have felt lost in a modern, bustling research institution with a large staff, pressing schedules, grant reports, and expensive equipment.

Reviewing this life of Wilhelm Conrad Röntgen reconvinces one of the old adage that accidental discovery favors the prepared mind. But more than that is involved. Many other contemporaries were experimenting with cathode-ray tubes and also had the opportunity to discover x-rays. Several even noted the same phenomenon that originally attracted Röntgen's attention, but they passed on to other concerns which were the immediate focus of their attention. Röntgen not only observed the phenomenon and understood that it could not be the direct result of cathode rays, he then concentrated his studies on the properties and effects of these strange new invisible rays and on establishing their penetrating powers with photographic evidence.

It is also worth noting the limitations of even so precise and resourceful an experimenter as Röntgen. He erroneously suggested that x-rays were longitudinal vibrations in the ether and not transverse vibrations as visible light. He was unable to note any significant reflection, refraction, or diffraction with x-rays. The establishment of the nature of x-rays within the present electromagnetic spectrum was left for others to make 17 years after his initial discovery in 1895.

The mass of detail included sometimes makes Nitske's style ponderous, but the overall effect is informative. Anyone interested in Röntgen or in the history of physics at the turn of the century will find this work worth the effort. Particularly useful are chapters 7 through 15, Röntgen's three original papers on x-rays which are included, and the extensive bibliography.

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Autobiography and Essays

Wanderings of a Biochemist. FRITZ LIPMANN. Wiley-Interscience, New York, 1971. x, 230 pp., illus. $8.95

In *Wanderings of a Biochemist* Fritz Lipmann presents first an autobiography, which deals mainly with his scientific genesis and his personal philosophy, and then a collection of his essays selected for their humanistic and general interest rather than for their technical value. Lipmann initially set out to publish a number of his papers and essays with a brief commentary for continuity, but the scope of the book was altered, as he relates in his preface, following discussions with several of his students at the Rockefeller University, in which he found that the students were surprisingly interested in biochemical history and wanted to know more of how his important contributions came about. It is indeed fortunate that the original aim was not followed, for the scientific community would have been denied the opportunity to gain insight into the thought and the warm personality of Lipmann that he provides as he recounts the evolution of his many discoveries in the era when biochemistry grew to maturity.

Lipmann defines the "wandering" of the title as having a meaning somewhere between the German and the English connotation; the word as he uses it denotes not only "just wandering" but also "scientifically, following one's instinct without knowing exactly where it will lead." Lipmann's career has been distinguished by a sense of intellectual wandering, and his wanderings have been fecund. His work on pyruvate oxidation in *Lactobacillus delbruckii* led not only to an understanding of pyruvate metabolism in animal tissues but to the discovery of coenzyme A. The finding of this coenzyme and the elucidation of its function became the basis for research into protein synthesis, with all its far-reaching implications.

Lipmann started his career in medicine and wandered into biochemistry. Those of us who have been associated with him are fully cognizant of the fact that his medical training has played a significant role in shaping his research orientation and thinking. He himself writes, "The biological education to which the observant student is exposed in medicine is a superior preparation for any career." It is of interest to note that his first major opportunity to utilize his scientific ability was in the department of surgery at the Massachusetts General Hospital and not in a biochemistry department.

Lipmann had to pursue a career under the most adverse circumstances. Having to find a job as a Jew in an emerging Nazi Germany, or in the United States as a refugee who had yet to distinguish himself, were not conditions most favorable to a scientific wanderer. Lipmann's reflections on these matters evoke compassion from the reader.

Another facet of this book that should have attraction for all readers is Lipmann's interaction with the chief architects of modern biochemistry. He speaks of the time he spent in Meyerhof's laboratory at the Kaiser-Wilhelm Institute in Dahlem as his "adolescence" in biochemistry and says that his future research was subconsciously mapped out for him during this period. Lipmann was influenced not only by Meyerhoff but also by the mysterious hero from the top floor, Otto Warburg. Lipmann's account of his meetings with Lundsgaard and Nilsson leads one to a better understanding of how the pathway of fermentation was elaborated. His characterizations of these figures are vivid and are provocative to those who are interested in the history of science.

The narrative is supplemented with relevant excerpts from Lipmann's technical publications; this approach is most helpful in giving the reader an understanding of the reasoning behind his research. It is in this manner that we are led through the work on aldolase (carried out in Meyerhof's laboratory with Lohmann), phosphoproteins, acetyl phosphate, ~P, coenzyme A, uncoupling of oxidative phosphorylation, carbamyl phosphate, sulfate activation, peptide bond formation, and chain elongation. This list reads like a primer in biochemistry and certainly elucidates the fundamental role Lipmann has played in determining the course of biochemistry.

