Genetics

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Preface

Genetics, the science of heredity, deals with the factors responsible for the similarities and differences between generations. These factors affect form and function at many different levels, from the molecules of cells to populations of organisms. The concepts of genetics are thus fundamental to all the biological sciences and play a central role in the study of modern biology.

The purpose of this book is to provide an introduction to genetics that is readable and challenging to students and broad enough in scope to serve as the textbook in a one-quarter, one-semester, or two-quarter general genetics course. In this text, we are giving what we feel is a balanced coverage of the major areas of genetics: cytogenetics, molecular genetics, population genetics, quantitative genetics, and transmission genetics, but in a fashion such that the component parts can be dissected out for individual course needs. The concepts and techniques of these areas are presented along with sufficient historical background to show how many of the important principles have evolved. Introductory topics, such as basic Mendelism, probability, and mitosis and meiosis, are explained in full, and many practical applications to fields such as agriculture and medicine are given. The book is thus suited for use in courses where students have varied backgrounds and interests.

The book consists of seventeen chapters, which are arranged into seven discrete sections to provide flexibility in the order of their use. The chapters start with a description of Mendel's experiments and the application of Mendel's rules of inheritance. This historical introduction is followed by a consideration of the rules of counting and probability and their application in the analysis of genetic crosses. Probability is introduced early in the book to maximize its use in problem solving. Five chapters (Chapters 5 through 8 and Chapter 12) deal with the concepts of cytogenetics and transmission genetics. The emphasis throughout these chapters is on the chromosomal basis of inheritance. Six chapters (Chapters 3 and 4, Chapters 9 through 11, and Chapter 17) cover topics related to the molecular basis of inheritance, and are more chemically oriented than the others. Although DNA, RNA, and proteins are considered at length, chemical notation and jargon are kept to a minimum since the text does not presuppose a course in organic chemistry. The remaining four chapters (Chapters 13 through 16) discuss population and quantitative genetics. Quantitative inheritance, selection, and breeding principles are covered in greater depth in these chapters than in most introductory texts, and thus serve as a useful source of information for students specializing in

animal and plant breeding. Other useful features of the book include an extensive glossary of terms and frequent internal summaries within each chapter, which help the student in reviewing important terms and concepts.

Although genetics is a comparatively young science, having developed primarily in the twentieth century, the growth of knowledge in this field has been phenomenal. Progress has been particularly impressive at the molecular level. As more discoveries are made, more techniques are developed that enable geneticists to probe even deeper into the molecular basis of inheritance. Research in modern genetics has therefore become a mushrooming industry that continues to open up exciting new areas of inquiry. The area of genetic engineering is a well-publicized example, in which recent technological advances have served to broaden our understanding of genetics at the molecular level and have provided new approaches to the synthesis of drugs and other chemicals and to pollution control. These new technologies also promise to have a major impact on the agricultural and medical sciences by providing tools for crop and livestock improvement and cures for genetic diseases. Since these new technologies have potential applications in all areas of genetics, we have included a detailed account of the current accomplishments and future prospects of genetic engineering in the last chapter, after the more traditional topics have been discussed.

Genetics is an analytical branch of science in which principles are expressed in quantitative terms. A certain amount of mathematics is therefore unavoidable. Despite the quantitative nature of the subject, the mathematical operations used in elementary genetics are not difficult, but require only the elements of algebra and a basic understanding of probability. A problem approach is used in this book to help the student develop the needed analytic skills and to provide the student with an opportunity to apply these skills to the analysis of genetic experiments. Graded sets of supplementary problems and review questions are included at the end of each chapter with answers given at the end of the text. The problems vary in character and degree of difficulty, and range from exercises that provide necessary repetition of basic skills to questions that are designed to challenge the student and test his or her comprehension of the subject material. Great care has been taken in the development of the problems to provide a useful teaching aid and to illustrate the wide range of applications of this area of study. Since students entering a beginning genetics course usually have little experience with problem solving, the book includes several numerical examples in the body of the text and number of solved example problems that are set off from the text proper. The solved example problems extend and amplify basic principles and help to familiarize the student with the logical sequence of steps that can be used in finding solutions to problem situations.

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Abridged Contents

Contents