process; trial-and-error methods are inefficient in lens design. Dr. Jacobs uses the methods of theoretical computation of the aberrations, surface by surface, described by Conrady, whose notation he also adopts. The possible usefulness of the method involving the aberrations of the lens as a whole might be stressed. The notation and formulae given, for example, by Gardner in "Scientific Papers of the Bureau of Standards, No. 550," are excellent and give a deeper insight into the properties of complex systems; furthermore they permit the isolation of trial solutions quickly. A further possible criticism may be directed against the suggested computation of longitudinal aberrations; in camera lenses the lateral aberration on the focal plane is of practical importance while in telescopic systems the angular aberration is the most useful quantity.

The ideas involved and the general approach to a lens-design problem, together with the differential correction of a preliminary design, are treated in some detail. The student should obtain sufficient insight to design aplanatic objectives, standard eyepieces and simple telescopes. The final chapter discusses optical tolerances and gives methods for estimating quantitatively the permissible aberrations in a lens system. The text will undoubtedly prove useful to physicists as well as to technologists and helps to fill a gap in the literature on modern optics.

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SEROLOGICAL REACTIONS

The Specificity of Serological Reactions. By KARL LANDSTEINER, M.D. Revised edition. Cambridge 38, Mass.: Harvard University Press. $5.00.

WHEN the reviewer compares the first with the revised edition of this work, he is impressed with the extent to which the author has gone in rewriting and extending the discussions of the material comprising the first edition as well as his success in bringing each subject up to date as of 1944. The first edition contained 178 pages, including the index, as compared with 310 pages in the revised edition. The increased number of pages is due in part to the addition of new material throughout the book and the development of two new chapters, one of 35 pages entitled "Antigen-Antibody Reactions" and the second of 19 pages entitled "Molecular Structure and Intermolecular Forces." In all there are eight chapters in the revised edition.

In the previous edition the first chapter contained only a brief discussion of antibodies and of "specificity" as related to serological reactions. This has been extended to include a discussion of the "Principal Immunological Phenomena and Nomenclature." The reader is supplied with simple definitions of various immunological terms. Reference is also made to methods of immunization and to the significant steps that have occurred in the development of immunology.

The second chapter is entitled "The Serological Specificity of Proteins" and has been enlarged from 34 to 62 pages. The author has expanded his discussion of the work of Dean and Webb on optimal proportions and of Heidelberger and Kendall's work on estimation of the amount of antibody in serum by nitrogen analysis. In both the first and the revised edition the author speaks of the rabbit as being a rodent. This concept leads him to say that "from this it may be understood why rabbit immune sera are very useful for revealing dissimilarities in the proteins of other rodents, . . ." This is rather surprising since the zoologists have for many years classified rabbits as belonging to an entirely different order called Lagomorpha.

Further on in this chapter he discusses some of the newer factors determining specificity and says that "one can not safely offer an opinion concerning the specific groups of protein (determinants) as long as it is not known what the maximal size of such a determinant can be." The author seems to feel that the view advanced by Obermayer and Pick that aromatic groups have prominent significance is probably incorrect. He feels, however, that one can not flatly deny that aromatic groups may be of greater importance than others for the specificity of protein reactions.

Chapter 3 is entitled "Cell Antigens," and in size has been increased by nine pages. The author stresses in both editions the two kinds of specificity—the one observed in proteins and the other observed in cells. He has added numerous references to his discussion of heterophile antigens and their behavior as well as to the specificity of the Wassermann reaction, and suggests the inadvisability of the use of the term "antigen" in reference to the use of the Wassermann substance. He also adds a section of new material entitled "Antigenicity of Phosphatides, Sterols, Starch, et cetera."

The title of Chapter 4 has been changed from "The Specificity of Antibodies" to "The Nature and Specificity of Antibodies" in the revised edition. The chapter has been expanded from 14 to 20 pages. The first two pages of the chapter are largely rewritten. He has added a discussion of the work of Kidd and Friedewald and of Durham-Reynolds on natural antibodies, especially those acting upon material derived from the same individual and other members of the same species. The section on immune antibodies is completely rewritten. The subject is discussed under

the following headings: Physico-Chemical Properties, Purification Methods, Antibodies and Normal Globulins, Alteration of Antibodies, Plurality of Antibodies in Sera, Formation of Antibodies and the Theories of Antibody Formation.

