are convenient for conveyance but they have to be soaked up before they are palatable.

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## SCIENTIFIC BOOKS

*An Introduction to Cytology.* By LESTER W. SHARP. McGraw-Hill Book Company, New York, 1921. 452 pages, 159 illustrations.

For a subject of such wide interest and great significance as cytology, there are surprisingly few text books. For years Wilson's classic work, "The Cell in Development and Inheritance," has been the chief reference volume, especially of the beginning investigator. Very recently two English texts, one by W. E. Agar, "Cytology, with Special Reference to the Metazoan Nucleus," and another by L. Doncaster, "An Introduction to the Study of Cytology," have appeared. These are good books, dealing in both cases, however, with a rather limited field and largely with animal material. There has long been felt the need for an introductory text which would present an outline of the subject in both its botanical and zoological aspects. The rapid advances made by numerous investigators, working upon a great variety of materials, and the intimate relation of these in many cases to equally rapid developments in the other new science of genetics, have made the writing of a cytological text book a very difficult matter.

Professor Sharp, despite these obstacles, has done an excellent piece of work for he not only covers the fields of botany and zoology, but embraces in his consideration of subjects most of those necessary for an understanding of the scope of cytological knowledge. Very properly, however, he places emphasis upon the topics of greatest general interest. We find, therefore, that of the 452 pages of text, 240 are devoted to the hereditary mechanism and the results of its operation. Zoologists, particularly, will welcome so comprehensive a summary of the achievements of their botanical fellows as Professor Sharp presents. While this is naturally the strong part of the work, zoological material is well considered. Indeed, the author deserves special commendation for the completeness and fairness with which the contributions of zoologists are treated. In view of the general excellence of the book in this respect, it might be permitted, in the interest of the accuracy for which the author very evidently strives, to point out that in a few cases he has allowed his personal studies to influence his presentation of topics concerning which there are differences of opinion. Perhaps the most conspicuous example of this is in the discussion of the differential structure of the chromatin thread. While there may be uncertainty on this point in plant material, there is none in many animal forms.

The method by which the material is presented is entirely to be commended. In recognition of the developmental stage of the subject, Professor Sharp has endeavored to set forth its status by showing what the problems are and how they are being met, rather than by attempting to define in categorical terms the content of our knowledge. The spirit and motives of an investigation are as important as its achievement, and, since cytology is now so largely a matter of discovery, it would be a misrepresentation to exhibit it otherwise than as an active field of research.

As practical measures for such a presentation it may be noted that the numerous illustrations are, almost always, copies of those found in research papers instead of those from text books; extensive bibliographies follow each chapter, offering the means for a comprehension of the extent of the work done and for following up any particular subject;[1] there is a full index in which may be found the taxonomic position of all materials discussed; scattered through the chapters are brief historical or critical reviews of nomenclature; there are frequent diagrammatic figures which

[1] As indicating the scope and character of these references it may be noted that at the end of Chapter XI, "The Reduction of the Chromosomes," a total of 170 individuals, of 11 nationalities, are quoted. The distribution of these biologists is interesting, indicating, as it does in a general way, the interest in cytology exhibited in different countries. Of the 170 individuals referred to, there are 54 Americans, 46 Germans, 26 British, 13 French, 9 Japanese, 7 Scandinavians, 6 Belgians, 4 Hollanders, 2 Russians, 2 Italians, and 1 Pole.

present concisely the essential steps in the processes under consideration. These, with other features, make the book very accessible and helpful. It might here be suggested that the diagrams would be improved by larger index characters, and that somewhere a concise index to the various terminologies scattered through the chapters would make them more available.

It is not to be hoped that in a book of this character there should be an absence of errors, although in this instance they are not so numerous as usual. Certainly they do not render the text as a whole unsafe for the unguided beginner. Because of the merit of the book in general and its obvious adaptability to the present needs of a great variety of people, it is particularly important to reduce errors of all sorts to a minimum. Undoubtedly, the cordial invitation of the author for assistance in eliminating these will be met with a helpful response by his fellow workers. Here it should suffice to speak of only more general features needing attention.

Owing to the fact that the book will most largely be used by those generally unfamiliar with cytology, and having varied approaches to it, there is need for the greatest clearness in distinguishing between the different categories of objects and conditions described. This is not always done and there is sometimes confusion between gene and character, and between the valence of the elements in the chromosome complex. In the effort to simplify the presentation of the maturation phenomena in some of the diagrams, only one mitosis is shown. While this displays clearly one of the important conditions of meiosis it entirely neglects another, viz., the essential unity of the two maturation mitoses as a process. This is further emphasized by the consistent use of the terms "heterotypic" and "homotypic." Enough evidence has been presented to show beyond question that the first maturation mitosis is not necessarily a reduction division as the terms imply. It is necessary only to recall the behavior of the sex chromosomes in the Hemiptera and the "selected chromosomes" in Phrynotittix, as described by Wenrich, to demonstrate this. There is something in meiosis besides a reduction division and an ordinary equation division. It is important to show clearly that meiosis is a unique phenomenon.

Doubtless, there are other instances of similar differences in point of view between author and reviewer which might be used to illustrate the present status of opinion in cytology, and the degree of adaptability of the text of Professor Sharp as an introduction to the subject. What has been given will, however, suffice to show that the existing differences of opinion are not extreme, that they are fairly presented in the text, and that in their exposition, a work has been produced that will serve to extend the usefulness and influence of cytology greatly. It is not venturing far to predict that the "Introduction to Cytology" will take its place as a worthy member of the very successful series of which it is a part.

C. E. McCLUNG

## SPECIAL ARTICLES

### CONTINUOUS RENEWAL OF NUTRIENT SOLUTION FOR PLANTS IN WATER-CULTURES

IN the experimental study of the salt nutrition of plants, it is of course very important that all the influential features of the culture media be definitely known. The initial composition of a mixed salt solution employed for water-cultures may be known with a marked degree of accuracy, but the chemical make-up of such a nutrient solution begins to be altered immediately after the introduction of the plants; materials, of course, move from the roots into the solution, as well as in the opposite direction, and the solution soon becomes significantly different from what it originally was. Since there is no feasible way by which all the various kinds and rates of alteration may be adequately determined, the culture solutions must be renewed from time to time if the growth of the plants is to be correlated with known chemical conditions surrounding their roots, and renewal must be frequent enough to allow these unknown alterations to be regarded as uninfluential.

How frequently water-culture solutions should be renewed is always a difficult question. With small culture vessels, with large plants, or with many plants in a vessel, it is