REVIEWS

The Rewards and Risks of Studying Genes

by Stephen P. Stich

The Gene Factory. By John Elkington. New York: Carroll and Graf Publishers, Inc., 1985. 240 pp. $16.95.

In the Name of Eugenics: Genetics and the Uses of Human Heredity. By Daniel J. Kevles. New York: Alfred A. Knopf, 1985. 426 pp. $22.95.

Broken Code: The Exploitation of DNA. By Marc Lappé. San Francisco: Sierra Club Books, 1984. xii+354 pp. $17.95.

The last dozen years have been boom years for molecular genetics. Our knowledge about the biochemical mechanisms of heredity has increased at a rate that could hardly have been imagined as recently as two decades ago. Efforts to exploit that knowledge have led to the formation of hundreds of new companies and have created a multimillion dollar industry. The big boom in genetic engineering has spawned a little boom in the publishing industry, with dozens of books chronicling, analyzing, prognosticating, and offering advice. Indeed, so rich has been the literary harvest that a pair of new genres has begun to emerge.

Greed and Gloom and Gee Whiz

First came the Greed and Gloom format—a book that gives the reader a taste of scientific background, a dollop of recent history, and a healthy dose of ominous prediction about the horrid things that might happen and the important opportunities that might be missed unless we regulate, or restrict, or redirect genetic engineering and the self-interested entrepreneurs who control it. More recently a spate of books in the Gee Whiz format has joined the list. Like the Greed and Gloom books, these offer some science and some history, but they go on to survey the wonders that have already emerged from the laboratory and to predict still better things to come.

John Elkington's *The Gene Factory* is a variation on the Gee Whiz theme, focusing on the commercial biotechnology industry. He offers an informative guided tour of the products and plans of that industry, along with an account of its business intrigues and its financial risks and rewards. Reading the chapters on biomedical, agricultural, and industrial applications, even the most jaundiced reader is likely to be impressed by the sheer inventiveness of these biotechnology entrepreneurs who are exploring applications ranging from cancer therapies to snowmaking on ski slopes.

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There is, in all this, hardly more than a hint that biotechnology may raise serious moral issues. The risks that loom large from Elkington's perspective are business risks. The regulations aimed at protecting society against untoward consequences of the technology are simply factors to be weighed in the business equation. These regulations, often requiring long and expensive testing, can be major considerations in corporate decisions. According to a spokesman for Genentech, a leading genetic engineering firm, the company decided to become involved in the animal health care field partly because veterinary pharmaceutical products have "shorter routes to the market than are typical of human pharmaceuticals."

Marc Lappé's book, *Broken Code*, covers some of the same ground as Elkington's and includes a chapter on military applications, which Elkington largely ignores. However, Lappé approaches his subject from the Greed and Gloom tradition, and his book is both more thought-provoking and more annoying. The wonders of biotechnology bring with them a full budget of problems which Lappé does a generally commendable job of exploring.

In medicine, for example, genetic engineering has for the first time made ample supplies of human growth hormone available. This is welcome news to sufferers of pituitary dwarfism. However, he reports that some pediatricians "are under extreme pressures to treat even moderately under-height children." In the diagnostic area, new tests employing monoclonal antibodies and other breakthroughs will soon enable physicians to give their patients early warning of susceptibility to a wide range of afflictions including late-onset diabetes, heart disease, rheumatoid arthritis, and neuropsychiatric disorders. But these same tests will enable employers and insurance companies to identify and turn away people who run a higher risk than average of developing health problems in the future.

In agriculture, crops may eventually be capable of producing their own fertilizers and insecticides. One research group is already attempting to test a bacterial strain that will enable crops to withstand frosts that would now destroy them. However, our understanding of ecological systems is not nearly as advanced as our understanding of molecular genetics, and we are not terribly good at predicting what will happen to complex ecosystems when these genetically engineered species are released into the environment. In most cases, no doubt, the effects will be negligible. But as the sorry history of rabbits in Australia illustrates, when the ecological balance is seriously disturbed, things can go very wrong indeed.

What makes Lappé's book annoying is its self-righteous tone, an all too common characteristic of the Greed and Gloom tradition. Lappé, along with many critics of genetic engineering, writes as though the right answers to morally vexing social questions are obvious. Those answers almost always involve regulation, oversight, and public involvement in decision making. Lappé's unargued moral perspective gives little weight to the value of allowing people and corporations to make their own decisions in the marketplace, and shows little sensitivity to the fact that governmental regulation and oversight can easily become stultifying and oppressive.

