Preface

The study of biology continues to undergo profound changes as we approach the twenty-first century. Courses and textbooks that emphasize facts, vocabulary, isolated concepts, and content without context are being supplanted by new curricula designed to provide students with an understanding of the scientific enterprise and the excitement that characterizes studies of the living world. We wrote *Biology: The Network of Life* as a textbook to compliment this new way of teaching and learning. Since the publication of the first edition we have communicated with hundreds of colleagues. Their comments and suggestions validated the relevancy of our approach and aided us considerably in refining the second edition.

GOALS OF THE SECOND EDITION

We have pursued six goals in writing the second edition: They are:

- To convey *fundamental knowledge* of the major principles, concepts, and ideas of modern biology.
- To explain principles, concepts, and ideas related to biology within a framework of the *process of science*. Accurate historical information is an essential component of the approach.
- To promote an understanding of *scientific inquiry*, the methods, approaches, and techniques scientists use to answer interesting questions.
- To present *content in context* to facilitate learning.
- To concentrate on *relevant information* that has significance, now and in the future.
- To provide students with a background that will encourage *lifetime learning* and ongoing interest in biology.

THE PROCESS OF SCIENCE

The framework of *Biology: The Network of Life* is that scientific information is presented within a context of the *process of science*. The process of science considers the total dynamic enterprise of science. It encompasses questions that biologists address, the origins of those questions, the methods used to tackle the questions, the answers achieved, the resulting effect on the general picture of nature, the directions of new research, the institutions in which all the work is performed and the social context in which questions arise, are investigated, and are funded.

Central to the process of science are questions that motivate *scientific inquiry*. Scientists work hard to answer important questions, using diverse methods, techniques, and technologies. They also raise new questions, often as a consequence of answers obtained to old questions, or as a result of new, related observations, technological advances, or relevant information from another field. In some cases, questions that drive research are answered quickly, within a few months or years. Some questions, however, were posed by our ancient ancestors and, to this day, have not been answered completely. Early Greek philosophers first asked, "Why do offspring resemble their parents?" Although we now have a reasonably solid answer to that question, it is not yet complete because molecular geneticists continue to make new discoveries that apply to the original, ancient question. Finally, some questions, after driving research for a period of time, turn out to be dead ends. For example, in 1628, William Harvey published a book in which he accurately described the motion of the heart and the circulation of blood in humans. Soon after this a new question arose: "Do plants have hearts?" Although this question stimulated research for many years and led to a better understanding of plant structure, no one found a plant heart, and scientists turned to other questions. Thus science can be thought of as a *lineage of questions* in which the search for

answers to one question or a set of questions leads to a new question or even a whole new set.

Lineage of Questions

The concept of lineage of questions reflects the dynamic nature of biology. It is often difficult to grasp the ever-changing nature of biology because of the enormous amount of information being generated. However, historians have shown that science is constantly changing. This feature of science is often confusing to students, who may believe that change means that earlier conceptions were wrong. In fact, change is consistent with the dynamic nature of science. We emphasize the concept of the lineage of questions so that it is integral to the framework of the second edition.

Each unit of *Biology: The Network of Life* 2nd edition opens with a lineage of questions that serves as an organizational structure to enhance teaching and learning. Within each unit we examine the origin of significant questions, describe how they are derived from earlier questions, consider various methods used to answer them, and discuss the social context in which they were studied. This approach allows students to understand that the search for knowledge in science is an interesting, dynamic process, not a rigid procedure as described by the mythical scientific method.

CONTENT IN CONTEXT

To maintain our focus on scientific process, facilitate learning of fundamental principles and ideas, and ensure our concentration on relevant information, all content is presented *in context*. This can mean different things within the organization of the text. Within chapters, specific topics are generally introduced where there is a *need to know*. For example, detailed discussion of proteins, enzymes, and nucleic acids appears in the fourth chapter of our genetics unit, Chapter 17, where we consider the discovery of DNA as being the genetic material. For five of the six units in the book, material is presented in the framework of scientific process. However, Unit I differs from the other units because time is used as the context for presenting information about origins of the universe, Earth, and life.

COVERAGE AND ORGANIZATION

Biology: The Network of Life 2nd edition consists of six units, each of which deals with major areas of contemporary importance. We present information, ideas, and concepts in the approximate sequence in which they originated or became known to scientists. This sequence reflects the actual development of science and allows students to follow the progression of scientific ideas that have led to what we currently know. It also gives a sense of the direction of future research in the life sciences. By emphasizing the historical development of knowledge, we can better understand the process of science and social context in which science operates.

Unit I, *The Sphere of Life*, deals with the origins of the universe, Earth, and the life that came to exist on Earth. Starting with the mythical world views of our ancient ancestors, this unit traces scientific thought on the origins of the universe and Earth. Current hypotheses on the origin of life and the early evolution of cells are then discussed. The nature and functions of cells and their ability to transform energy set the stage for a survey of the tremendous diversity of life that exists on Earth.

Unit II, *The Interactions of Life*, focuses on our environment, knowledge of the global distribution of life, the interactions that occur among plants and animals, and the impact that humans have had and are having on our environment. It begins by explaining the physical forces that act on earth, world climate, and the development of biomes. The unit then traces the roots of modern ecology and explains its major concepts. Separate chapters focus on our knowledge of terrestrial and aquatic ecosystems. The growth and impact of the human population and an up-to-date chapter on global climate change end the unit.

The detailed level of understanding we now have in genetics represents one of the most stunning breakthroughs in biology. New genetic technologies are revolutionizing medicine and agriculture, and these changes raise controversial social questions. In Unit III, *The Language of Life*, we follow the entire development of the field of genetics from Aristotle to the present. While exploring some of the elegant experiments that led to our current knowledge, students will experience the ingenuity and power of critical thinking applied to answering interesting scientific questions.

Unit IV, *The Evolution of Life*, explains the central unifying idea of modern biology. We trace the origin of the theory of evolution and show how the theory arose to answer a set of interesting scientific questions. The nature of scientific theories is discussed along with the relationship between scientific theory and religious thought. Following the development of the theory of evolution to the present, students can appreciate how the original theory has expanded and how it relates to the various fields of biology. A chapter on human evolution discusses current hypotheses of human origins, and two chapters on animal behavior explore the evolutionary significance of this subject.

Plants are discussed throughout the entire text, but Unit V, *Plant Systems of Life*, examines specific features of plants. We explain why, until the nineteenth century, the study of plants was limited to identification and description. Modern knowledge of plant life is described by following the general life history of a plant from seed to adult. Current research on how plants handle environmental stress and on plant adaptation is included.

The concluding unit, Unit VI, *Human Systems of Life*, explores the area of biology that currently commands the greatest amount of research funding worldwide. This unit has increased coverage of human body systems, especially in Chapters 34 and 35. Individual chapters trace the growth of our knowledge of different human organ systems and describe the