the peaks higher'' made substantial progress. The General Education Board, the International Education Board, the Carnegie Corporation, the Rockefeller Foundation, and other such institutions were mobilized to that end. By 1930, Kevles reports, ''The profession had become highly pyramidic in institutional structure.''

The 1930's marked the infusion into American science of Hitler's émigrés, vastly enriching it, and saw as well the beginnings of big science, with its big machines, large research teams, and voracious appetite for money. And here is the crunch. To economic development and progressive reform the physicists added as an ally national security. The days of laissez-faire were over. Vannevar Bush and others attempted to enlist the powers of the Executive Branch on the side of the best-science program and joined battle with congressional adversaries such as Senator Harley Kilgore who resisted the political elitism of Bush and others of the scientific establishment. The Cold War sealed the Faustian bargain between physics and government. This bargain constituted what Kevles calls

> a revolution in the relationship of American physicists to their society and government. Now through the Office of Naval Research, the Atomic Energy Commission, and the National Science Foundation, they were supplied with what they had been seeking for the better part of a century—a system of federal support . . . insulated from political control.

Of course, in Faustian bargains the payment comes due. The 1950's witnessed the Oppenheimer case and McCarthyite incursions; the 1960's saw the rise of pork-barrel science and a severe antiscience reaction. The physicists, it should be noted, provided some of the most outspoken criticism of the science-defense-corporation troika, but nevertheless their community profited from the arrangement. The book ends with uneasy tensions still unresolved:

> How was physics to enjoy sustained support in identification with the needs of economy and defense, yet avoid becoming their creatures. . . ?
>
> How was the scientific community's demand for political elitism to be reconciled with the principle of politically responsive public policy?

Kevles's book is a curious mix of peaks and valleys. Overall, scientists, historians, and concerned citizens will find it provocative and informative. Physicists and historians of science may, however, find that it lacks strength when it deals with the ideas and praxis that help define the physics community. Despite hints to the contrary in the preface and despite neatly packaged ''scientific'' chapters, the scientific work of the physics community and the character of the institutions that succored it are not the author's main concerns. The real strength of the book lies in its forthright presentation of the public posture of the community. It is here that the author exercises command of his materials and injects the proper measure of skeptical insight. Kevles is knowledgeable, has mined the important archives, and has presented his work in a clear and readable form. Apart from an overly precious bibliography, he has made an evident effort to write well, for which he should be applauded. One hopes that Kevles's substantial contribution will stimulate historians of science to their long overdue work in providing studies of American scientific ideas and institutions during this century.

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Historical Lectures

History of Twentieth Century Physics. Proceedings of the International School of Physics ''Enrico Fermi,'' course 57. Varenna, Italy, July–August 1972. C. WEINER, Ed. Academic Press, New York, 1977. xvi, 462 pp., illus. $39.50.

In 1972 the Italian Physical Society for the first time devoted its two-week International School of Physics ''Enrico Fermi'' to lectures on the history of 20th-century physics rather than on some area of current research in physics itself. Charles Weiner directed the school and with the help of its secretary, G. Jona-Lasinio, organized the program and invited approximately 80 historians, philosophers, political scientists, and physicists as speakers and participants. The present volume constitutes its proceedings. It is incomplete in at least two respects: Léon Rosenfeld's lectures were lost to the volume owing to his untimely death, and none of the discussions have been included. A further deficiency is also apparent: owing to the long delay in publication, M. J. Sherwin's lecture has already appeared in print as one chapter in his 1975 book *A World Destroyed*, and substantial portions of others are by now well known to scholars. Nonetheless, the volume as a whole can be warmly recommended.

The individual lectures reveal some of the diversity and complexity of developments in 20th-century physics, as well as some substantial differences in the way they may be approached and analyzed historically. M. J. Klein, in tracing the beginnings of quantum theory in the work of Planck and Einstein, and J. Bromberg, in discussing the background to Dirac's first paper of 1927 on quantum electrodynamics and its implications for understanding the wave-particle duality, show the great value of close historical analysis of internal conceptual developments in physics. J. L. Heilbron's lectures on Thomson's, Rutherford's, Bohr's, and Sommerfeld's work on atomic structure between 1900 and 1922 illustrate this same point, but add a new dimension as well in setting this work within the general contexts of physicists' model-making endeavors and the state of the physics profession at the turn of the century. G. Holton, by contrasting the work of Millikan and Ehrenhaft in their pursuit of the electron and subelectron, respectively, establishes the way in which differences in age, educational background, philosophical commitments, styles and methods of research, and similar factors can lead to success or failure in physics research. Y. Elkana draws definite lessons for present-day teaching and research in physics in his deliberately provocative lectures on the historical-philosophical roots of modern physics, in which he advances a theory of the growth of scientific knowledge involving a critical dialogue between competing research programs.

Interspersed with these lectures by historians are ones by prominent physicists who bring their personal knowledge and experiences to bear on their historical reflections and analyses. P. A. M. Dirac and V. F. Weisskopf present captivating recollections of their life, work, and interactions with other physicists. H. B. G. Casimir sketches theoretical and experimental developments in solid state physics and superconductivity, recalls personal experiences he had with Ehrenfest, Bohr, and others, and analyzes in general terms the relationships between science and technology. E. Amaldi recalls in very extensive and illustrated lectures the neutron work of the Rome group in the 1930's and then turns to a discussion of postwar international cooperation in high-energy physics. L. Kowarski gives a closely related account of the origins of CERN and postwar big science. These last lectures are counterbalanced by W. Goldstein's impersonal analysis of postwar science and politics as viewed by a political scientist.

