

SCOTT FORESMAN - ADDISON WESLEY

SECOND EDITION

Life

The Web of Life



SCOTT FORESMAN-ADDISON WESLEY

*"We did not weave the web of life,
we are merely a strand in it.
Whatever we do to the web, we do
to ourselves."* —CHIEF SEATTLE

Biology

The Web of Life

Second Edition

ERIC STRAUSS • MARILYN LISOWSKI

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Biology

The Web of Life

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Second Edition

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About the cover: Wolves and aspen trees are just two of the millions of species that comprise the web of life. The effects of the wolf's removal from and reintroduction to ecosystems demonstrate the delicate and complex connections among living things.

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Big Ideas

THE BIG
IDEA!

There is much to learn in every chapter of this textbook. The Big Ideas! will help you organize and understand the essential knowledge and skills that comprise biology. Build a framework of biology by learning and connecting these Big Ideas.

Unit 1 The Basis of Life

- Living things share many characteristics, including organization and adaptation. 1.1–1.2
- Scientists use careful observation and controlled experiments to study the natural world. 1.3
- Living things are made of chemicals with characteristic structures and functions. 2.1–2.2
- Life processes depend on breaking and forming chemical bonds in chemical reactions. 2.3–2.4
- Life processes depend on the properties of water and the characteristics of solutions. 2.5
- Cell structures of living organisms perform life functions. 3.1–3.3
- Cells of major groups of organisms can be distinguished by their structural differences. 3.4
- Cells exchange materials with their environment by chemical and physical processes. 3.5
- All organisms get energy by breaking down the chemical compounds in food and making ATP and other molecules. 4.1–4.3
- Energy from sunlight passes through a series of living organisms. 4.4
- Cell division is the basis of reproduction and development 5.1–5.2
- Chromosome number is reduced in meiosis. 5.3–5.4

Unit 2 Genetics

- Traits are inherited in a consistent pattern. 6.1–6.2

- There are patterns of inheritance that make some traits predictable. 6.3–6.5
- The structure of DNA, the molecule of heredity, enables the molecule to copy itself. 7.1–7.2
- Genes, sections of DNA that code for a specific trait, are linked together on chromosomes. 7.3–7.5
- Genes are sequences of DNA bases that can be translated into proteins or parts of proteins when they are activated. 8.1–8.2
- Changes in DNA can cause changes in phenotype. 8.3–8.4
- Genotypes can be changed through selective breeding and genetic engineering. 9.1–9.2
- Technology enables us to find out about genotype and use this knowledge to affect phenotype. 9.3–9.4

Unit 3 Change and Diversity

- Populations change over time through natural selection. 10.1–10.2
- Scientific analysis of fossils and modern organisms supports the theory of evolution. 10.3
- New species can originate through natural selection and other changes in a population's gene pool. 10.4–10.5
- Evidence indicates that organic molecules and cells may have formed spontaneously on ancient Earth. 11.1
- Our planet and the organisms that inhabit it have changed greatly over time. 11.2–11.3
- Primates are mammals with binocular vision and dexterous hands and arms. 12.1
- There have been many different hominid species over time, each species with its own unique characteristics. 12.2–12.3

- Scientists classify organisms into a hierarchy of groups based on evolutionary relationships. 13.1–13.2
- Classification has numerous applications, including identifying species. 13.3

Unit 4 Monerans, Protists, and Fungi

- Viruses are particles that depend on living things to replicate. 14.1–14.3
- Monerans are microscopic organisms that lack a membrane-bound nucleus and membrane-bound organelles. 14.4–14.6
- Protists are a diverse group of eukaryotes that include unicellular and multicellular organisms. 15.1
- Protists can be classified into three groups—protozoans, algae, and molds. 15.2–15.4
- Protists have a major ecological impact as food sources, decomposers, and infectious agents. 15.5
- Fungi are stationary organisms that live as heterotrophs. 16.1–16.2
- Fungi act as decomposers and symbiotic partners of humans and many other organisms. 16.3

Unit 5 Plants

- Most plants have structures that enable them to survive on land and produce food. 17.1–17.3
- Key features can be used to classify plants. 17.4
- Plants perform life processes using specialized structures. 18.1–18.2
- The parts of most plants grow from specialized tissues. 18.3

- Plants respond to and affect the environment. 19.1–19.2
- Plants reproduce both asexually and sexually. 19.3–19.5
- Plants are multicellular organisms with adaptations for life on land. 20.1–20.2
- Ferns have vascular systems and reproduce by means of spores. 20.3
- Seed plants do not require water for fertilization and have therefore colonized extensive areas of land. 20.4–20.5

