Genetics, the Axial Thread of Biology

Education, despite the attention it commands, remains an immensely complicated, subtle, and tenaciously recalcitrant subject. As Thomas Huxley pointed out, to steer dexterously between the "Scylla of teaching too little and the Charybdis of teaching too much, is no easy matter and the great practical problem of education is to avoid both rocks."

When Huxley wrote his textbook on elementary biology in 1875 he was emphatic in his belief that the separation of biology into zoology and botany was artificial and that the study of "all living bodies is really one discipline." A scant 10 years earlier Mendel's experiments had been published unobserved, and the term genetics had yet to be invented. Today the science of genetics is widely recognized as the axial thread of biology, and publishers' shelves testify to the increasing number of textbooks that offer the student a background in genetics. Two of the three books considered in this review—**Genetics** by Irwin H. Herskowitz (Little, Brown, Boston, 1962. 476 pp. $7.50) and **Genetics** by Robert C. King (Oxford University Press, New York, 1962. 358 pp. $7.50)—present the science of genetics in the round, whereas the third—**Evolution and Genetics** by David J. Merrell (Holt, Rinehart, and Winston, New York, 1962. 437 pp. $6) discusses the particular role of evolution in biological thought. The book by Herskowitz proclaims its modernity by the familiar adornment of the two-stranded DNA molecule, while the classicism of King's book is suggested by the representation of the drosophila chromosomes.

Genetics by Irwin H. Herskowitz (St. Louis University) is a sturdy and thorough introductory treatment of the science of genetics. If this were all, it would be laudable but unexciting. But Herskowitz has managed to inject the vigor and pace of modern genetics into his book while recording the systematic interconnection of well-established genetic facts. The book is divided into 49 chapters, which, at the price of a certain telegraphic abruptness, provide easy reference. However, the largeness implied by the multiplicity of chapter headings is never quite achieved, and the book remains an introduction. One of its most successful aspects is the way the author has come to terms with the problem of embracing the new genetics without summarily jettisoning the old. Herskowitz has used a novel approach in that many of the chapters have been focused on the work of particular named investigators, thus effectively incorporating authenticity into the text while encouraging the more adventurous student to pursue the original papers. The need for the geneticist to understand the basic chemistry of nucleic acid is not overlooked, and a commendably precise chapter on the chemistry of nucleic acids is included.

Rather more than one-quarter of the book deals with bacterial and viral genetics and the nature of the genetic code. It is particularly pleasing that these spectacular advances of the role of DNA are set clearly against the background of pneumococcal transformation. The chapter on biochemical genetics might have been clearer if the author had developed the subject from the observations of Garrod in man rather than from the work on nuclear transplantation by Briggs and King. The chapters on mutation and radiation are thoughtful and moderate, but it may be a little rash to assume that chemical agents are not responsible for a significant number of germ line mutations. At the end of the book the author has collected and reprinted the Nobel Lectures on genetic subjects. It is pleasant and rewarding to reread the lectures of Morgan (abbreviated), Muller, Beadle, Tatum, Lederberg, and Kornberg. In summary, it would be hard to praise this book too highly. Not only is its content admirable; it is, in addition, well written, excellently illustrated, and agreeably produced.

The other general textbook bears an identical title. It was written by Robert C. King (Northwestern University) and is presumably intended for a general undergraduate course in genetics. It is a hundred pages shorter than the Herskowitz text and makes no attempt to be as up-to-date or as comprehensive. In particular, the large contribution of microbial genetics is barely discussed, and information on the chemical nature of the genetic material is omitted. In contrast, the chapters on developmental genetics and chromosomal aberrations are particularly valuable and lucid. Human cytogenetics is discussed only briefly, and this discussion is marred by errors such as the statement that mongolism is due to trisomy of the smallest autosome. A series of questions to test the student's understanding are provided at the end of each chapter. The textual matter is clear and well presented, but in general this volume does not appear to have any clear-cut advantages over the classical work of Sinnot, Dunn, and Dobzhansky, or that of Srb and Owen with which it will inevitably be compared. Nevertheless, as an introduction to genetics, King's book offers the student a useful and accurate account of the basic principles but it should be supplemented by additional reading.

The third book of the trio has a more restricted but potentially more exciting term of reference. *Evolution and Genetics* by David J. Merrell (University of Minnesota) has been written "for those who wish to know more about the theory of evolution and the operation of evolutionary forces." The volume is divided into three main parts: the evidence for evolution, the mechanism for evolution, and evolution and man. The first two parts are approximately equal in length, while the section on evolution in man is considerably shorter. The unbalanced and rather lengthy recitation of evidence in favor of the concept of evolution in plants and animals was included because of the author's disquieting contention that "at least half" of the high school biology teachers do not believe in evolution. To be sure, ignorance still exists in knowing how man developed his capacity to think or evolve symbolic communication, but this clearly is not what Merrell has in mind. Moreover it seems doubtful that a full discussion of this problem could be legitimately included within the confines of this book.