There is, in sum, hardly an essay in this volume that will not repay reading and reflection, and the volume is there-

fore valuable and successful on its own terms. It is, however, mistitled; it should have been given a more modest title such as "Aspects of the History of Twentieth Century Physics," for, in common with every similar volume published to date, it does not satisfy the need for a general historical overview of 20th-century physics. This is beyond doubt one of the greatest challenges facing contemporary historians of physics, or physicists qua historians, and one is therefore slightly disappointed that the Varenna lectures, taken together, do not make greater progress in this respect. The production of a more comprehensive and balanced history of 20th-century physics might well serve as the major goal and organizing principle for some future conference of historians, philosophers, political scientists, and physicists.

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Membranes

Structure of Biological Membranes. Proceedings of a symposium, Skövde, Sweden, June 1976. SIXTEN ABRAHAMSSON and IRMIN PASCHER, Eds. Plenum, New York, 1977. xii, 580 pp., illus. $49.50.

Faced with the prospect of reviewing yet another volume on membranes one is tempted merely to praise the book rather than to read it. In the last few years, at least four small paperbacks have appeared that are suitable for an undergraduate interested in an overview of the field, and many volumes have been published on specialized aspects of membranes—bioenergetics, structure, ion transport, biochemistry, and spectroscopic techniques. Yet we have been at a loss to know what book to recommend to a graduate student, postdoctoral fellow, or colleague who wanted to read brief, authoritative accounts of these topics. This volume of symposium proceedings is timely in that it deals with all these topics.

Perhaps recognizing that genius is "a gift for clever theft," the organizers of the conference selected as speakers scientists who have been clever in taking from physics and chemistry the concepts and techniques necessary to understand the structure and function of biological membranes. Consider the subject of bioenergetics. The chemiosmotic hypothesis of Peter Mitchell has produced both some of the most acrimonious debates and some of the most elegant experiments in biology in the last decade, and the power of the hypothesis in interpreting energy transduction in chloroplasts is amply documented by Avron, Pick, Shahak, and Siderer in this book. We were amused to learn that one can actually induce the emission of photons from the photosystem by "proton gradient-induced-reverse-electron-transport," an impressive testimony to the reversibility of the various reactions involved and to the predictive power of the hypothesis. The reconstitution approach to studying energy transduction, an approach that has yielded some of the strongest experimental support for the chemiosmotic hypothesis, is illustrated in the chapter by the preeminent workers on this subject, Eytan, Schatz, and Racker. The fluidity of mitochondrial components is reviewed by Hackenbrock, and cautionary notes indicating that the gradient of the electrochemical potential of protons might not be the only coupling factor in chromatophore membranes from photosynthetic bacteria and in mitochondria are sounded by Baltscheffsky and by Ernster, Asami, Juntti, Coleman, and Nordenbrand respectively.

The contributions dealing with physical "probes" of membrane structure (nuclear magnetic resonance [NMR], electron paramagnetic resonance [EPR], and fluorescence) emphasize the special problems that membranes, being heterogeneous, anisotropic systems, pose for the interpretation of the experimental results. The elegant contribution of Ehrenberg, Shimoyama, and Ericksson deals with the extraction of dynamic information from EPR spectra of spin-labeled lipids. They show how isotropic models that are widely used to interpret membrane data give quantitative results an order of magnitude different from those obtained from more realistic models. The contribution of Cullis, Kruijff, McGrath, Morgan, and Radda deals briefly with NMR and with a new technique, positron annihilation, but its emphasis is on the problems of interpreting fluorescent probe measurements. In particular, the authors point out the important problem of "clustering" of probes. Brûlet, Humphries, and McConnell present some interesting preliminary results on the effect of hydrocarbon phase transitions and cholesterol on the complement fixation of model membranes but point out that the observed effects (or lack of effects) are very sensitive to the nature of the spin-label probe employed.

All the contributions cannot be considered in detail here: we merely note that the book contains carefully written chapters authored or coauthored by the well-known investigators Chapman, Cadenhead, van Deenen, Luzzati, Metcalfe, Ovchinnikov, Skou, Stoeckenius, Tanford, and Vanderkooi.

The volume is dedicated to Hermann Träuble, whose death soon after the conference robbed the membrane field of one of its most brilliant and productive scientists. His chapter on membrane electrostatics, which is mainly theoretical, illustrates the many roles that diffuse double-layer potentials can play in biological phenomena. The book is a fitting memorial.

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Cellular Immunology

Lymphocyte Differentiation, Recognition, and Regulation. DAVID H. KATZ. Academic Press, New York, 1977. xii, 750 pp., illus. $24. Immunology.

One of the more thought-provoking aspects of current bioscience is the division between the chemical and the biological traditions. Each has its cultural norms, its own standards of required precision, its peculiar genre of publication output. Recent developments in the two chief branches of immunology research, the molecular and the cellular, illustrate the point well. The molecular tradition gives us precise amino acid sequences and x-ray crystallographic pictures of the antibody molecule, and it is beginning to address the structure and organization of the immunoglobulin genes. At first sight, the cellular tradition seems more untidy. Its attempts to make sense of the big scene, to grapple with the physiology of this exquisitely regulated molecular recognition and learning system, seem clumsy and imprecise. The contrast is deceptive, however, because, shining through the mass of pedestrian literature in cellular immunology, the perceptive can readily identify lines of activity that are capitalizing on classical insights. The division of lymphocytes into the two great families, the regulatory role of T cells in antibody formation, the "one cell, one antibody" rule, the genetics of immune responsiveness, the cellular mechanisms whereby the immune system distinguishes "self" from