GENETICS

THIRD EDITION

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Preface

The purposes of this book are to provide basic theoretical information about genetics, the study of heredity, and to present some of the experiments and reasoning through which this information has been achieved.

Although genetics is a modern science, it has grown even more rapidly in recent years and its branches now extend to almost all fields of biology. In fact, the diverse specializations of genetics enable it to occupy at present a unique central position among the biological sciences in that it ties together different disciplines that involve form, function, and change. This unifying "core" quality of genetics stems from the many levels in which genetic phenomena operate, from the molecules of cells, through developmental stages of individuals, to populations of organisms. Compartmentalization at each of these levels is common and even unavoidable since research work proceeds separately in each area of genetics. To picture genetics, however, only in terms of its many separate constituent parts leads easily to an unbalanced and fragmented view that does not do justice to the unity of the science as a whole.

Where does the unity of genetics lie? Initially the recognition of heredity began with the simple observation made among different organisms that "like begets like." In the course of history, however, the simplicity of this observation was replaced by many complex questions: From what source does this wonderful correspondence between generations arise? How is the knowledge transmitted that determines biological development? What factors account for similarities between generations and what for differences? What is inherited and what is not? What hereditary factors do members of a species have in common and in what factors do they differ? Why and how do new species of organisms arise? How can we control heredity?

A theme shared by all these questions is a concern with the materials and modes of inheritance. Since genetics is the science that seeks to answer these questions, it can be broadly defined as the study of biological material transmitted between generations of organisms. More exactly, this science encompasses studies of the kind of material transmitted, the manner in which this is accomplished, and the effect of this material on an individual organism and on generations of organisms. If we call this hereditary material *genetic material,* we can mark out the following areas of study.

1. What and where is genetic material?
2. How is it packaged and how is it transmitted?
3. How is it structured and how is it changed?
4. How does it function and how can it be manipulated?
5. What happens to it among groups of organisms as time passes?

The fundamental unifying theme of genetics is thus a material one that can be studied at many different levels of existence. The order of these questions and levels does not at all imply a rank of importance, since each aspect is only one facet of genetics, although some problems may assume more interest at particular historical times. It is with this over-all view in mind that the book is organized.

Within this framework a historical approach to genetics has been presented in many places for a number of reasons. First, in the swift progress of modern genetics, many aspects of our present understanding will rapidly be changed by future discoveries. Rather than be the study of a static set of axioms, a true presentation of genetics should include a sense of its continuity and progress. Second, such an approach provides many opportunities for a logical development of ideas from the simple to the complex and thereby facilitates learning. Third, the people who have contributed to a science and the relationship between their contributions are an important and interesting aspect of the science and help to encourage student interest.

For teaching purposes, the instructor can select sections of the text according to his training and inclination, but it is suggested that material be used from each of the basic subdivisions of the book with special emphasis on chapters included in the sections on transmission and arrangement of genetic material. A thorough understanding of basic genetic methodology and recombinational principles is extremely important in enabling students to forge ahead intelligently in areas of their own interest. One suggested

program for a single-semester genetics course meeting three times weekly is to include Chapters 1 through 7, 9 through 12, 16 and 17, and selected sections of Chapter 8 (e.g., chi-square) and of Chapters 19 through 32. A one-semester course that is oriented toward evolutionary problems can follow a similar program but include material in Chapters 14 and 15, Chapters 33 through 37, and omit material in Chapters 19 and 20, and 24 through 31.

M. W. S.

Acknowledgments

In the face of the large volume of genetic literature and the many important developments and changes that are continually taking place in genetics, it would be an illusion for an author to maintain, or for a reader to believe, that a textbook in this field can be written without errors or misinterpretations. For previous editions of this book I was therefore fortunate in obtaining the help of a large number of friends, colleagues, students, and publisher's reviewers, including: J. Antonovics, H. N. Arst, Jr., M. Ashburner, J. Boynton, D. J. Cove, A. Derby, Th. Dobzhansky, G. A. Dover, N. W. Gillham, G. B. Johnson, R. T. O. Kemp, D. W. MacDonald, N. E. Melechen, P. Oliver, J. H. Postlethwait, R. Rolfe, H. E. Shaffer, E. Simon, F. W. Stahl, H. D. Stalker, J. M. Thoday, L. Van Valen, H. L. K. Whitehouse, A. S. Wiener, and C. J. Wills. Exercise problems were offered to me by S. W. Brown, M. M. Green, J. A. Jenkins, and H. D. Stalker.

Material used in the present edition was reviewed at various stages by: T. Blumenthal, R. Bolla, I. Duncan, D. J. Fox, L. Grossman, C. Johnson, R. D. Milkman, G. O'Donovan, J. R. Powell, G. P. Redei, D. Sheppard, F. W. Stahl, C. Stoddard, and J. N. Thompson, Jr.

To improve the clarity of diagrams and to take advantage of color shadings, I drew or redrew the illustrations for this edition wherever possible. These were executed in final form by Vantage Art Associates, with the exception of a few figures in Part I which were completed by Elizabeth C. Cohen. Credits for illustrations that were borrowed or adapted are given in the figure legends, and the full citations are usually in the references at the end of each chapter. The references also include sources used for the text material as well as selected further articles or books that may be relevant. Citations for authors mentioned in the problems are usually not included in the references, but will mostly be found in the *Answer Manual for Genetics, Third Edition*, published separately by the Macmillan Publishing Company. I take responsibility for errors that remain, and I would be grateful if they are brought to my attention in a constructive fashion.

I wish to thank everyone at the Macmillan Publishing Company who worked on this new edition, especially Gregory Payne, editor, Dora Rizzuto and Edward Neve, production supervisors, Harold Stancil, designer, and Gwen Larson, production manager. I am grateful to C. Boyd for help with typing and other clerical tasks; to Paul B. Strickberger and Ursula Rolfe for helpful illustration suggestions; and to D. D. Dennis, F. B. Phillips, S. Presnell, and C. M. Redden for aid in indexing.

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