and loops of the microwave oven, the "Q" of the oven was too high. So Purcell—it wasn't either Jerry or me but we were there—said, "Why don't you put in a little fan that just sort of rotates slowly?" So they did.

—*Jerrold R. Zacharias*, as quoted by Jack S. Goldstein in *A Different Sort of Time: The Life of Jerrold R. Zacharias, Scientist, Engineer, Educator* (MIT Press)

It must have amazed the National Inventors Council when it received a suggestion for an antijamming communications device from none other than Hollywood screen goddess Hedy Lamar and her partner, George Antheil, a film score composer. . . .

Lamar [had been] for three years the petted wife of a wealthy Austrian arms dealer whose company . . . supplied munitions for Italy's invasion of Ethiopia. As his wife, she learned about designs for military materials and even suggested a radio-contolled torpedo herself, but discovered that it was too easily jammed.

When the Nazis invaded Austria, the then Hedwig Keisler abandoned her husband ("I couldn't be an object; so I walked out") . . . . It was in 1940 that she confided to . . . Antheil her scheme for a remote controlled radio system that would allow signals to be transmitted without danger of detection, deciphering, or jamming, a device they hoped the War Department could use against the Nazis. Antheil grasped the basic concept and realized that he could as easily synchronize microsecond hops between radio frequencies as he synchronized player pianos. The slotted paper rolls and the eighty-eight frequencies he then proposed (identical to the number of piano keys) reflect his musical experience. Two years after being urged by the Inventors' Council to reduce their concepts to a patentable state, Lamar and Antheil did . . . .

The War Department, however, never adopted their method, until many years later when, long after their patent had expired, Sylvania independently developed a system based on a similar concept but substituting electronic operation for Antheil's paper rolls.

—*Anne L. Macdonald*, in *Feminine Ingenuity: Women and Invention in America* (Ballantine Books)

Cognition and Context

Everyday Cognition in Adulthood and Late Life. LEONARD W. POON, DAVID C. RUBIN, and BARBARA A. WILSON, Eds. Cambridge University Press, New York, 1992. xii, 708 pp., illus. $99.95; paper $29.95. Reprint, 1989 ed.

Most research in cognitive psychology has been based on the assumption that cognition can be meaningfully investigated in the laboratory by simulating critical aspects of the phenomenon in question. This assumption has been challenged in the last two decades or so by researchers working within a loosely defined area that has come to be known as "everyday cognition." A core belief of these researchers is that cognitive functioning in natural settings is likely to involve processes that differ, either quantitatively or qualitatively, from those that occur in artificial and contrived situations such as psychological laboratories. This book contains several chapters on the philosophical and theoretical rationale underlying research on everyday cognition (A. Baddeley, H. Bahrick, T. Landauer, D. Mook, L. Petrinovitch, D. Rubin), but it also summarizes research on everyday cognition in what is still widely considered in psychology a "special" population, namely, normal healthy adults ranging from about 18 to 80 years of age (as opposed to the more typical research subjects, who are 18- to 25-year-old college students).

The everyday cognition perspective has been enthusiastically embraced by a number of researchers interested in the relations between age and cognition. A primary motivation, stated most explicitly in the book by N. Denney, is the belief that age-related differences might be less pronounced in cognitive tasks more closely resembling the types of activities in which one naturally engages. Unfortunately, no evidence directly relevant to this intriguing hypothesis