So, for example, the Frito-Lay Corporation takes it on the chin from Lappé for seeking, vainly as it turned out, to engineer a potato that would contain less water and thus be cheaper to transport to their potato chip factories. "No one," Lappé's informant revealed, "ever asked whether or not such an objective was consonant with human nutritional needs." Well, I for one don't much fancy living in a society in which potato chip manufacturers are expected to ask whether their attempts to reduce manufacturing costs are "consonant with human nutritional needs." And I positively dread a society in which such decisions would require governmental oversight and public involvement.

Lappé concedes that "from a purely ethical perspective" (whatever that might be) our economy "can tolerate the generation of commodities...that may be devoid of any intrinsic value beyond their appeal to consumer taste." His use of the word "tolerate" speaks volumes about the moral and political perspective underlying his critique. We do not "tolerate" what is welcome or good; we would not ordinarily talk of tolerating good health or peace on earth. It is only what is unwelcome that must sometimes be tolerated.

In Lappé's ideal society, perhaps we would not have to tolerate the generation of commodities whose only value is that they appeal to consumer taste. Perhaps we would have public hearings to seek guidelines for the determination of intrinsic social value, and we would have regulators whose job it was to determine whether any proposed product met the guidelines. Then we wouldn't have to worry about "the recent emergence of a 'junk biotechnology' industry in which manufacturers of snacks, food additives and fragrances, and other nonessential commodities are seizing on rDNA-based products to facilitate production." There would be no wasting of manpower and resources on "junk tech...commodities such as flavors, fragrances and perfumes." And Campbell's would have some hard questions to answer before it sunk R&D money into the development of a square tomato. Sound attractive? I'll stay here, thanks.

Understanding Human Heredity

Daniel J. Kevles's book, *In the Name of Eugenics*, focuses on the study of human heredity. He has written a serious, scholarly history of the science of human genetics from Galton to the development of recombinant DNA technology. But this characterization of Kevles's book is likely to give many readers exactly the wrong idea. "Serious and scholarly" sounds like a euphemism for "dry and boring," and nothing could be further from the truth.

The story Kevles has to tell is one of intellectual struggle and adventure, of political battles that shaped the educational system of Britain and the immigration policy of the United States, and of extraordinary minds and personalities. The story is told with clarity and verve, weaving together biographical sketches and historical narrative in a fascinating and informative tapestry. It is, in short, a "good read." But it is also a book with important lessons to teach about the enormous difficulties we face in trying to understand human heredity, the very limited extent to which we do understand how nature and nurture conspire to produce complex mental and behavioral traits, and the strong temptation to deceive ourselves into thinking we understand more than we do.

There is a striking, and instructive, contrast between the history of human heredity that Kevles recounts and the much better known history of molecular genetics that both Lappé and Elkington sketch in their introductory chapters. The story of molecular genetics is brief, dramatic, and marked by a string of major discoveries. In 1944, Avery, MacLeod, and McCarty established that genes, the conveyors of hereditary information, are composed of DNA. Less than a decade later, after some famous and frantic competition, Watson and Crick showed that DNA was a double helix capable of unzipping into a pair of chemical templates, each able to reconstruct the entire molecule.

Within thirteen years of the Watson and Crick discovery, the core of the genetic code had been discovered, and we knew which sequences of DNA bases coded for each of the twenty major amino acids. Most of this knowledge was acquired by experiments using micro-organisms, though it is now clear that the amino acid code and many of the biochemical mechanisms of genetics are quite general. Bacteria, mice, and human beings all use essentially the same genetic code. Thus modern molecular genetics is teaching us a great deal about the mechanisms of human heredity.

But the tradition of inquiry into human heredity that Kevles chronicles is much older than molecular genetics and focused on very different questions. That tradition began with a concern about those human traits that interest all of us—intelligence and creativity, beauty, strength, and virtue. It was also concerned, indeed sometimes obsessed, with the opposites of these traits—feeblemindedness, deformity, weakness, and depravity. Those who studied human heredity wanted to know which of these traits were passed on from parent to child, and they sought to discover the laws governing that process.

