

Chapter 1 Review

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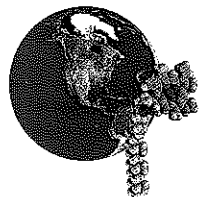
SUMMARY OF KEY CONCEPTS

CONCEPT 1.1

Themes connect the concepts of biology (pp. 3–11)

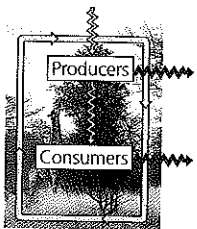


► **Evolution, the Overarching Theme of Biology** Evolution accounts for the unity and diversity of life, and also for the match of organisms to their environments.



► **Theme: New properties emerge at each level in the biological hierarchy** The hierarchy of life unfolds as follows: biosphere > ecosystem > community > population > organism > organ system > organ > tissue > cell > organelle > molecule > atom. With each step “upward” from atoms,

new properties emerge as a result of interactions among components at the lower levels. In an approach called reductionism, complex systems are broken down to simpler components that are more manageable to study. In systems biology, scientists make models of complex biological systems.

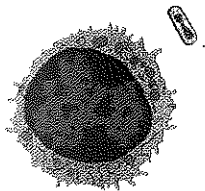


► **Theme: Organisms interact with their environments, exchanging matter and energy** An organism’s environment includes other organisms as well as nonliving factors. Whereas chemical nutrients recycle within an ecosystem, energy flows through an ecosystem. All organisms must perform work, which requires energy. Energy flows from sunlight to producers to consumers.

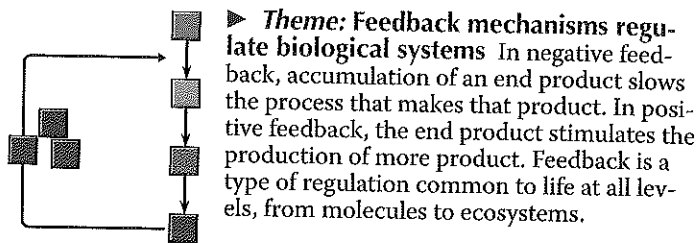
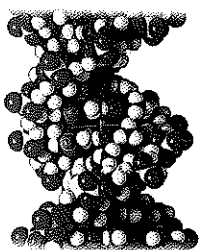
► **Theme: Structure and function are correlated at all levels of biological organization** The form of a biological structure suits its function and vice versa.



► **Theme: Cells are an organism’s basic units of structure and function** The cell is the lowest level of organization that can perform all activities required for life. Cells are either prokaryotic or eukaryotic. Eukaryotic cells contain membrane-enclosed organelles, including a DNA-containing nucleus. Prokaryotic cells lack such organelles.



► **Theme: The continuity of life is based on heritable information in the form of DNA** Genetic information is encoded in the nucleotide sequences of DNA. It is DNA that transmits heritable information from parents to offspring. DNA sequences program a cell’s protein production by being transcribed into RNA and then translated into specific proteins. RNA that is not translated into protein serves other important functions.



► **Theme: Feedback mechanisms regulate biological systems** In negative feedback, accumulation of an end product slows the process that makes that product. In positive feedback, the end product stimulates the production of more product. Feedback is a type of regulation common to life at all levels, from molecules to ecosystems.

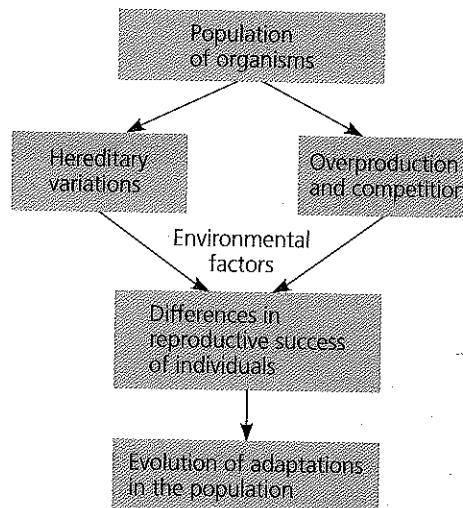
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- Activity The Levels of Life Card Game
- Activity Energy Flow and Chemical Cycling
- Activity Form Fits Function: Cells
- Activity Comparing Prokaryotic and Eukaryotic Cells
- Activity Heritable Information: DNA
- Activity Regulation: Negative and Positive Feedback

CONCEPT 1.2

The Core Theme: Evolution accounts for the unity and diversity of life (pp. 12–18)

- **Organizing the Diversity of Life** Biologists classify species according to a system of broader and broader groups. Domain Bacteria and domain Archaea consist of prokaryotes. Domain Eukarya, the eukaryotes, includes various groups of protists and the kingdoms Plantae, Fungi, and Animalia. As diverse as life is, there is also evidence of remarkable unity, which is revealed in the similarities between different kinds of organisms.
- **Charles Darwin and the Theory of Natural Selection** Darwin proposed natural selection as the mechanism for evolutionary adaptation of populations to their environments.



- **The Tree of Life** Each species is one twig of a branching tree of life extending back in time through ancestral species more and more remote. All of life is connected through its long evolutionary history.

