Bombing Surveys of Germany and Japan. Often his associates were the same young social psychologists who moved from agency to agency. The group included Rensis Likert, Daniel Katz, Richard Crutchfield, David Krech, and Ernest Hilgard—all of whom became prominent scholars in the postwar years.

Of all his wartime experiences, the postwar bombing surveys of the German and Japanese populations made the deepest impression on Hyman. He directed numerous studies that required both innovative research designs and interviewing under extreme conditions. People who often had lost family members and their houses were questioned about the psychological impact of the destruction. The interviews revealed that bombing up to a critical level of intensity decreased civilian morale; beyond this level, bombing served to increase and strengthen morale. Almost 25 years later, during the U.S. bombing of Vietnam, this evidence on the futility and cruelty of saturation bombing was ignored by the military, and the total tonnage dropped during that war greatly exceeded that dropped years earlier on both Germany and Japan. To his credit, Hyman tried unsuccessfully at that time to remind the nation of the lessons that had been learned in World War II.

In the postwar era, Hyman worked both at the National Opinion Research Center (NORC) of the University of Chicago and at the Bureau of Applied Social Research (BASR) of Columbia University. NORC was established in 1941; during the war it carried out hundreds of surveys for government agencies; and since the war it has become a major university-affiliated social research organization. Among his other activities at NORC, Hyman conducted numerous surveys and directed a major study of the interview process (Hyman *et al.*, *Interviewing in Social Research*, University of Chicago Press, 1954).

In 1951, Hyman became a professor of sociology at Columbia University and an associate director of BASR, one of the nation's oldest and most influential university-affiliated social research organizations. Here he directed a number of surveys and published, among other books, *Survey Design and Analysis* (Free Press, 1959), which became a standard textbook in the field. In 1969, he left Columbia to be a professor of sociology at Wesleyan University. He died in China in 1985 while lecturing on the use of survey research in developing countries.

The wealth of substantive and methodological knowledge contained in this autobiography cannot be adequately described in a brief review. It is not too much to say of Hyman—as has been said of Samuel Stouffer—that he and survey research grew up together. He was "present at the creation" of survey research as it is now practiced throughout the world, a method whose diffusion he fostered by teaching abroad and by working with international agencies. This modest book offers eloquent testimony to its relevance as a mode of communication between a democratic government and its people.

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Physical Topics

A Physicist on Madison Avenue. TONY ROTHMAN. Princeton University Press, Princeton, NJ, 1991. xiv, 147 pp., illus. $19.95.

Science à la Mode. Physical Fashions and Fictions. TONY ROTHMAN. Princeton University Press, Princeton, NJ, 1991. xii, 207 pp., illus. Paper, $12.95. Reprint, 1989 ed.

How one longs to overcome the popular image of a physicist as a breed apart, a cold, calculating scientist incapable of communicating in layman's language, content to remain aloof and preoccupied with research, wherever it may lead. We all know of many individual exceptions, but surprisingly few have managed to communicate with the public by developing popular writing to the point where such barriers are broken down. Tony Rothman is such a physicist who writes well and lucidly. His hallmark is a rare attention to detail combined with abhorrence of any hint of condescension and an emphasis on the lighter side of physics.

In a series of physics-oriented vignettes, Rothman covers topics ranging from workday experiences to reflections about the beginning of the universe. *A Physicist on Madison Avenue* features Rothman's valiant battle to impress the sales staff of *Scientific American* with normal distributions and histograms in a frustrated attempt to account for monthly variations in sales: did animal covers lose sales or did red covers improve sales? Sadly, the outcome may never be known, insofar as a statistical analysis awaits a future, more mathematically literate, generation of sales executives and publishers. The author's musical inclinations are featured in an illuminating discussion of the application of physics to musical instruments. From plastic violins to platinum flutes, musicians will go to any length to extract the ultimate refinement in sound quality that harmonic analysis cannot yet quantify. Some regularities have emerged: for example, the bore of a wind instrument must be cylindrical, conical, or "bessel" to produce a harmonic scale. Consequently, no new instrument has succeeded since the saxophone for the past century and a half, and others, like the crumhorn and sackbut, have shared the fate of the dodo and the dinosaur.