Unit 6 Invertebrate Animals

- Animals have evolved a number of adaptations enabling them to perform essential functions of life. 21.1
- Sponges are sessile animals without specialized tissues and organs. 21.2–21.3
- Cnidarians are radially symmetrical animals with specialized tissues and stinging tentacles. 21.4–21.5
- Sponges and cnidarians provide food and protection for a large number of organisms. 21.6
- Flatworms and roundworms have bilateral symmetry and specialized tissues. 22.1
- Mollusks share a common body plan that includes a muscular foot, a visceral mass, and a mantle. 22.2
- Annelids are wormlike animals with a segmented body. 22.3
- Arthropods are segmented invertebrates with jointed appendages and an exoskeleton. 23.1
- In general, arthropods are classified by the number of body segments they have and the structure of their appendages. 23.2–23.4
- Arthropods, as members of the largest phylum, have many important roles in the biosphere. 23.5
- Echinoderms are marine animals with spiny skin, an endoskeleton, and a water vascular system. 24.1
- Invertebrate chordates represent possible evolutionary links between invertebrates and vertebrates. 24.2

Unit 7 Vertebrate Animals

- Vertebrates are animals with backbones. 25.1
- Fishes are a diverse group of vertebrates that are adapted for life in the water. 25.2–25.4
- Although amphibians share some fish traits, they are adapted to life on land. 25.5–25.7
- Reptiles represent the first vertebrates with adaptations that enable them to live their entire lives out of water. 26.1–26.3
- With the development of feathers, birds were the first vertebrates able to maintain a constant body temperature. 26.4–26.6
- Although different species have unique adaptations, all mammals are endothermic vertebrates with hair and mammary glands. 27.1–27.2
- Mammals live almost everywhere on Earth and play important roles in ecosystems. 27.3
- Animal behaviors are adaptations that maximize survival and reproductive fitness. 28.1–28.3
- Animal behavior involves interactions between individuals, between groups, and with the environment. 28.4

Unit 8 Human Biology

- The human body consists of twelve systems. 29.1
- The body's skeleton provides support and protection. 29.2–29.3
- Muscles contract to move the body. 29.4–29.5
- The skin covers and protects the body's internal organs. 29.6
- The digestive system breaks down food into usable compounds. 30.1–30.3
- The excretory system eliminates nitrogen-containing wastes and helps maintain homeostasis. 30.4–30.5
- The vital exchange of oxygen and carbon dioxide occurs in the respiratory systems of animals. 31.1–31.3
- Circulatory systems transport materials necessary for life. 31.4–31.6

- The immune system protects the body from harmful organisms and substances. 32.1
- The immune system consists of specialized cells, organs, and organ systems that respond to the presence of a pathogen. 32.2–32.3
- A healthy immune system requires a healthy lifestyle. 32.4
- The endocrine system controls long-lasting internal changes. 33.1–33.3
- Reproductive systems make possible the continuation of life. 33.4–33.6
- Nervous systems control our detection of and response to the environment. 34.1
- The human nervous system consists of the brain, spinal cord, nerves, and sensory organs. 34.2–34.4
- The health of the nervous system can be affected by injury, disease, and substance abuse. 34.5

Unit 9 Organisms and the Environment

- Life depends on the relationships between living and nonliving parts of the environment. 35.1–35.2
- Regions of the biosphere have distinguishing characteristics. 35.3–35.4
- The size of a population is affected by living and nonliving factors. 36.1–36.2
- How populations interact determines the structure and characteristics of a community. 36.3
- Biotic and abiotic changes in a community alter the community structure. 36.4
- In an ecosystem, the flow of energy moves in one direction. 37.1–37.2
- Nutrients are recycled in ecosystems. 37.3
- Human use of essential natural resources can affect the web of life. 38.1
- Land, water, and air are invaluable natural resources. 38.2–38.4
- Humans can affect the future of the biosphere in a positive way. 38.5



