Genetics, the Core Science of Biology

Acquisition of a broader understanding of a particular branch of science may be an exhilarating experience.

Theodosius Dobzhansky

"Genetics is the core science of biology. . . . Genetics is unique in biology for its broad and fundamental theory, and for methods which provide approximate solutions of the problems posed" (Sager and Ryan, 1961). Being another geneticist, I like to hope that this prideful affirmation is warranted. It is certainly true that the interest toward genetics has increased greatly in recent years, not alone among biologists but also among other scientists and to some extent among the general public. Genetics is one of the fastest growing fields of study, and it impinges upon an extraordinary variety of problems of both the natural and social sciences, and even of the humanities. Different approaches to the field of genetics or to some of its subdivisions are represented in the fine collection of five books reviewed here: **The Science of Genetics** by Charlotte Auerbach (Harper, New York, 1961. 273 pp. Illus. $5.95); **Genetic Research** by Arne Müntzing (LTs Forlag, Stockholm, Sweden, 1961. 345 pp. Illus. S.Kr. 36); **Genetics on the Population Level** by Marianne Rasmuson (Svenska Bokforlaget Bonniers, Stockholm, Sweden; Heinemann, London, 1961. 192 pp. Illus.); **Human Genetics** by C. C. Li (McGraw-Hill, New York, 1961. 218 pp. Illus. $8.50); and **Cell Heredity** by Ruth Sager and Francis J. Ryan (Wiley, New York, 1961. 411 pp. Illus. $7.50).

The Science of Genetics, by Charlotte Auerbach, is addressed to the shadowy creature called "the general reader," but it disclaims any intention of providing a merely entertaining account of the more spectacular recent discoveries. On the contrary, it aims to give "the indispensable knowledge without which the most recent advances in genetics cannot be understood." To do this in a rather compact book, assuming no previous knowledge of biology, is really a *tour de force*, and it is remarkable how successful the brave attempt turns out to be. The order of presentation is unlike that of any other book on genetics familiar to me. The first chapter is in the form of a colloquy between a geneticist, a physician, a farmer, and a schoolboy earnestly discussing "What genetics is about." This is followed by a brief statement of the result of Mendel's work, by an equally brief introduction to chromosomes and genes, and only later by a more circumstantial account of Mendel's law of segregation, and by "A very little statistics" (without a single formula). Mendel's second law enters only in chapter 19 and is followed by a brief consideration of linkage. Eugenics is in chapter 13 and a discussion of the heredity-environment problem and of twin studies is in chapters 16 and 17. The nature of the gene and the story of deoxyribonucleic acid come in chapters 23 to 26, and the book concludes with "Evolution as seen by a geneticist." A series of simple and sometimes slyly humorous cartoons and eight plates of photographs illustrate the text.

The style of writing throughout is even, restrained, and simple, but without patronizing talking down. An attitude of judicious nonpartisanship is maintained without evading some "fighting" problems. Thus, Auerbach thinks that it is "not impossible that the genes that enable a person to excel in intelligence tests devised by Whites are more frequent among American Whites than among American Negroes," although "No reasonable conclusion can be drawn as long as there is no equality of environment and opportunity between the two groups." Dangers of genetic radiation damage are duly stressed, but the often neglected risk of genetic damage by chemical mutagens is given emphasis. Eugenical measures are endorsed in principle, but the more strident projects in this field are barely mentioned. In a book which says so much so concisely, some oversimplifications are probably unavoidable. Why human and other populations happen to carry heavy loads of harmful genes is not really comprehensible without explanation of the gene frequency concept and at least a dash of "mathematics." The conventional way of writing about genes as determining "traits" obscures the idea that the genotype determines the responses of the organism to its environments; one may well doubt that animals carry special genes which determine whether or not a heart will be formed (page 33). These few misgivings do not seriously detract from the value of the book as perhaps the most simply presented and yet solid account of basic genetics.

Emphasis on Botany

Genetic Research is an English translation (by the author himself) of the second revised Swedish edition of the text of genetics (also available in German) which is widely used, particularly in continental Europe. Coming from the pen of an eminent plant geneticist, the book properly emphasizes botanical materials and the aspects of genetics which bear on problems of plant breeding and scientific agriculture. I know of no other modern text which does this quite so thoroughly and so well. This does not mean that nonbotanical materials are neglected. Quite the contrary: *Drosophila*, the queen of genetics which some geneticists would now relegate to the position of a mere queenmother, other animals, and especially human examples are used wherever convenient. One chapter (the 21st) covers briefly the work on the genetics of bacteria and viruses. The presentation is accurate, up to date, and well balanced throughout.