The general essays Lipmann has included in the second part of the book are timely and easily read. They range in subject from the function of the B vitamins through the evolution of mechanisms of biosynthesis to "Disproportions created by the exponential growth of knowledge." These papers are exciting discourses in biological thought.

Lipmann has shown in this book that biochemistry, thought by many to be only an experimental field, actually is a discipline with deep philosophical ramifications.

Lipmann's research has not been goal-oriented, but no one can question that his work will be of profound benefit to mankind because of its currently recognized importance in such fields as medicine and agriculture. One must take pause and contemplate whether

our present generation of young scientists will have the opportunity for the kind of wandering that has been so fruitful in Lipmann's case. Are not the pressures of goal orientation and relevance factors that prevent the luxury of wandering? Do not medical school admission boards take precautions to exclude those who have a tendency to wander? Does not the urgency of grant requirements hinder deviation? What will be the consequences for scientific wandering of the developing anti-research trend in our universities? Will all these factors preclude studies such as Lipmann's on *Lactobacillus delbruckii*, which laid the foundation of much of modern biochemistry, or Mary Shorb's on *Lactobacillus lactis*, which made possible the isolation of vitamin B_{12}, or McElroy's esoteric studies on firefly luminescence, which have become the basis of important new tools in clinical medicine and industry? Lipmann has clearly demonstrated the need of society for scientific wanderers, and his presentation should become a factor in refuting those who would deny that need.

This book should become a contribution equal to Lipmann's scientific accomplishments. It should serve as an inspiration to students at all levels as well as to mature investigators and can be of value not only to those interested in biological sciences but also to physical scientists, for it is a volume that should encourage a new generation of scientific wanderers.

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Arboreal Ontogeny

Growth and Development of Trees. Vol. 1, Seed Germination, Ontogeny, and Shoot Growth. T. T. KOZLOWSKI. Academic Press, New York, 1971. xvi, 444 pp., illus. $23. Physiological Ecology series.

As author, coauthor, or editor, Kozlowski has been responsible for a number of authoritative texts dealing with tree growth. The present work, the first part of a two-volume treatise, again bears witness to his energy and dedication.

It is no easy task to produce a comprehensive yet readable account of a subject like tree growth, on which there is an enormous and widely scattered literature, ranging on the one hand from the electron micrography of leaf surfaces to the gross morphology of tree crowns and on the other from basic biochemical and physiological processes to innumerable empirical observations on growth in the field. The inclusion of too many observations and opinions makes for very dull and confused reading, and lengthy arguments, welcomed mostly by the more critical reader, take up a great deal of space. To serve the needs of both pure and applied scientists, as the book intends, also means striking a reasonable balance between academic and practical aspects.

The author, clearly recognizing these difficulties, has sought a new approach. Instead of the usual treatment of this subject, organ by organ and process by process, he has concentrated on a developmental theme. After a conventional opening chapter summarizing morphological and anatomical features of crowns, leaves, stems, and roots, he devotes the next three chapters to a description of the significant changes that occur in vegetative and reproductive growth during the progression from the seed and seedling to the adult and senescent stage.

In many respects this is an attractive and stimulating approach. We begin to look at the growing tree not as a collection of seemingly independent organs but as a single organism proceeding from juvenility to adulthood and, finally, old age. There are, however, difficulties in maintaining this ontogenetic theme. Differences between species, the need for physiological explanations, and the increasing complexity of the organization of a tree as it matures entail constant side excursions which confuse continuity. Furthermore, there are physiological phenomena that influence growth and development at many different stages; for example, photoperiodism is involved in seed germination, bud dormancy, shoot growth, and flowering. This means frequent repetition.

The author has tried to deal with these problems by emphasizing general morphological development in the earlier chapters and continuing this emphasis in separate chapters on bud, shoot, and leaf development. A chapter on "within tree variations" allows him to deal with phenology and geographic factors, leaving most of the physiology of shoot growth, including environmental relations and internal hormonal control, to the final chapter. This scheme is not altogether unsuccessful, though it entails a considerable amount of cross-referencing.

The text is profusely illustrated and contains a wealth of information. The inclusion of almost 1000 references gives some idea of the extent of the reading involved in its preparation. We look forward to the second volume, which is to deal with cambial activity.

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