Books

Symposium on Radiobiology—The Basic Aspects of Radiation Effects on Living Systems. Oberlin College, June 14–18, 1950. Edited by James J. Nickson. 465 pp. John Wiley and Sons, Inc., New York, 1952. $7.50.

This is a good book. It is not only a welcome but also an indispensable addition to our library of radiobiology. Students of radiation effects will recognize that there is an important contribution because it is much more than a review of the literature.

A perusal of the pages of this book will inevitably take the reader's memory back to 1936 when the two-volume treatise, *Biological Effects of Radiation*, under the editorship of Duggar, was published. The next landmark in the subject was Lea's book, *Actions of Radiations on Living Cells*, of 1947. Since then numerous symposia and reviews have appeared of which the Fiat Review, *Biophysik*, Volume 21, edited by Rajewski in Germany, should be mentioned. There can be no doubt that the Oberlin Symposium of 1950 stands out as another landmark. Moreover, it provides the most comprehensive review yet made of the many diverse phases of basic radiobiology.

There are several remarkable highlights in this Symposium. One of the best of these is perhaps the paper entitled "Gene Mutations Caused by Radiation," by H. J. Muller. Scientists whose modes of thought are as divergent as those of biologists and physicists will find common ground in Muller's analysis of the facts of gene mutation. Everyone will be stimulated by his easy and thorough comparison of spontaneous mutations with those caused by physical and chemical agents. It is likely, too, that cancer researchers will find here cogent ideas about the possible ways in which gene molecules may be disturbed. The reader is aware here of the same sure touch that was felt, say, in the Pilgrim Trust Lecture of 1945.

Another feature of the Symposium is the treatment of the target hypothesis, which may be said to be a central problem of radiobiology. There is a real clarification of the meaning and limitations of the target theory. As for the application of this theory, Lea described the troubled situation as of 1947 when he wrote "There may be found in the literature discussion *ad nauseam* of whether the exponential survival curve obtained . . ." After this outburst he proceeded to give his brilliant and well-known analysis of the target problem. The Oberlin Symposium raises all the questions again. In four chapters (8, 17, 18, and 19) M. Burton, H. J. Muller, C. A. Tobias, and R. E. Zirkle each separately discuss the theory from four different angles. Taken as a whole, these independent analyses form an excellent critique of the target hypothesis. Tobias' analysis of different theories of the mode of action of radiation on cells presents much experimental data and culminates in a lucid section entitled "The Number and Meaning of Sensitive Sites in Cells."

The target theory assumes that there are certain sensitive regions in a cell wherein an energy absorption process has a high probability of eliciting a reaction from the cell. One of the required data in support of the theory is the determination of the size and shape of these submicroscopic, sensitive regions. In the papers of Muller, Tobias, and Burton this problem is clearly stated and is defined in terms of the experimental data.

Corollary to the determination of the size and shape of the sensitive region is the matter of the precise amount of energy imparted to the region when a "hit" is scored. Furthermore, there is the question of how the energy is conveyed from a single atom to the group of atoms comprising the target. These questions have had an interesting history, and to judge from this Symposium their treatment promises to become fascinating as time goes on.

For example, to account for the transfer of energy the exciton hypothesis has been introduced. The arguments supporting this idea were summarized in the Fiat Review, *Biophysik*, of 1948, by M. Schön. In the Oberlin Symposium the process of exciton migration of energy is discussed by R. Livingston, although he does not mention any possible direct bearing it might have on biological effects. The possibility of exciton migration of energy in the anharmonic crystal (as Schrödinger called it) of genic material is not speculated upon anywhere in this Symposium.

There is, however, a thought-provoking discussion by R. Platzman entitled "Primary Processes in Radiation Chemistry and Biology" in which he describes Auger disruptions. This is a new process for radiodiologists to consider and one which has not been pointed out before. Since the exciton hypothesis seems to be currently untenable or in disfavor, the Auger disruption may possibly serve as an admirable substitute. At any rate, it may be one of several primary mechanisms by which energy is transferred from the incident radiation to many atoms via an absorption in a single atom. Platzman's emphasis on the Auger effect in the light elements, carbon, oxygen, and nitrogen, is in the speculative stage. Here is the gist of his idea: ". . . there can be no doubt that, wherever a K ionization occurs, a relatively great amount of energy is communicated to a small region of space—perhaps a single molecule or a portion of a very large molecule. The 'primary process' embraces the effects of the initially ejected K electron, of the Auger electron(s), and of the multiple ionization, all centering at the atom originally affected. This energy, transferred in a single primary encounter, will soon be converted to molecular *potential* energy by electronic 'rearrangements'. . . ."

