BOOKS: MOLECULAR BIOLOGY

A Scientific Kokopelli

Bob Edgar

The pioneers who created molecular genetics in the 1950s and 1960s were an interesting and colorful group, and none were more fascinating—as a scientist or as a person—than Sydney Brenner. The depth and breadth of his contributions to molecular biology are astounding. His research, characterized by the use of genetic methods to answer biochemical questions, always had a special elegance and beauty. His fertile and vivid imagination was coupled with a rare gift for words. Brenner influenced the thinking of all those who came in contact with him. As the editors of this autobiography (Errol Friedberg and Eleanor Lawrence) remark, "He ranks high on everyone's list of scientists whose achievements clearly merit a Nobel Prize but who have never received that accolade." He is at the top of my list.

My Life in Science
by Sydney Brenner
Errol C. Friedberg and Eleanor Lawrence, Eds.
BioMed Central, London, 2001. 197 pp. Paper, $21, £14.99. ISBN 0-9540278-0-9.

Brenner was a major figure during the early years of molecular biology, when the genetic code was deciphered. Among other contributions, he coined the term codon. He, Francis Crick, and Matthew Meselson proved the existence of messenger RNA. In a brilliant genetic analysis, Brenner and Crick demonstrated that the genetic code was a three-letter, nonoverlapping code. Then in the late 1960s, Brenner decided the time was ripe to tackle the problem of how complex structures, such as the nervous system, are constructed from the blueprint in the DNA. He selected and developed a small nematode worm, *Caenorhabditis elegans*, as a model system for such studies. Thousands of researchers now study this worm, and Brenner continues to play an active and influential role in this fruitful field.

I first met Sydney in 1954, when we were lab partners in the "Bacterial Genetics" course at the Cold Spring Harbor Laboratory. As was traditional, the course ended with a parade of the students in costume walking from Davenport Lab to Blackford Hall, where we performed a skit before partying. Sydney had organized the skit: Most of us were hidden under a table that represented a lysogenic bacterium harboring viruses, and we were phages ready to burst out. Naked to the waist, Sydney stood on the table, giving resonant voice to an amazing Shakespearean soliloquy about lysogeny. He performed it from memory, and he went on and on and on. (I realized from the autobiography that it was probably largely *King Lear*, parts of which he had memorized as a schoolboy in South Africa.) I have been in awe of Sydney ever since.

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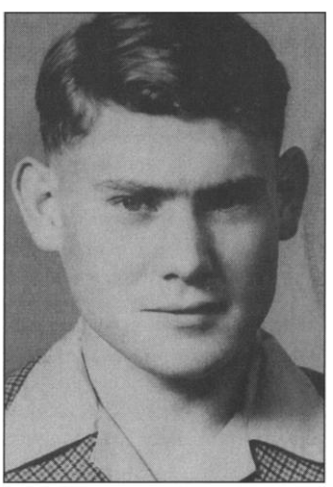
The book is slim and, unfortunately, lacks illustrations other than the youthful portrait on the cover. Only about 80 percent of the text is in Sydney's own words. These are selected from 15 hours of videotape of Brenner talking to Lewis Wolpert about his life and works. The editors have created an integrated story by providing details and explanatory material in passages between excerpts from the videotapes. I initially found the editors' interpolations disconcerting, but soon accepted them as necessary, and they are done well. The account covers Brenner's major scientific accomplishments and is heavily laced with his irreverent judgments about people and scientific politics. Thus the book fulfilled most of my hopes and manages to capture the Sydney I know.



Brenner before Cambridge.

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It starts off with a description of Brenner's childhood in a small South African town. His father was a poor Jewish cobbler, an immigrant from Lithuania. During high school (which he entered three years early), he found classroom learning was not his forte and he was not at the top of his class. But the subsequent "lives of total intellectual obscurity" of those who did better in school later led Brenner to conclude "that if a student came to me with a First Class degree he still had to prove to me that he could have had a Second Class degree if he'd tried!" Although he wanted to study biology, he began medical studies at the University of Witwatersrand (at the age of 14) because he was offered a scholarship. But he took advantage of opportunities to obtain bachelor's and honors degrees in anatomy and physiology and to complete a master's thesis in cytogenetics.