Rothman comes out on the anthropic side in a free-ranging discussion of the debate between proponents of anthropic principles and those who prefer theories with elements of predictability. In its weakest and least objectionable form, the anthropic principle asserts that the presence of intelligent observers restricts the class of possible universes to one closely resembling our own. Rothman reminds us of the many guises of the anthropic principle, with unforgettable acronyms that include WAP, SAP, PAP, FAP, and CRAP. It is difficult for me to tell which of these is tongue-in-cheek and which is for real. One is tempted to toss all anthropic arguments into the rubric of pseudo-science because of overuse that has heralded proofs that extend from physics, including the uniqueness of the fundamental constants of nature and the closure of the universe, to metaphysics, with the imminence of nuclear Armageddon and the existence of a supreme deity.

A highlight of *Science à la Mode* is the story of Evariste Galois, the brilliant founder of group theory who was killed at the age of 20 in a duel over an infamous coquette. Did he really spend his last night frantically scribbling down the theory of equations, annotated periodically with the phrase "I have not time," before the dawn appointment? Or was Galois a political loose cannon, a dangerous republican firebrand challenging the entrenched establishment, who was set up by a female agent provocateur for the fatal duel? Rothman reveals that previous biographers, including E. S. Bell, Leopold Infeld, and Fred Hoyle, unduly romanticized Galois's life and death to create a legend that, without detracting in the slightest from his mathematical achievements, deserves debunking.

Other chapters are devoted to topics in cosmology. We learn about the many options that confront a cosmologist. Despite appearances, Rothman reminds us that the universe need not be isotropic or even homogeneous in the large. Inflation is lucidly explained as a phase of the very early universe that isotropized all we can see, but at a price. It predicts that the mean density of matter is far greater than is directly observed. The modern cosmologist invokes his version of epicycles: dark matter distributed

uniformly throughout space, or else a cosmological constant term in Einstein's equations to provide the required source of energy density in what is equivalent to an energy density of the vacuum.

A delightful essay on entropy demolishes pseudoscientific overuse of the second law of thermodynamics. Metaphors are fine, but applications to society and even biology seem hopelessly flawed. It is just as well that someone has challenged the propagator (who else but Jeremy Rifkin?) of such statements as "If love were antientropic, it would be a force in opposition to becoming, for the entropic flow and becoming go hand in hand," or "The governing principle of a low entropy world view is to minimize energy flow . . . a low entropy society deemphasizes material consumption," or again, "New genetic technologies, like recombinant DNA, might greatly increase the matter energy flowing through the system, just as the first industrial revolution did with renewables," or to balance this, "The practice of meditation is designed to slow down the wasteful expenditure of energy." Somewhere along the way, "entropy" and "energy" have gotten hopelessly confused, but this is the least of one's worries: after all, as Rothman notes, Clausius said their meanings are nearly identical. Nearly, but not quite: that ultimately is the distinction between science and pseudoscience.

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Genetic Structures

The Molecular Biology of Plastids. LAWRENCE BOGORAD and INDRA K. VASIL, Eds. Academic Press, San Diego, CA, 1991. xxvi, 340 pp., illus. $109. Cell Culture and Somatic Cell Genetics of Plants, vol. 7A.

DNA molecules, like organisms, have an evolutionary history that can be read by comparative studies of their structure. These studies find their ultimate expression in the analysis of genomes that have been completely sequenced in several different species, for in these cases all of the available evolutionary information has been obtained and the investigator can focus on interpreting it. Plastid genomes are a notable success story, for their structure has illuminated the evolutionary history of photosynthetic organisms and provided insights into evolutionary mechanisms. Thus it is entirely appropriate that the term "molecular biology" as used in the title of this book includes evolutionary analyses as well as the study of plastid DNA replication, transcription, and translation.

