BOOKS: MOLECULAR BIOLOGY

Was There Life After DNA?

David Weatherall

A Passion for DNA
Genes, Genomes, and Society
by James D. Watson

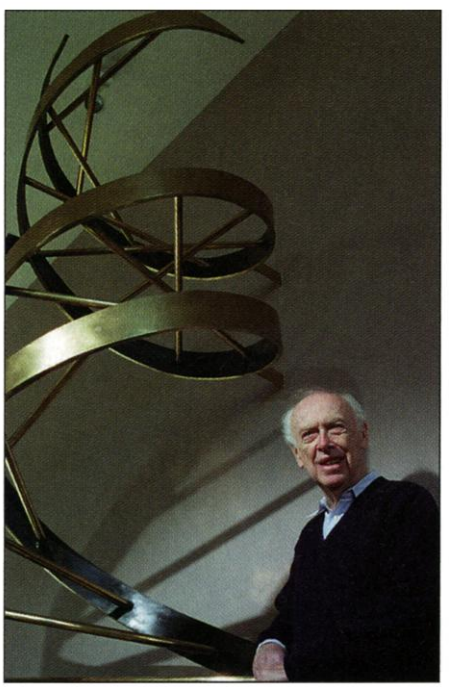
Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 2000. 270 pp. $25. ISBN 0-87969-581-1. Oxford University Press, Oxford, 2000. 270 pp. £18.99. ISBN 0-19-850697-X.

A few years ago, while visiting the Institute of Molecular Medicine at Oxford University, Jim Watson was invited to lecture to the students and staff. At the end of his stimulating if idiosyncratic account of the ethics of the Human Genome Project, a timorous young student rose to his feet. "Dr. Watson, you made the most important discovery in biology of the last 100 years, perhaps ever. What will be the nature of the discovery of equal importance in the next 100 years?" After an interminably long silence, during which Watson's eyes rolled to the ceiling and 400 future scientists shuffled expectantly on the edges of their seats, he replied, "Gee, there won't be one."

This characteristic response raises an intriguing question that surely will occur to most readers of Watson's latest book, the essay collection *A Passion for DNA*. It is posed in a delightful introduction by Walter Gratzer, who describes a *New Yorker* cartoon that shows a gloomy-looking Neandertal deep in thought, clearly the object of discussion by two of his fellows. The caption reads, "So he invented fire and the wheel, but what has he done since?" How did Watson, the co-discoverer of the structure of DNA in his mid-twenties, cope with what could have been the prolonged scientific anticlimax of the following 40 years? As evidenced by the series of essays that spans this period, Watson was never troubled by his early achievements. The essays reflect a life of unbroken enthusiasm for science and of widely diverse and often seminal contributions to the further development of the revolution in biology that he and Francis Crick had spawned in his youth.

Watson begins with some revealing snapshots of his family and early life in Chicago, which describe how a course taught by Sewell Wright and the chance reading of Erwin Schrödinger's *What is Life* diverted him from a fascination with how birds migrate to a lifelong obsession with genetics. These accounts and the following series of pen portraits of the scientists of the phage group, Cambridge, and Paris focus with great warmth and generosity on those who played important roles in Watson's scientific development. The remainder of the book is concerned with his multifaceted roles in seeing molecular biology through its teething problems.

These essays, many of which were written as introductions to the *Annual Report* of the Cold Spring Harbor Laboratory, span almost every major controversy and uncertainty that plagued the field's early days. Whether the debates concerned the perceived dangers of recombinant DNA technology, the value and potential misuses of the Human Genome Project, cloning, prenatal detection of genetic disease, or fears of the resurgence of eugenics, the author was in there fighting. Because many of the essays were written some years ago, the reader has the advantage of hindsight in judging how often Watson was justified in his interventions and, incidentally, why he may have irritated people along the way. In retrospect, perhaps the accusations of naïveté and arrogance were often as not reflections of frustration on the part of those who could not always define these complex issues with such childlike simplicity, not to mention the fact that Watson appears to have often committed the cardinal sin of being right. Many may disagree with some of his ethical views, but because these are stated so clearly, they provide a valuable framework on which the thorny problems can continue to be debated. Taken together, the essays offer the general reader an absorbing insight into the multilayered complexities of modern science, which range from the personal and institutional to the governmental and international.