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Discover

The Web of Life

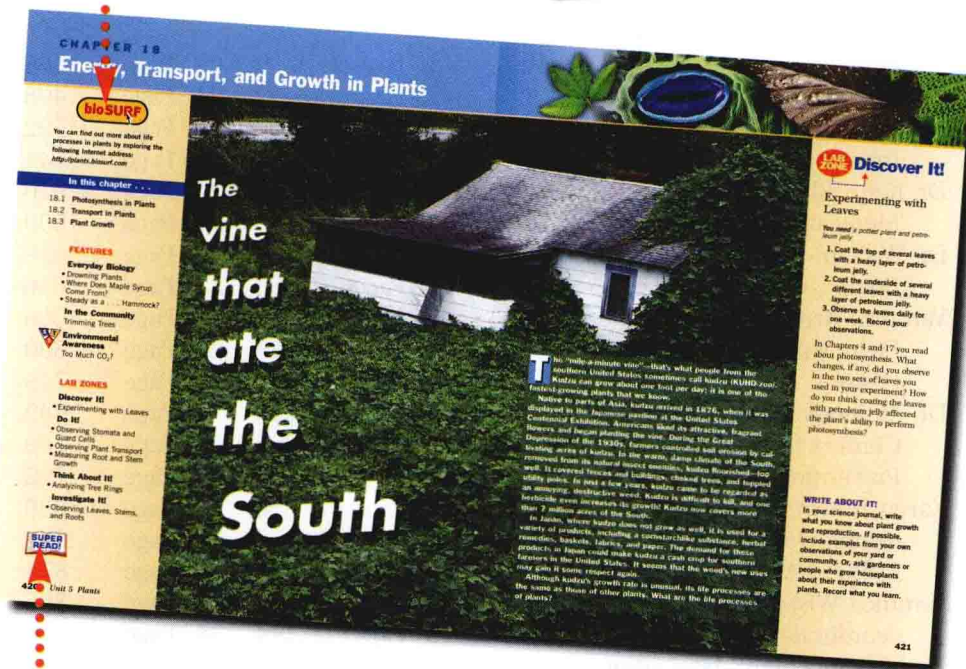
You are about to explore the amazing and wondrous web of life. Your textbook will serve as a valuable tool for your journey through the world of living things. Use the next few pages to become familiar with the organization and features of this textbook. Then begin your travels and enjoy biology!

Hit or Myth?

The amazing stories of **Hit or Myth**—sometimes fact and sometimes fiction—reflect the relevance of biology to today's world.

bioSURF

Connect the *Web of Life* to the World Wide Web using the **bioSURF** internet site.



Chapter Opener

We introduce you to the chapter with a story that puts the content in context. Use the **LAB ZONE Discover It!** activity to begin your exploration of the chapter material. Practice expressing your knowledge, ideas, and experiences as you **WRITE ABOUT IT!**

Super Read This logo refers to additional **Super Read** activities that can be used to practice reading skills.

Living cells host viruses. These host cells provide all the materials that viruses need to copy themselves.

When it enters a host cell, a virus may immediately begin to replicate, or it may remain relatively inactive. The latter replication process that rapidly kills a host cell is called the **lytic** (LIT-ik) cycle. You can follow the lytic cycle in Figure 14.3. The lytic cycle begins when a virus invades a host cell and begins to replicate immediately, producing many new viruses. Eventually the host cell lyses, or breaks apart, releasing the newly made viruses. The new viruses may then enter other cells and repeat the cycle over and over.

As a child you may have had a chicken pox, which is caused by the virus. While you were ill, the new viruses were in the lytic cycle.

FIGURE 14.3
Lytic and Lysogenic Cycles
Follow the replication cycles of a virus that has invaded a bacterium. In the lytic cycle, a virus immediately replicates after entering a cell. In the lysogenic cycle, viral DNA attaches itself to a host's chromosome, where it may wait for the virus enter the host cell.

The diagram illustrates the two pathways a virus can take after entering a bacterial cell.
 1. **Lytic Cycle:** A virus enters the cell and injects its DNA. The viral DNA forms a circle. A stimulus causes the viral DNA to separate from the host cell's DNA, leading to the division of the host cell and the release of new viruses.
 2. **Lysogenic Cycle:** A virus enters the cell and injects its DNA. The viral DNA forms a circle. A stimulus causes the viral DNA to integrate into the host cell's chromosome, forming a prophage. The host cell then divides, passing the prophage to daughter cells.
 3. **Induction:** A stimulus causes the viral DNA to separate from the host cell's chromosome, leading to the division of the host cell and the release of new viruses.

time the host cell's chromosome replicates.

Some prophages remain in the lysogenic cycle indefinitely. Usually, however, some type of environmental stimulus eventually results in the separation of a prophage from the chromosome of its host cell. The viral DNA then enters the lytic cycle. The virus that can go through the lysogenic cycle, for example, Cold sores erupt when those viruses enter the lytic cycle.

Lysogenic Cycle
After a virus injects its DNA into a host cell, the viral DNA inserts itself into a host's chromosome.

The diagram shows a host cell with a circular chromosome. A virus enters the cell and injects its DNA. The viral DNA integrates into the host chromosome, forming a prophage. A stimulus triggers the transition to the lytic cycle, where the viral DNA separates from the host chromosome and the host cell divides to release new viruses.

