Preface

EVOLUTIONARY BIOLOGY IS ONE OF THE CORNERSTONES of modern science. The publication of *On the Origin of Species*, by Charles Darwin in 1859, changed forever the way that people view life on our small planet. Over the 150 years since, the study of evolution has itself evolved, taking a quantum leap in the past 20 years through the exciting discoveries that have occurred at the interface of molecular and evolutionary biology. The powerful tools available through the use of molecular markers, genome sequences, and genetic manipulation have provided extraordinary insights into how evolution works. In addition, a fascinating new realm of natural history has opened up, revealing a remarkable variety of molecular adaptations and an array of fundamental molecular mechanisms that are unexpectedly conserved throughout the living world.

Yet, these remarkable developments in evolutionary biology are scarcely reflected in the way that evolutionary biology is taught. Recent advances in topics such as molecular evolution and developmental evolution are often relegated to minor chapters in other textbooks. Our aim here is to integrate these and other modern breakthroughs into a complete evolutionary perspective that forms the central theme of the book.

Fundamental principles are illustrated repeatedly across all levels of organization (from molecular to organismal) and the entire diversity of life (from microbial to human). We illustrate the basics of natural selection using in vitro selection on RNA molecules and using the Galapagos finches (Chapter 17). We show how selection can be measured in laboratory populations of yeast and in natural populations of deer (Chapter 19). We illustrate evolutionary optimization using mating behavior in dung flies and metabolic flux in *Escherichia coli*, and we illustrate evolutionary games using production of toxins by bacteria and mating behavior in lizards (Chapter 20). We show how evolutionary conflicts occur between transposable elements and their host genomes and also between bees in a hive (Chapter 21).

The interdisciplinary approach that we adopt will be valuable to students from a whole-organism background (the majority of students now taking evolution courses), because it will widen their perspective on the scope of evolutionary biology and show them the new methods that are so important in current research. The integration of molecular and evolutionary biology also will be attractive to students whose background and interests are primarily molecular and to faculty in molecular biology departments who develop modern evolution courses.

Structure of the Book

The book is divided into four parts. In Part I, we summarize the history of evolutionary and molecular biology and the evidence for evolution by natural selection. As well as

giving a historical overview, this provides a compact summary of our current understanding, which guides the reader through the rest of the book. Part II describes the origin and diversification of life, including biochemical as well as morphological complexity, and gives a balanced treatment of bacterial, archaeal, and eukaryotic diversity. This section includes some of the most exciting recent discoveries in biology, such as the identification and characterization of particular genes and genetic pathways that play key roles in development and important roles in the morphological evolution of plants and animals. In Part III, we explain the fundamental processes of evolution: mutation, random drift, recombination, gene flow, and, most importantly, natural selection. We then bring this understanding of the evolutionary process to bear on major questions: Why do organisms age? How can conflicts between organisms be resolved? How do new species originate? Why is sexual reproduction widespread? How do novelties evolve? In the final two chapters (Part IV), we turn to our own species, describing our evolutionary history and discussing the implications of evolution for humanity today.

This book provides the basis for a full course on evolutionary biology: building from a historical overview of evolutionary and molecular biology, through an account of the origin and diversification of life, to an explanation of the processes of evolution and how they interact, and ending with application to humans. Parts of the book can also be used as a text for smaller courses.

- Chapters 1–3 give a concise overview of the subject.
- Part II provides material for a course on the origin and diversity of life. More specifically, Chapters 5–8 form the foundation for a course on microbial evolution.
- Part III treats the topics found in standard texts on the processes of evolution but with a strong molecular emphasis. Ideally, this would follow from a course based on Part II.
- Chapters 14, 17, 19, and 26 provide a course in quantitative genetics that goes further, and is more up-to-date, than any other textbook at this level.

Web Resources

Our book is accompanied by an extensive Web site, which will be especially valuable for instructors and advanced students.

- Most of the illustrations are available in a form that can be used in lectures.
- The index and glossary, which are included in the printed book, are also available online. All glossary terms are highlighted in **bold** at their first appearance within a chapter. Terms that are used only once may not be in the glossary, but can be traced using the index.
- Each chapter is accompanied by discussion topics, which will allow the student to review ideas and should stimulate further thought.
- Chapters in Part III are accompanied by problems. It is important that the student work through these, so as to reinforce the quantitative material in these chapters. Some of the problems are more advanced and will require knowledge of the material in the online chapters (see next bullet).
- The main text describes the basics of quantitative and population genetics. The Web site includes two supplementary chapters, which allow students to build on the basics and explore more quantitative aspects of the subject. Chapter 27 explains methods for inferring phylogenetic relationships, and Chapter 28 shows how the evolutionary process can be modeled. (These chapters are not indexed, but they can be searched, and are accompanied by Web Notes, as explained below.)

Exploring the Literature

It is important that the reader uses this book as a platform to explore the literature of evolutionary biology. The success of science depends on being able to trace the evidence and arguments that support each statement and on this web of knowledge being open to all. We have not cluttered the main text with references to our sources, but have provided several routes into the literature. At the most basic level, each chapter ends with a Further Reading section, which lists reviews that cover the material. On the Web site, we include a section that describes the most useful journals in the field and explains how online databases such as the ISI Web of Knowledge and Google Scholar can best be used to search the literature. Each section of the book is accompanied by Web Notes, which give the primary sources for the material in the main text and expand on some points. Together, the Web resources make it straightforward for the reader to go beyond the introduction that we provide in the main text and to explore the subject in depth.

Evolutionary biology is an active and thriving field. Much is well established, but there are many open questions, and new discoveries are continually opening up new questions, which are highlighted throughout the book. We aim to set out clearly what *is* known, but also to lay out the evidence and arguments upon which this knowledge is based and to show how we can set about answering new questions. Our book is unique in integrating molecular biology with evolutionary biology—an approach that reflects the convergence of these fields in recent years.

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