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1 THE SCIENCE OF BIOLOGY

CHAPTER OUTLINE

Biology and the Living World (p. 16)

1.1 The Diversity of Life (p. 16; Fig. 1.1)

A. Biology is the study of living things.

B. All living things can be grouped into six kingdoms.

1. The six kingdoms include the Archaea, Bacteria, Protista, Fungi, Plantae, and Animalia.

C. Biologists study the diversity of life in many ways.

1. Biologists observe behavior, study fossils, and examine DNA.

D. All living things have much in common.

1.2 Properties of Life (p. 17; Figs. 1.2, 1.3)

A. All living things share certain properties as a result of millions of years of evolution from the first organisms.

1. All living things are composed of one or more cells and thus show cellular organization.

2. Living organisms carry out metabolism in which they use and transform energy.

3. All living things maintain stable internal conditions, or homeostasis.

4. Living organisms reproduce.

5. All living things possess a genetic system based on DNA and transmit characteristics from parent to offspring in a process called heredity.

1.3 Organization of Life (p. 18; Fig. 1.4)

A. There is a hierarchy of complexity within cells.

1. The hierarchy begins at the molecular level at which the chemistry of life occurs.

2. Next is the organelle level, at which cellular activities are organized.

3. The cell is the smallest living level of organization.

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4. In multicellular organisms, cells are arranged into tissues that consist of cells working together.
5. Different tissues may be combined into organs that carry out a function; various organs work together and comprise organ systems.
6. Individuals of the same type of organism living together make up a population.
7. All of the populations of a single kind of organism are members of the same species.
8. All the different species that live together in an area make up a community.
9. A community plus its physical habitat makes up an ecosystem.

B. Emergent properties are present at each higher level in the hierarchy that were not present at the simpler levels.

1. Emergent properties are the result of interactions between components.
2. These properties are the natural consequence of structural organization that characterizes all life.
3. Functional properties, such as metabolism, emerge as organization becomes more complex.

1.4 Biological Themes (p. 20; Table 1.1)

A. The living world is organized by major themes.

B. Evolution is the change in species over time.

1. Charles Darwin proposed the idea of the process of natural selection.
2. Humans have long carried out artificial selection on domesticated organisms.
3. The diversity of life on earth today is the result of a long history of natural selection.

C. The flow of energy through the food chain is a key factor in shaping ecosystems.

D. Cooperation between different organisms has led to coevolution and is responsible for much of the diversity of living things.

E. Biological structures are closely related to their functions.

F. Maintaining homeostasis has contributed to the specialization of complex organisms.

The Scientific Process (p. 22)

1.5 How Scientists Think (p. 22; Fig. 1.5)

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A. Deductive reasoning is the reasoning of everyday thinking and how we make decisions; deductive reasoning uses logic rather than observation.

B. Inductive reasoning is a way of discovering general scientific principles by the careful examination, or observation, of specific examples.

1. From a series of observations, a hypothesis could be formed.

1.6 Science in Action: A Case Study (p. 23; Fig. 1.6)

A. In 1985, British scientist Joseph Farman observed a 30% drop in the ozone levels in the Antarctic atmosphere.

B. Detailed evidence suggested that chlorofluorocarbons (CFCs), used as coolants, propellants, and foaming agents, reacted with ozone in the sun, destroying the ozone.

C. Thinning of the protective layer of ozone above the earth causes greater exposure to the sun's ultraviolet radiation, which can lead to skin cancer and other problems.

D. Ozone depletion continues to increase, producing major holes over the Antarctic.

1.7 Stages of a Scientific Investigation (p. 24; Figs. 1.7, 1.8)

A. Scientists employ a series of steps, called the scientific method, to carry out scientific discovery.

B. The scientific method can be said to have six stages.

1. The first step in the scientific method is observation.

2. Next, a set of hypotheses is formed.

3. Based on the hypotheses, predictions are made.

4. Experiments are conducted to test the hypotheses.

5. Experiments should include a control, in which the variable is not altered.

6. Based on the statistical analysis of the experiment, a conclusion is formed. A collection of related hypotheses that have withstood repeated experimentation is called a theory.