ALIVE OR NOT?
To be or not to be . . .

Do you think viruses are alive? To answer this question, ask yourself two additional questions: Which characteristics of living things do viruses have? Which do they not have? Which do they not share?

When viruses invade host cells, they share some of the characteristics of life with host cells. Viruses contain life with host cells. Viruses contain nucleic acid and protein. Viruses change over time as a result of mutations in their DNA or RNA that affect changes in their proteins.

Outside their cells, viruses are inactive. Because they cannot grow or replicate, viruses must be inside living cells to be active. After entering host cells, viruses use the host's resources, which harm or destroy the host, as they use it for their own benefit.

CHECKPOINT 14.1
What are the structural characteristics of viruses?

1. Compare the lytic and lysogenic cycles.
2. Critical Thinking Make a diagram to show the lytic and lysogenic cycles in a eukaryotic host cell.

Build on What You Know

Build a chart to compare viruses with prokaryotes and eukaryotes. (Need to jog your memory? Review relevant concepts in Chapter 3 Section 3.2.)

A black and white micrograph showing several E. coli bacterial cells. Numerous bacteriophages are attached to the surface of the cells, appearing as small, rod-shaped structures with long tails. Some phages are shown in the process of injecting their DNA into the host cells.

FIGURE 14.4
Many viruses are attaching to this *E. coli* bacterial cell, which is defenseless against their onslaught. What happens once the DNA is injected?

EVERYDAY SCIENCE

Stick Computers?

Computer viruses behave much like biological viruses. They attach themselves to files, then spread and multiply across data, sometimes deleting data, corrupting data, or deleting files. They may delete and corrupt behavior or may damage data.

Chapter 14 Viruses and Microbes

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Interact and Explore

LAB ZONE Think About It!
activities provide practice in
analyzing and applying concepts.

Review and Extend

Chapter Review

Test your knowledge of the **words** and **ideas** presented in the chapter by answering questions. Challenge your understanding by answering the **critical thinking** questions in **Take It Further**. Use the questions in **Consider the Issues** and **Make New Connections** to extend the Chapter content.

CHAPTER 9 REVIEW

Use Your Word Power
Completion Write the word or phrase that best completes each statement.

- Hybrid vigor can result from _____.
- _____ are bacterial vectors.
- _____ are genetically engineered life forms with the DNA of two different kinds.
- _____ are obtained through gel electrophoresis, can be used for identification.
- For centuries, humans have used _____ to produce crops and livestock.

True-False Write true if the statement is true, and false if the statement is false.

- A plasmid is a type of vector.
- Genetic engineering has many potential benefits.
- Transgenic organisms contain recombinant DNA.
- Insulin is produced by hybrid organisms.
- Everyone has a unique DNA fingerprint.

Show What You Know

- What is selective breeding, and what are the applications of selective breeding?
- What are the steps in gel electrophoresis?
- How is recombinant DNA technology used to produce human insulin?
- Why are recombinant plasmids more likely to be expressed in the offspring of clone animals?
- Name and describe two applications of genetic engineering.
- What are some safety precautions related to genetic engineering?
- What is a transgenic organism?

Take It Further

- Applying Concepts What advantages does genetic engineering have over selective breeding?
- Making a Prediction What might be a negative result of growing a crop that is genetically engineered to resist weed killers?
- Developing a Hypothesis A genetically engineered medicine for heart attack patients, tPA, is being used on some stroke victims. A stroke might tPA effectively treat strokes?
- Designing an Experiment The use of DNA fingerprinting as legal evidence is sometimes controversial. Design an experiment to test the accuracy of DNA fingerprinting.

Consider the Issues

- Make a New Organism If you could use genetic engineering to create a new organism or to mass-produce a product, what would it be? How would it affect the world? What safety precautions would you take? You may illustrate or create a model to accompany your answer.
- Biology and Cartoons What is the joke in the following cartoon? How is the cartoon accurate?

Make New Connections

People can change genomes through biotechnology. Other environmental influences can also affect genomes. In the next unit you will learn about theories that explain how traits of organisms have changed over time.

U.S. Death Rates from Diseases

Bar graph showing death rates from infectious diseases and noninfectious diseases from 1910 to 1990.

DNA Restriction Enzymes

Enzyme	Recognition Sequence
EcoRI	GAATTC
HindIII	AAGCTT
BamHI	GATC
PstI	CTGCAG
KpnI	GTACAC
XbaI	CTAGA

Chapter 9: The Biotechnology Revolution

CHECKPOINT 9.4

- What are some safety precautions scientists use when working with genetically engineered organisms?
- Identify a benefit and a concern in connection with the alteration of human genes.
- Critical Thinking** What are the possible harmful, long-term effects of engineering a crop to resist weed killers?