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Watson is, above all, extremely optimistic about the potential of molecular biology for the betterment of humanity. Using the example of how its tools have completely revolutionized our thinking about the nature of cancer, and without sacrificing accuracy by oversimplification, he provides the nonspecialist with a clear picture of the potential of the molecular approach to dissecting the cause of disease. And he manages to do this without any of the hype that characterizes so much current writing in this field, by taking the line that we must accept a long-term view of the full fruits of the Human Genome Project. For example, after guiding the reader through the multistep intricacies of the evolution of cancer by the progressive activation of different sets of oncogenes, he writes:

> Many of these new observations will initially unsettle us and momentarily make us despair of ever being able to have a fair fight against an enemy that so constantly changes the face it presents. But now is most certainly not the moment to lose faith in our ability to triumph over the inherent complexity that underlies the existence of the living state.
>
> Given enough time, and the financial and moral resources that will let those born optimistic stay that way, the odds for eventual success in beating down cancer are on our side.

This cautious and balanced type of approach to the fruits of the molecular era is particularly well timed. Unfortunately, it is frequently claimed—either from hopes of personal or commercial gain, or from naïveté on the part of some molecular biologists about the complexities of sick people—that the fallout from the Genome Project will revolutionize clinical practice overnight. It is not true that, as Gratzer suggests in his afterword, discoveries in molecular biology have engendered "momentous upheavals in clinical practice." Rather, with few exceptions the impact of molecular medicine has to date been very limited. The recent announcement of the partial completion of the Genome Project has already further raised the level of hyperbole about its potential for the conquest of disease. There are, however, already signs that society is becoming disillusioned by the lack of evidence of the practical benefits of the "breakthroughs" about which it reads every day; this trend could do immeasurable harm to molecular biology in the post-genome era. Robert

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Koch's 1882 discovery of the organism that causes tuberculosis was hailed by the world press as the end of that great scourge. Yet it was to be another 70 years, with innumerable false starts and dashed hopes, before Selman Waxman's discovery of streptomycin opened the way to a definitive cure for the disease. There is always a long gap between work in the research laboratory and its application in the clinic. The clinical applications of the Genome Project will, as Watson understands so well, be no exception.

There are long passages in this book that lull the reader into the belief that Jim Watson has finally become a sedate member of the scientific establishment. Every so often, however, the Chicago schoolboy makes a brief but reassuring reappearance. His third rule in a pithy guide to success for young scientists reads "be sure you always have someone up your sleeve who will save you when you find yourself in deep shit." That is an environment to which, as evidenced by these essays, he must have become well-accustomed over the years. Clearly, as Gratzer emphasizes in his summary, at the age of 70 the enfant terrible has lost none of his evangelical enthusiasm for science and is still captivated by the richness and promise of what flowed from the discovery he made with Crick all those years ago. *A Passion for DNA* is a reminder, if any were needed, that we should be equally indebted to Watson for his efforts in what must often have seemed the much more difficult task of overcoming the innumerable controversies and doubts that could have seriously interfered with molecular biology's long-term potential for the benefit of humanity. We owe him a great deal.

BOOKS: AGRICULTURE

Ensuring Enough to Eat

Adrienne E. Clarke

Can human ingenuity produce enough food to support healthy and vigorous life for the 10 billion people projected to live on Earth in 2050 without irreparably damaging the integrity of the biosphere? Vaclav Smil's book *Feeding the World* sets out to answer this question.

Smil, a geographer at the University of Manitoba, calculates how much food can be theoretically produced and estimates how much is actually needed. His approach is to examine issues such as the potential availability of arable land, the supply of water and plant nutrients, and the maximum theoretical photosynthetic efficiency. He considers the proportion of the food produced that is actually eaten and the nutritive requirements of individuals. He discusses the ecological risks that growing this amount of food will pose, including loss of topsoil, loss of biodiversity, and the addition of reactive nitrogen from synthetic nitrogen fertilizers to the atmosphere.

