

Preface

Goals of the Twelfth Edition

The mission of Dr. Sylvia Mader's text, *Biology*, has always been to give students an understanding of biological concepts and a working knowledge of the scientific process. However, like the world around us, the process of teaching science is changing rapidly. Increasingly, instructors are being asked to engage their students by making content more relevant, while still providing students with a firm foundation in those core principles on which biology is founded. These changes are clearly outlined in the AAAS/NSF report, *Vision and Change in Undergraduate Biology Education* (2009). The eleventh edition of *Biology* was one of the first texts to address the principles of *Vision and Change* by integrating themes within the text. In this edition we expand on that effort with the development of a number of new resources and processes.

In addition to the evolution of the introductory biology curriculum, students and instructors are increasingly requesting digital resources to utilize as learning resources. McGraw-Hill Education has long been an innovator in the development of digital resources, and the *Biology* text, and its authors, are at the forefront of the integration of these technologies into the science classroom.

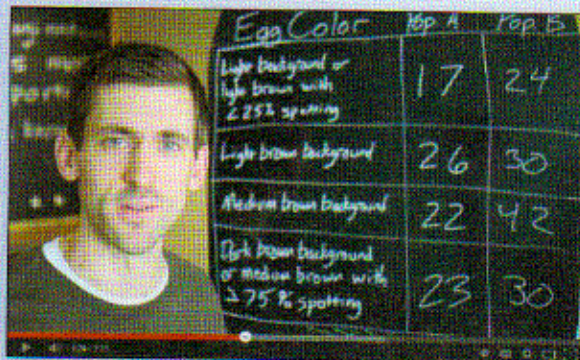
In this edition, the authors focused on the following areas:

1. utilization of the data from the LearnSmart adaptive learning platforms to identify content areas within the text that students demonstrated difficulty in mastering,
2. further development of the themes that connect the content of the text across multiple chapters,
3. development of a new series of videos and websites to introduce relevancy and engage students in the content,
4. refinement of digital assets to provide a more effective assessment of learning outcomes to enable instructors in the flipped, online, and hybrid teaching environments.

Relevancy

The use of real world examples to demonstrate the importance of biology in the lives of students is a key component of *Vision and Change* and an effective teaching strategy for introductory biology. The development of relevancy-based resources is a major focus for the authors of the Mader series of texts. Some examples include:

- A series of new chapter openers to introduce relevancy to the chapter. The authors chose topics that would be of interest to a nonscience major, and represent what would typically be found on a major news source.
- The development of new relevancy-based videos, BioNow Sessions, that offer relevant, applied classroom resources to allow students to feel that they can actually do and learn biology themselves. For more on these, see page ix.



- A new website, RicochetScience.com that provides updates on news and stories that are interesting to nonscience majors. The Biology101 project links these resources to the major topics of the text. The site also features videos to assist the students in recognizing the relevancy of what they are learning in the classroom.



The Vision and Change document clearly identifies the need to integrate core concepts throughout the curriculum. We recognize that scientific literacy is not based upon the memorization of a series of facts. Instead, learning is based on establishing associations and links between what, at first glance, appear to be diverse topics. The main themes we have chosen to emphasize include:

- Evolution
- Nature of Science
- Biological Systems

FOLLOWING the THEMES

10 CHAPTER 1: INTRODUCTION AND EVOLUTION

Evolution

Darwin's theory of natural selection proposes that all life on Earth descends from a common ancestor.

UNIT LEARNING OUTCOMES

The learning outcomes for this unit focus on three major themes in the life sciences.

Evolution

Evaluate why Darwin's theory of evolution by natural selection is considered a unifying theory of biology.

Nature of Science

Explain the scientific method and how it is used to study biological systems.

Biological Systems

Explain how biological systems are interconnected and how they change over time.

These themes are integrated into all aspects of the textbook, from the unit learning outcomes to the theme-based feature readings in the text. At the start of each chapter, "Following the Themes" introduces the relationship of the chapter's content to each of the themes. At the end of each chapter, "Connecting the Concepts with the Themes" not only reminds the student of the relationships between chapter content and the three core themes, but also acts as a prelude to topics in the next few chapters of the text. In essence, the themes act as the threads that unite the concepts throughout the text, enabling the student to see relationships from the molecular to ecosystem levels of biology.

