sequently grew into a $700-million-a-year corporation, the GM of the rocket industry. But most significant of all was his role in forming the Scientific Advisory Board, a cluster of civilian scientists recruited to help determine the direction of research to be pursued by the Air Force. It was he more than any other individual who upset the prewar division of federal effort by which the National Advisory Committee for Aeronautics largely monopolized fundamental research in aerodynamics, leaving applied research to the military services. Under von Kármán's prodding, the Air Force adopted fundamental research as a major military responsibility. The successive steps by which this was accomplished are spelled out in Thomas A. Sturm's official history of the SAB. If Sturm's prose is bureaucratic, his study is nonetheless welcome as a factual and official supplement to the somewhat freewheeling autobiography.

This reviewer would take serious issue with von Kármán on only two points. He is unfair in charging military men with myopic resistance to recognizing the importance of basic research. He fails to support his sweeping assertions on this score, and it is he who is myopic in failing to appreciate such institutional factors as the built-in inertia of large organizations manned by short-term staff. And concerning his harsh condemnation of his old master Prandtl for serving Hitler, it is only fair to ask: would von Kármán himself have done differently had he not been a Jew?

In retrospect, one sees von Kármán as a remarkable human being. A great showman, he was an inspiring teacher. But he demanded as he gave; his friends soon learned the voracious requirements of his ego. His zest for intellectual creativity thrived on convivial drinking and the company of beautiful women. He was a thoroughgoing internationalist, and his science knew no national horizons; one of the great prides of his life was his role in creating AGARD, the Advisory Group for Aeronautical Research and Development in the NATO nations. As scientist and engineer, to the day of his death in 1963, he retained the faith of his childhood; he saw no conflict between science and religion: "science deals only with consistency, not with truth."

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Developmental Immunology

Ontogeny of Immunity. Proceedings of a workshop, Sanibel Island, Florida, Feb. 1966. RICHARD T. SMITH, ROBERT A. GOOD, and PETER A. MIESCHER, Eds. University of Florida Press, Gainesville, 1967. xiv + 208 pp., illus. $15.

One has only to skim through this volume to realize the magnitude of the revolution that has taken place in experimental biological science during the past decade. The subjects discussed constitute the moving edge of the area in which immunobiology, tissue transplantation, molecular biology, and developmental biology meet. Most fundamental is the problem of differentiation —one of the enigmas of biology, and probably the key to the eventual understanding and control of the problems of neoplastic growth, transplantation of genetically foreign tissues and organs, aging, and indeed of biological evolution itself. We have come a long way from descriptive embryology and from the classical biochemical "bag of enzymes" approach of Needham's *Chemical Embryology*. This workshop illustrates well the grist of modern biological science, as well as its exciting intellectual fare. It is clear from the list of professional and departmental affiliations of the participants that in this as in other areas of modern biology, the traditional academic departmental boundaries are being transcended. There is obviously a lesson for us here with respect to what constitutes the "best" academic background and training for our next generation of experimental biologists.

One of the participants, Schneiderman, discusses control systems in the differentiation of silkworms and recounts the fascinating story of the molting hormone, ecdysone, which Karlson and Butenandt isolated from 1000 kilograms of pupae, crystallized, and identified as a steroid. This insect hormone and its relatives appear to act on the cell nucleus, and perhaps on the genes directly, to set into motion the synthesis of specific RNA's involved in growth and molting. The discovery of biologically active steroids in insects certainly implies that steroid hormones are not a recent evolutionary acquisition of the vertebrates.

The formation of fiber cells from epithelial cells in the vertebrate lens provides another example of differentiation susceptible to the molecular biological approach. Here, Papaconstantinou demonstrates the synthesis of a new group of specific proteins, the γ-crystallins. Initially, the synthesis of these proteins is susceptible to inhibition by actinomycin D, but this susceptibility is lost in the fiber cell—a loss probably referable to the differential turnover of messenger RNA in the different cell populations.

The many questions and conceptual problems associated with differentiation of the lymphoreticular cells to specific antibody formation are discussed in a series of excellent papers. Following the now-classic observations of Fishman on the two-cell interaction (macrophages and lymphocytes) in antibody formation, Feldman and Gallily beautifully show the applicability of the Fishman concept to the production of anti-*Shigella* agglutinins by x-irradiated mice. Still not settled is the question of whether the macrophage-processed antigen acts as a "superantigen," or whether the RNA of the complex contains specific messenger-like information for the antibody synthesis.

Clearly, one is concerned here with *messages* between cells, or at least with functional interactions between cells in a given microenvironment, the significance of which is just beginning to be glimpsed. The technically relatively simple procedure for culturing human blood lymphocytes represents, as Hirschhorn so cogently explains, another model experimental system for the investigation of derepression, differentiation, mitosis, and the specific cellular and molecular events occurring during the immune response. The question of pre- and postnatal immunological function of the lymphoreticular system forms a separate "chapter" of this volume. What is the nature of immunological immaturity? The immunological responses of the fetal lamb and of fetal rhesus monkey (Silverstein), in contrast with those of the "fetal" opossum, in which plasma cells are not found until 40 days after birth (Block), give us pause in the use of the term "immunological immaturity"; certainly in the case of several mammalian species, including man, fetal spleen can be shown to synthesize γ-M immunoglobulins in vitro (Thorbecke and Van Furth). Hildemann contributes a thoughtful discourse on transplantation disease. "Purified" small lymphocytes derived from peripheral blood or thoracic duct lymph are apparently able to initiate graft-versus-host reactions. But here again, the question of the role of the macrophage, as well as of the identity of the lymphocyte type respon-

sible for the reaction, must be raised. Of further compelling interest are observations, previously published, of Schwartz and Beldotti and of Walford which suggest the possibility of *escalation* of transplantation disease to malignant lymphoma in mice. The transcribed discussions after each paper are excellent and add much intellectual zest to the proceedings.