Feeding the World
A Challenge for the Twenty-First Century
Vaclav Smil
MIT Press, Cambridge, MA, 2000. 388 pp. $32.95. ISBN 0-262-19432-5.

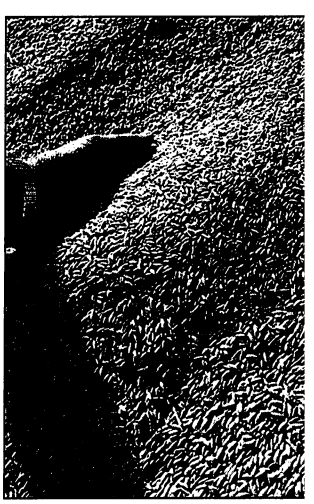
One of Smil's most important messages is that some of the conventional wisdom leading to the "catastrophists'" outlook on these questions may not be well founded. For example, loss of topsoil is often cited as having a major negative impact on food-growing capacity, but how robust is the evidence that degradation-induced productivity losses are rising? The problem may be real and urgent in many regions; for example, in large parts of Africa the annual soil degradation equates to millions of metric tons of grains and tubers lost per year. But from a global perspective, the losses may not be significant. Is there enough arable land? The answer is probably yes—when Earth is viewed as a whole. From the perspective of a poor African country, the answer may well be no.

What about water? Although current human uses of water show that overall there is stress on supply, there are many opportunities for more efficient use, particularly in irrigation. Again, the problem may be manageable at a global level, but at the local level, in some countries, water scarcity is devastating.

The view that emerges from Smil's account is that the inputs and assumptions underlying calculations of global resources are in many cases debatable. The variations in estimates give comfort that the world as a whole probably has the resources to adapt to demand and produce sufficient food. The picture at other levels, however, is not so optimistic. Existing and worsening constraints on food production at regional and local levels are real and urgent. The gravity of the situation is reinforced by the fact that most of the population growth is predicted to occur in the countries with the greatest local problems—nations in Africa, Asia, and Latin America. Interestingly, Brazil is the only modernizing country that has abundant reserves of both water and arable land. Another compelling point made by Smil is that post-harvest losses due to spoilage and waste can amount to more than 15% of the yield. Stemming these losses should be as important a target as increasing productivity, and in many cases doing so would require less sophisticated approaches. Insect pests and plant pathogens, which account for huge losses under some conditions, should also be a target.

The book provides a valuable contribution to current understanding of this critically important topic. Read along with papers from the December 1998 National Academy of Sciences colloquium "Plants and Population: Is There Time?" (*Proc. Natl. Acad. Sci. U.S.A.* **96**, 5903–6008 [1999]); it offers readers new to the field good insights into the major questions being asked and the uncertainty of the answers.

This uncertainty is compounded by the recognition that biological and physical systems (such as climate) often behave nonlinearly. In addition, the assumptions underlying predictions of the impact of climate change may be flawed. We should expect the unexpected. Another area likely to throw up the unexpected is biotechnology. Although Smil does not deal with biotechnology's potential in any detail, its impact, especially for the impoverished local communities in developing countries, may be profound. A major challenge will be finding ways to make the intellectual property rights, usually held by institutions in the developed world, available to the poor countries.



A dominant staple. In parts of monsoonal Asia, rice supplies over 65% of all food energy.

Are we capable of developing the institutions to plan for and manage these known and unknown challenges? As globalization proceeds, more issues that transcend national boundaries are developing. As a global community, we can point to one success: we did manage to arrest the use of chlorofluorocarbons responsible for the breakdown of stratospheric ozone. We can therefore be optimistic that we are capable of meeting the challenges and that we will find ways to work across boundaries. Smil's conclusions are also cautiously optimistic: we probably will be able to feed the world, or at least a great part of its future population, without irreversibly damaging the biosphere.

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