Though speculations on these themes can be found from antiquity onward, Kevles begins his history with Darwin's cousin, Francis Galton, who was born in 1822, the same year as Gregor Mendel. The choice is fair enough, since it was Galton who first attempted to apply statistical analysis

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to data about human traits. It was Galton, too, who first urged that the results of such inquiries might be used "to produce a highly gifted race of men by judicious marriages during several consecutive generations."

In contrast with the history of molecular genetics, however, the story that begins with Galton is not one of discoveries and breakthroughs; quite the opposite. Galton first published his eugenics ideas in 1865, and during the next seventy-five years the idea of improving humanity by breeding better people in accordance with "scientific principles" evolved into a variety of social and political movements, some of which had major effects on public policy. However, during those same years next to nothing at all was discovered about the heredity of intelligence or ability or virtue or feeble-mindedness or depravity. Only in the 1930s did we acquire good evidence that any form of mental deficiency is hereditary. And astoundingly, it was not until 1955—two years after Watson and Crick's discovery—that the correct number of human chromosomes was established! Why was progress in the study of human heredity so painfully slow? From the history Kevles recounts, several interrelated factors can be identified.

The first is simply that we cannot do the sorts of experiments with humans that proved to be so important in studying heredity in other species. People breed with partners of their choice, they produce a relatively small number of offspring, and those offspring take a very long time to mature. Just the opposite is true of bacteria or fruit flies or mice. So it is little wonder that knowledge about heredity in those species came much more easily than knowledge about heredity in our own.

Since they could not breed people, the only tool open to early investigators of human heredity was to collect facts about the results of nature's breeding experiments by assembling family histories. Those facts were collected with great zeal during the early decades of this century by Karl Pearson at the Galton Laboratory in London and by Charles Davenport at his exceptionally well-funded laboratory in Cold Spring Harbor on Long Island.

However, the masses of data were useless without sophisticated statistical techniques for detecting correlations. So it is no surprise that Galton and Pearson, the eugenically inspired founders of "biometrics," were trained as mathematicians, not as biologists. Their enduring contribution to science was to lay the foundations for modern statistical analysis. The statistical methods they developed were widely and successfully employed in studies of animal and plant heredity, as well as in disciplines far removed from biology. Yet their masses of data and their increasingly sophisticated statistical techniques revealed nothing of enduring significance about the traits of mind and character that were of greatest interest to the eugenics movement.

The reason was that they were looking at what they supposed to be the socially important traits of success, intelligence, ability, feeble-mindedness, criminality, and the rest, and these turned out to be the wrong traits. They are wrong because they are difficult or impossible to measure and because available statistical techniques were not, and still are not, able to isolate the genetic component from the numerous and complexly interacting factors that bring them about.

On a deeper level, they are the wrong traits because, in a sense, they are not traits at all. Rather each one is a hodgepodge of different traits, an "unnatural kind" clumped together by common sense psychology and sociology. To use an analogy suggested by the philosopher Patricia Churchland, "feeble-mindedness" is like dirt. It is not one thing, but many unrelated things; it is no more plausible to suppose we could discover laws or theories about feeble-mindedness than it is to think we might discover laws and theories about dirt.

This point was urged more than once in the heyday of eugenics, but it was made most convincingly by Lionel Penrose who, during the 1930s, conducted a painstaking study of the disorders and the family backgrounds of the residents of the Royal Eastern Counties' Institution in Colchester, England, a large facility for "mental defectives." Early on Penrose recognized that "there are a great many different types of retarded mental development, many of which have almost nothing in common except the inability to perform those functional acts which society regards as being an index of intelligence." For Penrose the classifications of mental deficiency which hinged on social aptitude were scientifically worthless. "They are about as much use from the biological standpoint as a classification of aquatic organisms based on their suitability for consumption as articles of human diet."

It was largely due to Penrose's efforts that a careful, scientifically respectable classification of mental defects began to emerge. Working with that classification Penrose accumulated the first solid evidence confirming that Huntington's chorea and neurofibromatosis are due to dominant genes, while microcephaly and cretinism are recessive.

The study of human genetics did make significant progress in one area prior to Penrose, underscoring the importance of looking at the right traits. Human blood groups had been identified early in the century. By the mid-twenties the complicated but essentially Mendelian inheritance of the A, B, AB, and O groups had been worked out by the German mathematician Felix Bernstein. After the Second World War, sophisticated electrophoresis and chromatography techniques enabled researchers to look at many other aspects of human blood chemistry, and to demonstrate the genetic origins of sickle cell disease and a host of other afflictions.