This is a book that can be highly recommended. The challenge, intellectual stimulation, and excitement of current biology are all here. Would that examples from these chapters be incorporated into undergraduate and even secondary-school biology curricula. Here, indeed, are challenges to the young, eager mind, worlds to conquer. This workshop approach, oriented toward a defined, interdisciplinary problem, would seem to offer many advantages over the usual series of 10-minute scientific papers at meetings.

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Chromatography Updated

Chromatography. ERICH HEFTMANN, Ed. Reinhold, New York, 2nd ed., 1967. xlii + 851 pp., illus. $27.50.

This book brings up to 1965 the literature survey on thin-layer, paper, ion-exchange, gas, and liquid chromatography, electrophoresis, and gel filtration. Fundamentals and applications in biochemistry, nutrition, and pharmacology are reviewed, as well as chromatographic methods for the separation of inorganic ions, phenolic compounds, nonhydrocarbon gases, and hydrocarbons.

Of the 40 authors, 20 contributed to the first edition; 11 nationalities are represented, so the coverage of the international literature is good. No previous chapters have been deleted, and chapters on paper chromatography, thin-layer chromatography, and the separation of antibiotics have been added. Except for chapter 1, all chapters have been rewritten. It is, in fact, a new book. The format is pleasing, the figures effective, the type attractive, and the paper good. There is no author index. This edition is supplementary and complementary to the first edition. It is a generally useful compendium of the state of the art up to 1965 which is likely to be needed by all serious students of chromatography and which should be available in libraries.

This having been established, some criticisms are in order.

The historical introduction is disappointing. It highlights developments only to 1949. This is a serious omission, for since 1949 the advances in ion exchange, gas chromatography, thin-layer chromatography, and gel filtration have been phenomenal. In fact, the entire content of the book concerns fundamental improvements that have been made since the time the historical introduction leaves off. Of particular note has been the evolution of theories of chromatography at the hands of many brilliant theoreticians. Historically this has been a real breakthrough, for thanks to the theoreticians chromatography is on a much more rational basis than it was in 1949, and future developments will have their origins in the insights and predictions made by theory. A good opportunity was missed to indicate the gradually growing unity of general concepts and approaches that are now being recognized as applicable to all chromatography.

Considering the important role that theory has played and will play, it is also disappointing to find that each theoretical treatment grinds its own ax. For example, chapter 3 is based on the stochastic concepts of Giddings. Chapter 9 details that of van Deemter, Keulemans, *et al.*, which had its origins in the mathematical analysis of Lapidus and Amundson. Chapter 12 presents the theory of Glueckauf. No attempt is made to reconcile these theoretical expositions (and they can be reconciled). As a result the reader is left with three (at least) apparently unrelated sets of ideas, symbols, and units which, unless he has more than ordinary curiosity, will remain unrelated. The criticism above is valid, but it is minor. However, future writing will be forced to give greater attention to theory, and theory should bear a closer relationship to the state of the art.

One notes also the virtual absence of any reference to data processing. The conversion of analog data to digital form for further processing is of major concern and is even now an integral part of chromatography. Only one brief, casual reference to this important aspect of chromatography was noted.

A third criticism is of the apparent lack of information of some specialists concerning significant events in other fields. For example, on page 88, the statement is made that normal glass tubing will withstand a pressure of approximately 10 pounds per square inch, whereas in fact pressures of from 200 to 800 pounds per square inch have been used with glass tubes in ion-exchange chromatography since 1959, and pressures in this latter range are now routine in many laboratories.

A serious defect in most such texts as this is that they do not report, even briefly, on the significant developments, and they can be great, that take place between the time of writing and the time of publication. One may philosophically accept the proposition that a text is out of date before it is published. But need it be? A brief addendum to each chapter submitted at the time galley proofs become available would do much to dispel this difficulty.

In part 2, Applications of Chromatography, the treatments are generally of a high order. The chapters on the chromatography of proteins and on the separation of nucleic acids and related substances are particularly good. The chapter dealing with the separation of amino acids and peptides places a major emphasis on paper chromatography and in consequence is rather inadequate in its treatment of ion-exchange methods.

The comments above notwithstanding, and in spite of the unevenness that is characteristic of books with many authors, the text is a worthwhile record of advances in the field.

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An Important Friendship

Darwin and Henslow: The Growth of an Idea. Letters, 1831–1860. NORA BARLOW, Ed. University of California Press, Berkeley, 1967. xii + 251 pp., illus. $6.50.

There is no doubt that the Reverend Professor John Stephen Henslow (1796—1861) had a great if indirect impact on the development of science. It was Henslow's influence and instruction that enabled Charles Darwin to develop his interests in natural history, and it was Henslow who was responsible for Darwin's being offered the place of naturalist on the famous voyage of H.M.S. *Beagle*. Thus Henslow did much to advance the theory of evolu-