Classical transmission genetics is outlined in the first two chapters, which

The author is professor of zoology at Columbia University; in 1941 he was awarded the Daniel Giraud Elliot Gold Medal by the National Academy of Sciences for his book *Genetics and the Origin of Species*, and in 1958, the Academy's Kimber Award for achievement in the science of genetics.

generally follow the historical sequence of genetic discoveries (except that the concepts of allelism, homozygosity, and heterozygosity are introduced in a chapter preceding that in which an account of Mendel's experiments is given). Sex-linked inheritance is discussed in chapter 14, that is, after linkage and the genetic maps of chromosomes (chapters 9 and 10); this is perhaps the only feature of the book which geneticists with a zoological background may find a bit contrary to their predilections. Mutation, genic and chromosomal, is discussed in chapters 16 to 19, physiological and biochemical genetics in chapters 20 to 22, population and evolutionary genetics in chapters 23 to 25 and in chapter 27, and plant and animal breeding in chapters 28 and 29. The book closes with a discussion of "Man and the laws of heredity" (chapter 30), which in my opinion is, unfortunately, the weakest chapter in an otherwise excellent book. Among the rather numerous texts of genetics now available in English, Müntzing's book is the most thorough in its coverage of the topics of particular interest to botanists and agriculturists: this probably defines its "ecological niche," although all geneticists, irrespective of their special interests, will find the book useful and stimulating.

Genetical Mathematics for Biologist Consumers

Though expanding rapidly in diverse directions, genetics is still an integrated science and preserves its logical unity. The two subdivisions of genetics which have made enormous strides in recent years are population genetics and, most notably, biochemical genetics. Rasmuson's *Genetics on the Population Level* and Li's *Human Genetics* deal, notwithstanding their dissimilar titles, with much the same subject matter, the mathematical fundamentals of population genetics. Writing mathematics for the benefit of biologists and students of medicine is a task that poses difficulties about equally staggering to mathematicians turned biologists and to biologists turned mathematicians. Many a biologist has been annoyed to read that certain formulas or equations "evidently" lead to other formulas or equations which to him look very different, and many a mathematician has been exasperated by the obtuseness of biologists who do not find these things so evident." Now, Li has shown himself in his previous books a real wizard at conveying genetical mathematics to the biologist consumer, and *Human Genetics* proves his hand has certainly not lost its skill. Rasmuson does equally well in her slightly shorter but just as rewarding book. Both authors begin with discussions of Mendelian segregations in families and of genetic equilibria in Mendelian populations. Li illustrates the genetic equilibria with amusing allegorical models of "Game of Give and Take," "The Glove Club," and "Muller's Trucking Company." Discussions of factors altering the gene frequencies then follow—mutation, selection, and migration pressures. Phenomena of inbreeding and random genetic drift in small populations are taken up next. The genetics of polygenically determined traits and correlations between relatives are discussed. Rasmuson concludes with examples of "Practical difficulties encountered in two problems of population genetics." It is a pity that Rasmuson's book does not have a list of literature references; Li gives a short but well-chosen list. So imposing has been the growth of population genetics in recent years that much of the material presented in the books by Rasmuson and Li is not to be found in older books. Of course, rapid growth of a branch of science is a two-edged sword, as far as books are concerned; the interest of new books is accentuated, but the rate of obsolescence is just as surely speeded up!

It is really a disservice to Sager and Ryan's *Cell Heredity* that its dust jacket claims the book provides "a wholly new synthesis of the field" of genetics and treats "The science of genetics as it appears today, within the framework of past findings." The authors say explicitly in their preface: "We have limited ourselves to the discussion of genetics at the cellular level." But they must be credited with a no mean achievement—a critical review and analysis of the truly magnificent advances of biochemical (or molecular, or physiological) genetics, advances which have not only transformed this branch of genetics in the last 20 years, and even in the last 10 years, but which are influencing the whole science of biology. The need for a book such as this has been keenly felt in recent years; the only other book covering very roughly the same field is *Genetics and Metabolism* by R. P. Wagner and H. R. Mitchell (1955), and a comparison of the two books suffices to show how spectacular have been the developments between 1955 and 1961.

To write a book about a new or a newly transformed branch of science means breaking new ground; an author has no precedents to follow and no old models to improve upon. Sager and Ryan have on the whole risen to the task, although it may be questioned whether the sequence of presentation they have chosen is the best possible one. The book opens with a discussion of bacterial transformations and of the chemistry of nucleic acids; this is followed by a discussion of mutation and of mutation rates in diverse organisms, from virus to man; of gene recombination, linkage, and chromosome maps; of recombination in viruses and bacteria. Chapter 6 is an excellent synthetic discussion of "What is a gene?" Then we return to recombination and to the chemistry of mutation; a chapter dealing with "Nonchromosomal genes" is intercalated; there follow discussions of gene action, of genetic control of cell integration, of genetics of somatic cells. The book closes with a perhaps too brief "Summing up."

The books of Rasmuson, of Li, and of Sager and Ryan will be most useful to graduate students and others familiar with the fundamentals of genetics. One hopes, together with Sager and Ryan, that "The acquisition of a broader understanding about a particular branch of science may be an exhilarating intellectual experience" also "to the curious-minded of all ages from college students, to mature scholars in disciplines other than genetics." Certain it is that no geneticist of any age can afford not to read and to study their book, if he wishes to be well informed about the most exciting recent developments in his field. No less certainly, the five books here reviewed show that the "core science of biology" is at present in a period of most rapid growth.

Nucleons in Nuclei

Nuclear Sizes. L. R. B. Elton, Oxford University Press, New York, 1961. 115 pp. Illus. Paper, $2.40.

This small monograph is on the subject of nuclear sizes and density distributions. Since Rutherford first noticed deviations from the point scattering formula bearing his name, the subject of nuclear sizes has been of continuing interest. Although the question of nuclear size and composition has stimulated a great deal of research,