It took a very long time to realize that the common-sense taxonomy embedded in everyday language was not one that could be used in scientific genetics. Being tidy or slovenly, shiftless, "wayward," or inclined to "sex immorality" are not categories that carve nature at its joints, though all of these were studied by Charles Davenport. Nor is "thalassophilia"—the love of the sea—which Davenport concluded must be a sex-linked recessive trait, since it almost always expressed itself in male naval officers.

It would all seem a bit laughable if this sort of silliness were not still very much with us. In the early 1970s Harvard psychologist Richard Herrnstein proposed that "the tendency to be unemployed may run in the genes of a family." And numerous authorities continue to speculate about the heritability of "intelligence" and its absence.

With the historical perspective Kevles provides it becomes clear that these speculations are no more justified than Davenport's, and that, whatever the intent of those who urge them, they will be used, just as Davenport's speculations were, to support racist and reactionary policies. The lesson is a profoundly important one. Kevles's book deserves a wide audience and attentive reading.

Tricks on the Body the Mind Can Play

by Carol Levine

The Man Who Mistook His Wife for a Hat and Other Clinical Tales. By Oliver Sacks. New York: Summit Books, 1985. xvi+123 pp. $15.95.

"Animals get disease, but only man falls radically into sickness." Oliver Sacks, a neurologist at The Albert Einstein College of Medicine, uses this distinction to explain both his primary concern with his patients' personhood and his use of the personalized clinical tale rather than the more detached "case study."

The Library of Congress Cataloging in Publication Data has classified his latest book as "Neurology—anecdotes, facetiae, satire, etc."; the "etc." includes nothing less than insights into the doctor-patient relationship, the existential meaning of sickness, and the goals of medicine. Like Montaigne, Dr. Sacks challenges our assumptions about what is normal in the human condition. But while Montaigne drew his examples from ancient history and primitive customs, Dr. Sacks uses neurological disorders to explore the terrain of "otherness." By focusing on the margins of what it means to be human, he illuminates the core.

The rare and often bizarre disorders that afflict Dr. Sacks's patients alter not only their perceptions of themselves and the world, as more common illnesses do, but their ability to perceive at all. In these tales the mind-body problem reaches new and dazzling proportions. Dr. P., for example, the man in the title story, was a gifted musician and teacher who lost the ability to recognize concrete objects like gloves and faces—even the ability to understand the idea of "glove" or "face." But he could remember in vivid detail musical compositions, incidents from the past, and abstract ideas. Christina, "a disembodied lady," suffered from proprioception, a condition in which she had no control over—indeed, no sense of—her body. Mr. Thompson, a patient with severe Korsakov's syndrome, could remember nothing for more than a few seconds but carried on vivid, constant conversation nonetheless.

Through his funny-sad narratives Dr. Sacks explores the loss of self such patients experience and their efforts to accommodate the deficit (or excess, or transformation of neurological activity), the reintegration of mind and body, and the transformative power of art, comedy, religion, and music.

In this context the physician's role is not so much a healer as a decoder of puzzles and a guide to the "therapeutic moment," when "half-appalled, half-amused," patients see for the first time "exactly what is wrong and, in the same moment, exactly what there is to be done."

So well do some patients learn to live with their disabilities that medicine's power to alter the condition may bring mixed results. Witty Ticcy Ray (his own name for himself), a young man with a severe case of Tourette's Syndrome, had learned to live with the excess nervous energy, grimaces, mannerisms, and tics that characterize his disease. Despite his handicaps, he graduated from college, married, and excelled at ping pong and playing drums in a jazz group.

The drug haldol calmed him down but it also threw him off balance and interfered with his speed and timing. Ray's solution was to take the drug during his working hours—to be "sober, solid, square"—and to "let fly" on the weekends.The clinician in Dr. Sacks wants to help people be "normal"; the artist in him appears to regret the loss of individuality and creativity that often accompanies clinical improvement.

Dr. Sacks does not present a systematic analysis or a theory that would encompass all his provocative observations. But his acute and empathetic powers of observation and his gifts as a storyteller exemplify the linking of the humanities and medicine.

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