Although he had a low regard for his clinical training, his exceptional talents were recognized by many of his teachers, South African scientists, and distinguished foreign researchers. Through their help, he received a scholarship to Oxford, where he completed a doctorate working in the lab of a distinguished bacteriologist, Cyril Hinshelwood. After a year in the United States and another back in South Africa, in January 1957 he joined Francis Crick at the Cavendish Lab in Cambridge.

Crick and Brenner became very close friends, and for many years at the Laboratory for Molecular Biology they shared an office: a small room with two desks in the middle facing each other to facilitate conversation. As I discovered during a 1975 sabbatical with Brenner, the door was usually open. I passed by it many times hoping to catch Sydney and Francis both present and in conversation (I never did) and wanting to know if they talked simultaneously or sequentially. They were the most verbal scientists I have encountered.

As Sydney relates in the book, his intellect fed off conversation, and much of his research was collaborative. In addition to the work with Crick, his major collaborations included studies with the phage geneticist Seymour Benzer (we referred to them collectively as "Sydmour Brenzer") and with François Jacob, who would win a Nobel prize for his studies of gene regulation.

Brenner writes that in those early "heroic" years, biochemistry had not yet become a tool of inquiry. Those probing the nature of the genetic apparatus had to rely largely on genetic analysis and a few biophysical techniques such as radioactive labeling. A single one-day experiment performed by one or two people could yield a profound discovery. But it had to be the right experiment, addressing the right question. Identifying such questions and experiments was largely intellectual work, and Sydney excelled at engaging others in this activity. An excellent example of this, one beautifully told in the book, is the discovery of messenger RNA by Brenner and Jacob.

I was also delighted by Sydney's account of the work he and Crick did with frameshift mutants in phage T4 that demonstrated that the genetic code was a nonoverlapping triplet code. When I had first heard him describe the work at a seminar at Caltech, I thought it was too incredible to believe. But it was no hoax, and it remains one of the most remarkable achievements of pure genetic analysis.

The book captures the spirit of the time. It abounds with anecdotes and descriptions

of the conversations Brenner and his friends had about what they knew, what they didn't know, and what was the next important question to tackle. It also offers readers a broad sample of Sydney's pungent opinions on scientists and science:

> If you simply say, "Development is just a matter of turning the right genes on in the right place at the right time and that's the answer," that's absolutely true. But it's absolutely useless because somewhere deep down what we'd really like to do is to actually go and make a mouse...Of course no one will build a real mouse, but we'd like to be able to make a gedanken (imaginary) mouse."

I last saw Sydney a few months ago at a dinner honoring the participants of a 1985 conference that was the first to examine the feasibility of a human genome project. As the speeches droned on and on, he sat at the next table, constructing something with his napkin (perhaps it was a mouse). He winked when our eyes met, and I thought of Kokopelli—the mythic musician, trickster, and sower of seeds of the American Southwest whose flute songs beguile the people and bring the rain.

Near the end of the book, Brenner comments that he hates writing but is good at talking. This no doubt explains why *My Life in Science* was compiled from videotapes. I was very disappointed that the "accompanying video" mentioned in the preface was not available for review. I would love to see and hear Sydney once again expounding on some topic. Any topic.

BOOKS: CLIMATE

Why Global Warming Is Controversial

George Philander

Suppose we are in a raft, drifting toward a waterfall. To avoid a calamity, we must address two questions: How far is the waterfall? And when should we get out of the water? We deal with these questions in radically different ways. The first can be answered with the methods of science. The second (a matter of policy) is far more difficult. It has a multitude of possible answers, none entirely satisfactory to everyone, and it requires compromises among the different values of different people (some timid, some foolhardy). The difference between the science and policy aspects of environmental problems is sharp in this allegory, but the distinction can easily become blurred when the scientific results possess uncertainties. Controversies are common when it is unclear whether disagreements about the distance to the waterfall reflect scientific or political differences.