It is the soundly speculative discussion of this kind which makes the Symposium unique. In all directions the essayists take apart the fundamental notions of radiobiology and then proceed to indicate problems for solution or to point out directions in which work could be done profitably. Platzman's description of the possible role of Auger disruptions shows that the basic physical processes of radiation absorption in cells are by no means clearly understood yet. Indeed, his two chapters outlining the details of energy absorption emphasize how meager the experimental data as well as the physical theory are as regards energy transfer into aqueous tissue. Zirkle's chapter on "Speculations on Cellular Actions of Radiations" is a frankly speculative attempt to account for the shapes of mortality curves. In another direction, Brues and Sacher, dealing with "Radiation Injury and Lethality," heuristically apply the concept of the Gompertz force of mortality to explain some of the data. It should be noted in passing that Brues and Sacher present ideas that will appeal to cancer researchers.

There is one more feature which must be described at least briefly, not only because of its scientific interest but also for its social and forensic aspects. In the atomic age people will become more and more exposed to penetrating radiations, both in war and in peace. The question arises as to how much the physical gene system can tolerate in the way of exposure; in other words, will there be a degradation of the genes in man?

The discussion of "Mammalian Radiation Genetics" by W. L. Russell along with Muller's remarks on "The Way in Which an Increase in Mutation Rate Will Affect a Population" give a good summary of current thoughts on the genetic hazard of chronic radiation dosage. The implications seem dire and are not mitigated by the quantitative estimates given by Russell wherein he concludes: "There are, then, various reasons for thinking that the number of roentgens required to double the natural rate of mutation per generation in man is not as high as the 300 r estimated by Evans, and there is at least one argument, that advanced by Wright, for thinking that it may be as low as 3 r."

It is not feasible to list here all of the many highlights in this book. Briefly stated, there is a uniformly high degree of excellence maintained in the twenty-three papers throughout the Symposium.

The purpose as stated in the foreword is admirably achieved, namely: ". . . the objective would be a thorough examination of the fundamental concepts that exist in radiobiology." The thoroughness with which the subject is examined will appeal to many different specialists in the basic sciences as well as to cancer research workers in general. Each will find here vitally interesting material. There are six chapters in which the dominant role of radiation chemistry in the reactions of cells is well delineated. Along with the chapters on primary physical absorption processes they form a solid foundation to the subject which will please expert and novice alike. As for the concepts of radiobiology, the essayists have tempered theory nicely with experimental data.

The last four chapters contain much material of an empirical nature on the reactions of organisms to radiation. These will be of interest, for example, to radiologists for whom basic radiobiology in its present nebulous state cannot provide answers to their numerous questions on tissue reactions.

It seems too bad that a book of this magnitude and stature was published without an index.

Joseph G. Hoffman
Roswell Park Memorial Institute
Buffalo, New York

Color Measurement

Those concerned in one way or another with colorimetry and its applications will be interested in the recent publication of a readable book on the subject by Deane B. Judd, physicist in the photometry and colorimetry section of the National Bureau of Standards. The volume (*Color in Business, Science, and Industry*, 400 pp., John Wiley & Sons, Inc., New York, 1952, $6.50) is written, as the title would suggest, primarily for the edification of the principal users of color in contemporary America, the business man and the industrialist, but it should also prove helpful to the practicing color technologist as a working guide for use in approaching problems dealing with color measurement.

Short-Wave Radiation

The late August Hund was a pioneer in the use of high frequency radiation. In the two volumes appearing under the title, *Short-Wave Radiation Phenomena* (McGraw-Hill Book Co., New York, 1952; 1382 pp.; $20.00), he has displayed a wealth of data, formulas, and figures reflecting the experiences of a technical radio consultant and practical engineer who spent more than thirty-seven years in the field. These books present a rather detailed but somewhat uneven treatment of electromagnetic theory stressing the practical applications of the frequencies over thirty megacycles. Various numerical examples are treated in very great detail, the work being no doubt intended as a self-study aid to introduce to the nonmathematical worker the complexities of the subject. Fourteen pages of bibliography and an eighty-page index increase its usefulness as a reference.

Atoms, Molecules, and Solids

The *Quantum Theory of Matter* by John C. Slater (McGraw-Hill, 1951, pp. 528, $7.50) is an intermediate treatment of the structure of atoms, molecules, and solids; only a moderate knowledge of atomic and mathematical physics is presupposed. Atomic spectra, intermolecular forces, band theory of solids, electrical conductivity, semiconductors, and dielectric and magnetic effects are considered in some detail. The more difficult material is included in twenty-two Appendices at the end of the book. The presentation is simple and