jury. The Council recommends wide dissemination of knowledge about the safety record, the dangers, and the safeguards involved.

Other quotations are made from the extreme fundamentalist American Council of Christian Churches, from the Union of American Hebrew Congregations, and from such pacifist groups as the American Friends Service Committee, the Brethren Service Committee, and the Mennonite Central Committee. These may be summarized by quoting a statement of the Executive Council of the Friends Committee on National Legislation. "The only realistic defense efforts are those which prevent a nuclear attack by abolishing war itself . . . we in the United States should use our time, energies and resources to prevent the bombs from falling and to build the conditions of lasting peace. This is our only real defense."

It is probably only an oversight that the author does not refer, as does Feis, to the fact that in its use of atomic weapons against Japan the American military forces showed no trace of revengeful passion and were eager to avoid the hand-to-hand fighting of invasion warfare, which would incite such passions.

If the reader discounts the antimilitary prejudice and the apparently anti-American bias of the author, he can find in Hiebert's account of the religious issues involved some illuminating discussion of the current politico-religious-military tangle of the world's affairs.

Hit and Target Theories

Studies on Quantitative Radiation Biology. K. G. Zimmer. Translated by H. D. Griffith. Oliver and Boyd, London, 1961. 124 pp. Illus. 15s.

Studies on Quantitative Radiation Biology is a translation by H. D. Griffith from the German version of a publication which appeared in the proceedings of the Mainz Academy of Science and Literature under the title "Studien zur quantitativen Strahlenbiologie" in August 1960. It is a very condensed discussion of a problem that has puzzled many radiation biologists, that is, the physical basis of the effects of radiation on living organisms. This short book is divided into six chapters. The first three chapters (Short historical review, Generalized formal hit "theory," and Target "theory") that emphasize the basic physical approaches to radiobiology should be most useful for radiation biologists. These chapters which also bring out the limitations of the physical approaches and their possible pitfalls should be required reading for anyone who wants to conduct quantitative studies in radiobiology.

The "hit" and "target" theories were first brought into prominence in the late 20's and early 30's when the application of quantum theory to physics caused many investigators to apply something equivalent to quantum theory to the study of the effects of ionizing radiation on biological materials. The hit theory was first developed by Dessauer, and later the mathematical background was formulated by Blau and Altenburger. Still later Crowther and others, especially Holweck and Lacassagne, gave it further support. The important development of this concept really has come through the publications of three investigators: Timofeeff-Ressovsky; Zimmer, the author of the present volume; and Delbrück.

It is rather interesting to reflect on the background of the three investigators. Timofeeff-Ressovsky is one of the world's most prominent geneticists. After his return to Soviet Russia from Berlin at the end of World War II, however, he began to investigate the effects of radioisotopes on biological systems. Delbrück has gone on and made his mark in the phage field, as well as in this field, and in many other fields of quantitative biology not necessarily connected with radiation. Zimmer is the only one of the three men who has continued to work in this field, and he is now one of the important investigators in radiation biology.

It is unfortunate that the "hit" and "target" theories have been so much neglected in the last few years. Both are very useful and helpful for interpreting radiation effects, especially if the investigator is interested in the quantitative aspects of the interaction of radiation and biological systems. They have not, however, always proved to be the most useful, especially with the entrance of biochemical approaches to modern radiation biology.

It is just this emphasis on the physical rather than the chemical approach that makes the fourth chapter, "Theories of action through diffusible agents," less convincing and less thorough than the first three chapters.

Finally, in the chapter "Recent developments," the author discusses electron spin resonance. I agree that electron spin resonance is a most promising approach and that the study of free radicals may some day give us a picture of what is happening when radiation is absorbed by a living substance. It is surprising, however, that so little attention is paid in this chapter to the quantitative aspects that are emphasized so well in the first three chapters.

In this volume there is very little mention of the biochemical aspects of radiation effects, especially the modern development of the chemistry of nucleic acids, the chemistry of protein synthesis, and the transfer of information from nucleic acids to proteins. All these new developments have become very important in biochemistry and also promise to become a possible key to the study of the mechanism of radiation effects. The investigator who goes into radiation biology must be conscious of the importance of the physical interpretation of radiation effects, which is so well emphasized in the first three chapters, but he also has to remember that, in the study of the basic mechanism of radiation effects, he must not ignore biochemical changes in metabolism, in synthesis of compounds, and in the sources of energy for the living cell which come about in the chain of events following the original absorption of the radiation. Only by an interplay of every possible approach is there any promise that we will some day understand the mechanism of radiation effects. As a matter of fact, radiation studies are so deeply bound up with the study of the syntheses of living cells, including their genetical makeup, that radiation studies will always lag slightly behind the basic biological, biochemical, and biophysical studies; but they have often shown also that they can open a new field and lead to an understanding of the function of living organisms.

I would recommend this book most highly to anyone who is interested in radiobiology and the quantitative aspects of the effects of physical energy on the function of living cells.

ALEXANDER HOLLAENDER
Biology Division,
Oak Ridge National Laboratory