1.8 Theory and Certainty (p. 26; Fig. 1.9)

A. A scientific theory is one that has withstood repeated observation and experimentation and holds true.

B. The term "theory" is used differently in common speech.

C. Scientists often do not just apply the scientific method in a series of steps; often, scientific intuition and creativity play a large role.

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D. Science cannot explain every facet of life nor can it solve all problems.

Core Ideas of Biology (p. 28)

1.9 Four Theories Unify Biology as a Science (p.28; Figs. 1.10–1.15)

A. The Cell Theory: Organization of Life

B. The Gene Theory: Molecular Basis of inheritance

C. The Theory of Heredity: Unity of Life

D. The Theory of Evolution: Diversity of Life

KEY TERMS

- **kingdoms** (p. 16)
- **emergent properties** (p. 19)
- **natural selection** (p. 20)
- **artificial selection** (p. 20)
- **symbiosis** (p. 20)
- **deductive reasoning** (p. 22)
- **inductive reasoning** (p. 22)
- **hypothesis** (p. 24)
- **experiment** (p. 24)
- **observation** (p. 24)
- **alternative hypothesis** (p. 25)
- **prediction** (p. 25)
- **variable** (p. 25)
- **control experiment** (p. 25)
- **theory** (p. 25)
- **scientific method** (p 26)
- **cell theory** (p. 28)
- **DNA (deoxyribonucleic acid)** (p.28)
- **gene theory** (p. 28)

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- **genome** (p. 28)
- **theory of heredity** (p. 30)
- **chromosomal theory of inheritance** (p. 30)
- **theory of evolution** (p. 30)

LECTURE SUGGESTIONS AND ENRICHMENT TIPS

1. During the first lecture in biology, students are often unsure of themselves and insecure about their ability to excel in a science course. Help to put students' fears aside by discussing what you expect from them at the outset of class, including: how you write your exams (emphasizing lecture or textbook or both); the nature of your exams (multiple choice, short answer, essay, and so forth); and an outline of any other expectations.
2. List ways students can enhance their performance in class (good note taking, attending class, asking questions, reviewing notes soon after taking them, studying two hours per lecture or more).
3. You might ask students to list topics they would like to see covered in a course on biology. Alternatively, give them a list of potential topics, and ask them to check off a certain number that they find most intriguing. Then try to incorporate at least a few suggestions to help personalize the class for your students, as well as to engage them in the learning process.
4. This chapter allows you to introduce the topics that will be covered throughout the course. Find a way to make it interesting, such as incorporating a slide show about the diversity of life on earth, or include a video about the ozone hole or science in the making. Any colorful, lively video is suitable at this point when you are introducing students to the realm of biology.
5. Emphasize the scientific process and discuss a few hypothetical (or real) examples of simple experiments. Have students attempt to design experiments or contribute to their designs.
6. Differentiate between DNA and the genome and discuss the importance of the Human Genome Project.
7. Be prepared with articles from the local newspaper dealing with topics in biology. Show them biology in the news, and have them be on the lookout for related stories.
8. Choose a topic that has bioethical/legal considerations. Discuss how these issues might be decided at the voting booth, and why it is important to have a working knowledge of biology to make informed decisions.

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CRITICAL THINKING QUESTIONS

1. How would you address the statement: “biologically speaking, humans have the same inherent worth as do all other living things on this planet”? Is this true for biological ecosystems? Explain.

2. George Perkins Marsh once said: “Animal and vegetable life is too complicated a problem for human intelligence to solve, and we can never know how wide a circle of disturbance we produce in the harmonies of nature when we throw the smallest pebble into the ocean of organic life.” Based on this quote, explain whether the ozone hole created by human activities constitutes a small or large pebble.

3. Obesity in white lab mice has been related to increased problems with infertility. To verify this, a researcher wishes to try a new high-fiber diet ration on a group of obese white mice to see if she can induce weight loss in the mice and thus increase their fertility. What should she use for a control group? Design a simple experiment to test the relationship between weight loss and increased fertility in white lab mice.

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