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- Activity Classification Schemes
- Investigation How Do Environmental Changes Affect a Population?
- Biology Labs On-Line EvolutionLab

CONCEPT 1.3**Scientists use two main forms of inquiry in their study of nature (pp. 18–24)**

- ▶ **Discovery Science** In discovery science, scientists observe and describe some aspect of the world and use inductive reasoning to draw general conclusions.
- ▶ **Hypothesis-Based Science** Based on observations, scientists propose hypotheses that lead to predictions and then test the hypotheses by seeing if the predictions come true. Deductive reasoning is used in testing hypotheses: If a hypothesis is correct, and we test it, then we can expect a particular outcome. Hypotheses must be testable and falsifiable.
- ▶ **A Case Study in Scientific Inquiry: Investigating Mimicry in Snake Populations** Experiments must be designed to demonstrate the effect of one variable by testing control groups and experimental groups that differ in only that one variable.
- ▶ **Limitations of Science** Science cannot address the possibility of supernatural phenomena because hypotheses must be testable and falsifiable, and observations and experimental results must be repeatable.
- ▶ **Theories in Science** A scientific theory is broad in scope, generates new hypotheses, and is supported by a large body of evidence.
- ▶ **Model Building in Science** Models of ideas, structures, and processes help us understand scientific phenomena and make predictions.
- ▶ **The Culture of Science** Science is a social activity characterized by both cooperation and competition.
- ▶ **Science, Technology, and Society** Technology is a method or device that applies scientific knowledge for some specific purpose.

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GraphIt! An Introduction to Graphing

Investigation How Does Acid Precipitation Affect Trees?

Activity Science, Technology, and Society: DDT

TESTING YOUR KNOWLEDGE**SELF-QUIZ**

1. All the organisms on your campus make up
 - a. an ecosystem.
 - b. a community.
 - c. a population.
 - d. an experimental group.
 - e. a taxonomic domain.
2. Which of the following is a correct sequence of levels in life's hierarchy, proceeding downward from an individual animal?
 - a. brain, organ system, nerve cell, nervous tissue
 - b. organ system, nervous tissue, brain
 - c. organism, organ system, tissue, cell, organ
 - d. nervous system, brain, nervous tissue, nerve cell
 - e. organ system, tissue, molecule, cell
3. Which of the following is *not* an observation or inference on which Darwin's theory of natural selection is based?
 - a. Poorly adapted individuals never produce offspring.
 - b. There is heritable variation among individuals.
 - c. Because of overproduction of offspring, there is competition for limited resources.
 - d. Individuals whose inherited characteristics best fit them to the environment will generally produce more offspring.
 - e. A population can become adapted to its environment over time.
4. Systems biology is mainly an attempt to
 - a. understand the integration of all levels of biological organization from molecules to the biosphere.
 - b. simplify complex problems by reducing the system into smaller, less complex units.
 - c. construct models of the behavior of entire biological systems.
 - d. build high-throughput machines for the rapid acquisition of biological data.
 - e. speed up the technological application of scientific knowledge.
5. Protists and bacteria are grouped into different domains because
 - a. protists eat bacteria.
 - b. bacteria are not made of cells.
 - c. protists have a membrane-bounded nucleus, which bacterial cells lack.
 - d. bacteria decompose protists.
 - e. protists are photosynthetic.
6. Which of the following best demonstrates the unity among all organisms?
 - a. matching DNA nucleotide sequences
 - b. descent with modification
 - c. the structure and function of DNA
 - d. natural selection
 - e. emergent properties
7. Which of the following is an example of qualitative data?
 - a. The temperature decreased from 20°C to 15°C.
 - b. The plant's height is 25 centimeters (cm).
 - c. The fish swam in a zig-zag motion.
 - d. The six pairs of robins hatched an average of three chicks.
 - e. The contents of the stomach are mixed every 20 seconds.
8. Which of the following best describes the logic of hypothesis-based science?
 - a. If I generate a testable hypothesis, tests and observations will support it.
 - b. If my prediction is correct, it will lead to a testable hypothesis.
 - c. If my observations are accurate, they will support my hypothesis.
 - d. If my hypothesis is correct, I can expect certain test results.
 - e. If my experiments are set up right, they will lead to a testable hypothesis.
9. A controlled experiment is one that
 - a. proceeds slowly enough that a scientist can make careful records of the results.
 - b. may include experimental groups and control groups tested in parallel.

- c. is repeated many times to make sure the results are accurate.
 - d. keeps all environmental variables constant.
 - e. is supervised by an experienced scientist.
10. Which of the following statements best distinguishes hypotheses from theories in science?
- a. Theories are hypotheses that have been proved.
 - b. Hypotheses are guesses; theories are correct answers.
 - c. Hypotheses usually are relatively narrow in scope; theories have broad explanatory power.
 - d. Hypotheses and theories are essentially the same thing.
 - e. Theories are proved true in all cases; hypotheses are usually falsified by tests.
11. **DRAW IT** With rough sketches, draw a biological hierarchy similar to the one in Figure 1.4 but using a coral reef as the ecosystem, a fish as the organism, its stomach as the organ, and DNA as the molecule. Include all levels in the hierarchy.

For Self-Quiz answers, see Appendix A.

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EVOLUTION CONNECTION

12. A typical prokaryotic cell has about 3,000 genes in its DNA, while a human cell has about 20,500 genes. About 1,000 of these genes are present in both types of cells. Based on your understanding of evolution, explain how such different organisms could have this same subset of genes. What sorts of functions might these shared genes have?

SCIENTIFIC INQUIRY

13. Based on the results of the snake mimicry case study, suggest another hypothesis researchers might use to extend the investigation.

SCIENCE, TECHNOLOGY, AND SOCIETY

14. The fruits of wild species of tomato are tiny compared to the giant beefsteak tomatoes available today. This difference in fruit size is almost entirely due to the larger number of cells in the domesticated fruits. Plant molecular biologists have recently discovered genes that are responsible for controlling cell division in tomatoes. Why would such a discovery be important to producers of other kinds of fruits and vegetables? To the study of human development and disease? To our basic understanding of biology?