Chapter 5 is devoted to a discussion of artificial conjugated antigens and serological reactions with simple chemical compounds. Most of the old material has been rewritten and much new material added. He calls attention to the observations of Haurowitz that strongly basic groups may be as effective as acid groups in directing specificity. The author has introduced new material under two new headings, one entitled "Carbohydrate-Azoproteins," and a second entitled "Pharmacologically Active Substances, Hormones." In connection with this the author discusses the attempts and failures to produce antibodies to strychnine and the success achieved in producing antibodies to thyroxine.

The title for Chapter 6 has been changed from "Chemical Investigations in Specific Cell Substances; Carbohydrates, Lipoids" to "Chemical Investigations on Non-Protein Cell Substances." In the revised edition one topic heading entitled "Serum Reactions with Phosphates and Sterols" has been deleted and four new topics added. These latter deal with "Complex Bacterial Antigens," "A Polypeptide-Like Haptene," "Preparation of Artificial Antigens Using Bacterial Proteins" and "Blood Group Substances," respectively. A few of the important things discussed by the author under these new headings are many recent findings relative to antigenic substances in both Gram-negative and Gram-positive bacteria; the polypeptide-like substance from *B. anthracis;* the new antigen prepared by combining the typhoid protein with the Shiga polysaccharide; and the precipitation of the blood group substance by antisera specific for the polysaccharides of Pneumococcus XIV.

Chapter 7 is entitled "Antigen-Antibody Reactions." In this new chapter the author discusses toxin neutralization, various aspects of the precipitin reaction, the mode of combination of antigen with antibody and serological specificity. In regard to agglutination and precipitation, the author concludes that it may be that both specific and non-specific forces may operate in the second stage of the reactions. As to the mode of combination of antigens with antibodies, he says that while there is data that warrants the correlation of serological specificity and chemical structure, yet "no finished theory of antibody reactions has yet been attained that is comparable to those that cover and make it possible to formulate the reactions of organic chemistry." While he frankly states that the present nature of the forces involved in serum reactions is still open to discussion, he says that "it is supposed that the union between antigen and antibody is brought about chiefly through electrically charged acid or basic groups, van der Waals forces and interaction between polar groups (or polar groups and ions) in which as Pauling emphasizes, hydrogen binding presumably plays an important part."

The final chapter of the book is contributed by Pauling and is entitled "Molecular Structure and Intermolecular Forces." Early in the chapter the author states that "it is, indeed, probable that the high specificity which often characterizes physiological activity is in most cases specificity of intermolecular interaction rather than primarily of chemical reaction with the rupture and formation of strong bonds." He discusses the structure of molecules, electronic van der Waals attraction, hydrogen bonds, and the interaction of electrically charged groups in proteins and their relation to serological reactions. It is a well-written chapter and throws light upon many statements made in the preceding chapters.

The reviewer feels that the book is well written and is indeed a classic in the field of immunology. It should be regarded as a "must" book for all who are both interested in the subject and who possess an adequate scientific background.

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THE ALGAE

Structure and Reproduction of the Algae. By FELIX E. FRITSCH. Vol. 2 (Phaeophyceae, Rhodophyceae, Myxophyceae). xiv + 939 pp. Frontispiece. 336 text figs. 2 maps. Cambridge: University Press. 1945.

PROFESSOR FRITSCH has undertaken the immense task of bringing together all that is known of the morphology and reproduction of the great plant group of Algae. Modern developments in this field are so extensive that it probably will not be possible for one man to accomplish this again. Only once before has it been successfully attempted, when Oltmanns[1] brought together a summary of all that was known about algae except their detailed taxonomy. Fritsch's two volumes are alike in treatment and constitute an advanced reference work. The amount of material reviewed is huge, and documented in detail; it is clear that every effort was made to include all significant work. After a Foreword the author analyzes the three great groups not covered in the first volume. These are dealt with in the same meticulous fashion which characterized the treatment of the Chlorophyceae and other groups covered earlier.[2] For each of the three classes there are several pages of general

[1] "Morphologie u. Biologie d. Algen," 1904–05, edit. 2, 1922–23.
[2] Vol. 1, 1935; SCIENCE, 83: p. 437, 1936.