The mechanism of evolution occupies approximately 150 pages and consists of a concise series of chapters dealing with fundamental principles of genetics,

beginning with Mendel's laws and the physical basis of evolution. Problems relating to population genetics are discussed clearly, and the role of polymorphism in evolution forms a special chapter. This section could perhaps have been profitably expanded. As the author points out, the relationship of falciparum malaria to the sickle cell gene is the best example of single gene heterosis, and it is a pity that the subject is dismissed in summary fashion. The clarity of the series of chapters on the mechanism of evolution is noteworthy, and these chapters provide a solid foundation for the section on evolution and man.

Unfortunately the chapters on human evolution are rather less satisfying. There is, for example, no real discussion of the problem of whether human evolution has come to a halt now that childhood mortality and birth rate have decreased. Thus we find no mention of Crow's useful index, Opportunity for Selection, with its initially surprising conclusion that the lower the birth rate the higher the index becomes. Although the phenomenon, unique to man, of cultural evolution is mentioned, it does not receive the treatment it deserves. The important but often neglected point that biological and cultural evolution are part and parcel of the same unified process could have been made more strongly. The book is, in general, well illustrated, but the inclusion of jejeune drawings in a serious text strikes a harshly discordant note. Despite these minor criticisms *Evolution and Genetics* is a sound treatise that can be expected to have a limited appeal. However, it seems unlikely that it will substitute for, let alone replace, the standard texts in the field.

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Enzymatic Mechanisms

Molecular Biochemistry. Edward M. Kosower. McGraw-Hill, New York, 1962. xii + 304 pp. Illus. $12.50.

As I predicted in an earlier review [*Science* 136, 1113 (1962)], the time is ripe for a profusion of books discussing the new and active field of biochemical or enzymatic mechanisms, or, as Kosower described it, molecular biochemistry.

The present book, a scholarly work aimed at the second-year graduate student, is organized in three sections. In one, on biochemical patterns, the author presents "a survey and classification of many of the reactions of intermediary metabolism" (63 pages), in which he attempts to initiate the nonbiochemist into some of the more important reactions and reaction sequences in metabolic reactions and the biochemist into a classification of biochemical reactions from an organic mechanistic point of view.

With this background, it is then possible to discuss in detail "the mechanisms of many of these reactions, with the relationship of the enzymatic reaction shown where possible." In this section, which is the heart of the book, the mechanisms of the following reactions are discussed: carboxylation and decarboxylation, enolization and aldol condensation, nucleophilic displacements, hydration and dehydration, imines, hydrolysis of esters and amides, principles of oxidation-reduction reactions, one-electron, two-electron, and atom or group transfer, pyridine nucleotides, flavins, and phosphates. It would have been desirable in certain of the discussions if the enzymatic counterparts of these reactions had been presented in more detail. As the author himself points out, his special interests are reflected in his treatment of pyridine nucleotides, a very complete and incisive treatment occupying 54 of the 208 pages of the second section. But this emphasis can certainly be justified on the basis of the author's experience in the field and also because a considerable amount of material is available on this topic. Other topics are not amenable to such treatment because the information needed to treat them within the context of this book simply does not exist. Consequently the book cannot be considered to be a balanced treatment of all topics in molecular biochemistry; it is rather a selection of some of the topics that have been amenable to experimental investigation. Particularly noteworthy are the discussions of the mechanisms of oxidation-reduction reactions and phosphate reactions, both of which are of great importance in biochemical systems and both of which have hitherto received little attention. Kosower's discussion has admirably corrected this deficiency.

The third, miniscule section deals with "one of the central problems of biochemistry, the 'active site'." It is an unfortunate reflection of the present state of our knowledge that this section is not the major part of this book, because it is obviously to this end that the book was written.

The book in general is well written and contains many ideas that will stimulate further research. The author has performed a heroic job of keeping the book up-to-date with many citations to 1962 articles; activity in this area can be measured by the fact that, even with such an accomplishment, the book is already out of date. Graduate students—of biochemistry and, in particular, chemistry—and others interested in this area will find this a valuable book.

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Botanical Classification

Plant Taxonomy. Methods and principles. Lyman Benson. Ronald, New York, 1962. ix + 494 pp. Illus. $11.50.

According to the author's preface, this book is "primarily written as a textbook for students who have already acquired some familiarity with plant classification." Its "orientation . . . is toward research," and it places "primary emphasis upon the dynamic application of taxonomic methods and principles. . . ." However, the book reflects too heavily Benson's own taxonomic views and research; because of this imbalance it may prove unsuccessful as a textbook. One finds, for instance, over a page of index references to *Quercus* and *Ranunculus* collectively, whereas such genera as *Achillea, Crepis, Layia, Oenothera, Potentilla, Rubus, Solidago,* and *Tragopogon* are scantily represented, or not listed. Similarly, such terms as *biotype, cline, cytotaxonomy, deme,* and *karyotype* are discussed briefly or not at all. At least a passing knowledge of the important research on these genera and of the meaning and significance of biosystematic terminology should be a part of the background of every plant taxonomist, even of those who believe that the study of evolution and the practice of taxonomy are disparate fields with little or no overlap in their objectives.