CONNECTING the CONCEPTS with the THEMES

Evolution

- All life on Earth has the same building blocks of inheritance, namely DNA, and has in common many proteins essential to life.
- Vertebrate embryos develop the same set of features early in development, even though these features develop into very different structures in the adult.
- All animals have genes in common that control the development of the body plan. Hox genes orchestrate the development of the body plan in all animals.
- The Tree of Life model has collected information on hundreds of organisms. Anatomy, DNA, and behavior are used to trace all of life back to a single common ancestor.

Nature of Science

- Fossils provide us with a glimpse of life in the past. Transitional fossils have been discovered that support the theory of evolution via gradual changes from preexisting forms, such as alteration of hindlimbs in whale ancestors.
- At the level of the gene, small changes in the DNA sequence of switches that turn genes "on" and "off" can produce new features, such as the black spot on the wings of *Drosophila melanogaster* males that play a role in mating rituals.
- Evolution does not always occur over millions of years; it can be witnessed over a short period of time. On the Galapagos Islands, a shift in the average beak depth of ground finches can be observed in relatively short periods of time.

Biological Systems

- Darwin proposed that natural selection is, in essence, a struggle for existence.
- Organisms tend to produce more offspring than can be supported by the environment.
- All living organisms require resources such as food, water, and mates in order to survive and reproduce—the intensity of competition is determined by the availability of resources in the environment.
- Natural selection operates on variation in populations. Change in the environment, both long- and short-term, can cause populations to evolve.

Evolution Theme

Evolutionary change, along with the mechanism of natural selection, represents the unifying concept of the biological sciences. In essence, biological evolution is the thread that links all life together. Throughout this textbook, feature readings on this theme both demonstrate the process of evolution and illustrate how scientists study and measure evolutionary change. By following this theme through the book, students develop a better understanding of why evolution is a dynamic process, and one that has shaped, and will continue to influence, life on this planet.

Nature of Science Theme

Through the processes of observation, the application of the scientific method, and the use of both inductive and deductive reasoning, scientists study life. To develop a deeper understanding of the biological sciences, students must appreciate that the study of life is a process, and that this process has application in their everyday lives. This theme focuses not only on how biologists do science, but also on the influences scientific inquiry has on our understanding of our world.

Biological Systems Theme

From cells to ecosystems, all life is interconnected. Increasingly, scientists are becoming aware that small changes in the chemical composition of an ecosystem can have a tremendous influence on the life in that ecosystem. This theme was chosen to provide a holistic approach to the study of the life sciences, by demonstrating not only that all life is interconnected, but also that the principles regulating life at the cellular level play a role in physiology and ecosystem biology as well.

Assessment To help instructors assess their student's understanding of these core concepts, we have designed a series of Connect questions for each theme in each unit of the text.

UNIT 7: Animal Evolution and Diversity

THEME Evolution

Evolution of the Animal Body Plan

The animal body plan can be divided into three major body plans: cephalopod, mollusk, and arthropod. The cephalopod body plan is characterized by a head with a brain and a mouth, a mantle with a foot, and a shell. The mollusk body plan is characterized by a head with a brain and a mouth, a mantle with a foot, and a shell. The arthropod body plan is characterized by a head with a brain and a mouth, a mantle with a foot, and a shell.

UNIT 7: Evolution

THEME Nature of Science

Genetic Basis of Beak Shape in Darwin's Finches

Darwin's finches are a famous example of how many species originate from a common ancestor. Over time, each species of finch in the Galapagos Islands adapted to its environment. The finches have different beak shapes and sizes, which are determined by their genes. The finches have different beak shapes and sizes, which are determined by their genes.

UNIT 7: Evolution

THEME Biological Systems

Biomagnification of Mercury

Mercury is a toxic metal that can cause serious health problems. Mercury is found in the environment in small amounts, but it can be concentrated in the food chain. This process is called biomagnification. Biomagnification occurs when a substance is taken up by an organism and then passed on to another organism. The substance becomes more concentrated in the second organism than it was in the first organism.