Changing the Atmosphere demonstrates convincingly that in the current debate about global warming the distinction between science and policy is almost absent. Edited by Clark Miller (a political scientist at the University of Wisconsin–Madison) and Paul Edwards (the director of the Science, Technology, and Society program at the University of Michigan), the book comprises ten essays on the interactions between the atmospheric sciences and public policy. In their introduction, Miller and Edwards state that, today, environmental "science's place in global policymaking is increasingly formalized, boosting its authority in policymaking processes but also subjecting it to new forms of political and legal oversight and review. International expert institutions such as the IPCC (Intergovernmental Panel on Climate Change) increasingly determine which knowledge counts and which does not, helping to shape crucial policy outcomes." In a later chapter, Edwards and Stephen Schneider describe the IPCC as a "hybrid scientific/political organization"; it involves hundreds of scientists and several nonscientists from all over the world in evaluating and synthesizing the scientific understanding of global climate change. That the IPCC is controversial is thus no surprise. Dale Jamieson tells us that many people regard it as "the voice of reason and dispassionate objectivity," but that others who disagree with its findings consider it a "malevolent conspiracy."

Changing the Atmosphere
Expert Knowledge and Environmental Governance
Clark A. Miller and Paul N. Edwards, Eds.
MIT Press, Cambridge, MA, 2001. 397 pp. $67, £47.95. ISBN 0-262-13387-3. Paper, $26.95, £18.95. ISBN 0-262-63219-5.

Several of the essays provide an excellent summary of how this state of affairs developed. After World War II, the creation of an integrated, global, observational network to monitor the weather was intimately related to the efforts of politicians to reconstruct a stable world order by promoting international cooperation in science and technology. An intriguing interplay between science and politics transformed weather and climate from local into global phenomena, thus setting the stage for global climate change to become an international issue. In dealing with this complex problem, a distinction between its science and policy aspects would be helpful. Several authors of this book seem to believe that, in the case of global warming, such a distinction is impossible. However, the arguments of these experts from the field of "science studies" are marred by misconceptions concerning models of weather and climate.

The discussions of models, except for Stephen Norton and Frederick Suppe's consideration from the perspective of philosophers of science, are poor. A major reason is a failure to explore why, at present, climate models have far larger uncertainties than those that predict the weather. Weather forecasts used to be regarded as auguries, but now are accepted as sources of reliable and important information. In early November 2001, for example, forecasts for Hurricane Michelle prompted the governor of Florida to order the evacuation of the Florida Keys. (Even though the order proved unnecessary on that particular occasion, it will be repeated under similar conditions in the future.) The advances in weather prediction that cause such predictions to be widely accepted were possible because the time scales of the phenomena of interest (a few days) are so short that the data collected over the past few decades provide stringent tests for the predictive models. Unfortunately, the instrumental records are too short to provide similarly demanding tests for models that predict climate changes decades hence. Scientists are therefore turning to the geological records (which are not mentioned at all in this book) that describe dramatically different climates in the past. Of particular interest is Earth's response to slight fluctuations in orbital (Milankovich) parameters such as the tilt and precession of its axis. Over the past few million years, the amplitude of that response has increased significantly, and it now includes recurrent Ice Ages. Why Earth's climate is currently far more sensitive to this modest Milankovich forcing than in the past is, as yet, unknown. But this sensitivity is ample reason to be concerned about the current exponential rise in the concentration of greenhouse gases in the atmosphere. (Most of the book's authors seem to believe that the basis for concern stems strictly from the results of climate models.) Confidence in the theories and models for future global warming will be bolstered significantly once we have explanations for and simulations of the Ice Ages.

Coping with global warming will require the collaborative efforts of people with diverse backgrounds. In *Changing the Atmosphere*, experts in science studies alert us to the current absence of a clear distinction between the science and policy aspects of global warming. They apparently believe that this will always be the case.

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