Essentials of The Living World 6th edition Johnson Solutions Manual

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Instructor's Manual

to accompany

Essentials of The Living World

Sixth Edition

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1 THE SCIENCE OF BIOLOGY
CHAPTER OUTLINE

LEARNING OBJECTIVES

- List the six kingdoms of life (1.1.1).
- Name and describe the five basic properties shared by all living things (1.2.1).
- List the 13 hierarchical levels of the organization of life (1.3.1).
- Explain the origin of emergent properties (1.3.2).
- Explain the five general themes that define biology as a science (1.4.1).
- Explain how the six stages of a scientific investigation allow biologists to discover general principles by careful examination of specific cases (1.5.1)
- Distinguish between hypothesis and theory (1.6.1).
- State the cell theory (1.7.1).
- Define the term gene (1.7.2).
- State how the theory of heredity is related to the chromosomal theory of inheritance (1.7.3).
- State how the theory of evolution is related to the gene theory (1.7.4).

Biology and the Living World (p. 18)

1.1 The Diversity of Life (p. 18; 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 are 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 share common attributes.

1.2 Properties of Life (p. 19; Figs. 1.2, 1.3)

A. All living things share certain properties.
   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 grow and 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 The Organization of Life (p. 20; Fig. 1.4)

A. There is a hierarchy of complexity within cells, within organisms, and within populations.
   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.
   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 make up an ecosystem.
B. Emergent properties are properties present at a higher level in the hierarchy that were not present at the simpler levels.
   1. Emergent properties are the result of interactions between components.

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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. 22)

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. 24)

1.5 Stages of a Scientific Investigation (p. 24; Figs. 1.5, 1.6)

A. Scientists employ a series of steps, called the scientific method, to carry out scientific investigations.
B. The scientific method can be said to have six steps.
   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 analysis of the experiment, a conclusion is formed; a collection of related hypotheses that have withstood repeated experimentation is called a theory.

1.6 Theory and Certainty (p. 26; Fig. 1.7)

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; scientific intuition and creativity play a large role.
D. Science cannot explain every facet of life nor can it solve all problems.

Core Ideas of Biology (p. 28)

1.7 Four Theories Unify Biology as a Science (p. 28; Figs. 1.8–1.13)

A. The Cell Theory
   1. All organisms are composed of cells, and all cells come from other cells.
B. The Gene Theory
   1. Organisms encode their genes (units of hereditary information) in molecules of DNA.
C. The Theory of Heredity
   1. The genes of an organism are passed on to offspring as discrete units.
D. The Theory of Evolution
   1. Modifications in genes are passed to offspring and, through natural selection, these changes lead to a diversity of organisms.

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KEY TERMS

- **kingdoms** (p. 18)
- **metabolism** (p. 19)
- **homeostasis** (p. 19)
- **population** (p. 21)
- **species** (p. 21)
- **community** (p. 21)
- **ecosystem** (p. 21)
- **emergent properties** (p. 21)
- **natural selection** (p. 22)
- **symbiosis** (p. 23)
- **hypothesis** (p. 24)
- **variable** (p. 25)
- **theory** (p. 25)
- **DNA (deoxyribonucleic acid)** (p. 28)
- **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, class attendance, asking questions, reviewing notes soon after taking them, studying 2 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 slideshow about the diversity of life on Earth, or include a DVD about the ozone hole or science in the making. Any colorful, lively DVD 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 to contribute to their design.
6. Differentiate between DNA and 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.
9. Direct your students to online resources to augment their learning process. If you have a website designated to the course, post a weekly discussion question and a list of online references to consult in order to enhance student engagement.

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.

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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.
4. Explain why it is so important to develop hypotheses that can be tested, as opposed to those that cannot.
5. How is the process of science different from other disciplines that describe the natural world?
6. Other than the examples given in the book, give two species that might be studied to see if one species’ presence limits the size of the other. Briefly explain why you have chosen these species, and which factors you would choose to study in order to document one species’ effect on the other.

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