Appropriately, the book begins and ends with evolution. Palmer's review of the gene content and structure of the chloroplast chromosome is thorough, thoughtful, and authoritative. A fairly detailed picture of the evolution of the plastid genome is emerging now that the chloroplast genomes of a number of plants and several algae have been largely or entirely sequenced and others thoroughly mapped. The transfer of genes from chloroplast to nucleus is well documented, and a picture of the evolution of introns is emerging. Mechanisms of these and other evolutionary changes in genome structure are now being examined by comparative and evolutionary studies. Gray concludes the volume with a review of information and ideas about the early evolutionary history of chloroplasts. Their origin from cyanobacteria-like endosymbionts is well established; now the intriguing question is how many separate endosymbiotic events occurred. Remarkably, it appears that the chloroplast of the cryptomonad algae is derived from a eukaryotic symbiont rather than a prokaryote. Together, the chapters by Gray and Palmer constitute the best available review of chloroplast genome evolution. The evolution of gene sequences, as opposed to genome structure, is treated only cursorily.

In between these chapters on evolution are seven chapters on molecular-level phenomena. Two of these review the properties of the plastid envelope membranes and the transport of proteins into plastids. The great majority of plastid proteins are coded by nuclear genes and synthesized on cytoplasmic ribosomes, and hence must be targeted to the plastids. At the conclusion of their review, Berry-Lowe and Schmidt express disappointment that intensive study in many labs has failed to provide useful generalizations about the important features of transit peptides and their processing. Genetic engineers will be glad to know that a transit sequence from one gene can sometimes assist the import of another gene, but there are no clues about how to improve the process or why some combinations don't work.

Replication, transcription, and translation of plastid DNA and the structure of tRNA and rRNA genes are the subjects of five chapters. There is some overlap, especially with respect to transcription, but surprisingly little given that each chapter has different authors, and the net result is thorough and critical coverage. The plastids have been a great source of novelty and puzzles for molecular biologists. An example is the remarkable case of the chloroplast RNA polymerases. There is a well-characterized soluble polymerase with subunits coded by four different *rpo* genes. But these genes and their protein products show surprising evolutionary variability in size for presumably essential proteins. There are hints that there may be more than one RNA polymerase, but no other plastid genes have been found to code for them. Moreover, the *rpo* genes are missing from the plastid DNA of a nongreen parasitic plant, which is transcribed nevertheless. Other intriguing puzzles include the transsplicing of exons from separate transcripts and the trimming of the 3′ ends of transcripts. The chapter by Sugiura in which these phenomena are described is entirely too brief, at least as tantalizing as it is informative.

Gillham, Boynton, and Harris review the transmission genetics of chloroplast genes in plants and the alga *Chlamydomonas*. Genetic analyses have not played as large a role in the dissection of molecular processes in plastids as they have in nuclear genomes, but this is changing as *Chlamydomonas* acquires the kind of molecular genetic versatility typified by yeast and *Drosophila*. Plants are much less useful for plastid genetics because of the scarcity of biparental inheritance and recombination. Gillham and Boynton correctly emphasize that there are very different modes of inheritance in different species of plants: strictly maternal, strictly paternal, and biparental, in which plastid genes from both parents are seen in the progeny, but often in different individuals. Thus the rule is uniparental inheritance, not maternal inheritance. The authors meticulously review the multitude of deterministic processes that predispose inheritance toward one parent. Unfortunately they neglect stochastic mechanisms such as random replication, turnover, gene conversion, and random partitioning of genomes between embryonic and extraembryonic tissue. As a result their models cannot explain some important features of organelle gene inheritance, especially the various patterns of biparental inheritance seen most strikingly in *Chlamydomonas* and *Pelargonium*.

Although this book is part of a series entitled Cell Culture and Somatic Cell Genetics, intended to focus on the use of these techniques in biotechnology, much of it has no apparent bearing on genetic engineering and plant cell culture. In fact, where there are implications for applied work, these are usually not pointed out. This volume displays careful editorship, with lucid writing in remarkably uniform style and few production errors. The information content is too dense for it to serve as an easy introduction to chloroplasts. But for readers with some