Build on What You Know

- How could the scientific method help resolve safety and ethical issues related to biotechnology? (Need *idea*)

Checkpoint

Evaluate what you have learned in each section by answering the **CHECKPOINT** questions. A **critical thinking** question gives you an opportunity to demonstrate your understanding. And the **Build on What You Know** question connects concepts in different chapters.

Unit Review

Integrate all the concepts you have learned throughout each unit by answering the questions and doing the activities in the **Unit Review**. Read a student's review of a book, film, or CD-ROM in **The Critic's Corner**. And through **Spotlight on Careers**, meet people whose lives exemplify biology in action.

Unit 2 Review

Answer the following questions to help you to link ideas and grasp the unit concepts.

Connect the Chapters

- Compare recombination as it occurs in crossing over with the recombinant DNA technology used to produce insulin.
- Explain why gene therapy for cystic fibrosis does not prevent the malfunctioning gene from being passed on to offspring.
- Compare Mendel's breeding experiments with pea plants to biotechnology.
- Contrast the use of restriction enzymes and DNA markers to identify carriers of recessive genes.
- How are chromosomes, genes, codons, anticodons, and proteins related?
- Explain how Griffith's 1928 experiment with bacterial strains was an early example of genetic engineering.

Connect the Units

- Cells do not need as much energy to produce RNA polymerase as they need to produce other proteins. Why?
- Identify one event in the history of gene expression in a eukaryotic cell for which the Law of Independent Assortment is essential.
- Explain the function of the interphase portion of the cell cycle.

Connect to Themes

- Unity and Diversity How does eukaryotic gene expression show unity and diversity?
- Patterns and Changes How do linked genes affect the Law of Independent Assortment?
- Systems and Interactions How does the concentration of lactose control the expression of the lac operon?

project plans

- In the past, marriages in European royal families were arranged to strengthen political alliances. The bride and groom were often related to each other. Some bloodlines were so close that the resulting offspring were infertile. Explain the genetic problem was the incidence of hemophilia. Make a poster of the genetic disorder hemophilia. Queen Victoria's lineage. Identify the descendants who carried the hemophilia gene, and those who expressed the gene.
- As a class, research and experiment with various types of flowers or vegetables. For example, find out how many varieties of tomatoes can be grown in your area. Then design an experiment to find the variety best suited for local soil and weather conditions.

CRITIC'S CORNER

The Double Helix, by James Watson and Francis Crick, tells the story of the discovery of the structure of DNA. The book describes a scientist's journey with a little help from a model. Earth scientists had long known that DNA was the key to life. The story of these scientists, and their often tumultuous relationships with each other, make this book a page-turner for students of all interests and backgrounds.

SPOTLIGHT ON CAREERS

DR. KEITH BLACK
Neurosurgeon, UCLA Medical Center, professor of neurosurgery at UCLA. Exciting, neurosurgical surgery requires general surgery training. M.D., Ph.D.

Specialize in brain tumors. Most of these tumors are very complex, and about half of them are malignant. One part of my work is surgery, because malignant tumors cannot be cured without it. I also do research—a try to find ways of curing or improving the treatment of brain tumors. One of the newer treatments is gene therapy. We aim to deliver a tumor-suppressing gene to the tumor cells to fight disease. We turn off the ability of tumor cells to grow. They no longer release genetically modified tumor cells so that they no longer release these proteins, then we can take the modified cells and inject them back into the patient. That way, the person's immune system can recognize the tumor's cells and fight them.

Learn more about Dr. Black's cancer research at UCLA Johnson Cancer Center by visiting <http://genetics.ucla.edu>

ANAMARIA CRACI
College senior at the National Cancer Institute, National Institutes of Health. Researcher in cancer biology. Exciting! College junior exploring how cells find their way through the body.

As a class, research and experiment with various types of flowers or vegetables. For example, find out how many varieties of tomatoes can be grown in your area. Then design an experiment to find the variety best suited for local soil and weather conditions.

As I have always known that science was where I wanted to go. You work with an organism, a question, I an organism, a question. I have to follow themselves against all kinds of pathogens. A pathogen is an organism that can cause a disease—a bacterium, or a virus, for example. Dr. Craciu, professor, Dr. Craig Topp, professor, Dr. Craig Topp, is looking for the genes that turn on when a plant is attacked. My job is to do

neuroscience. By studying how plants defend themselves, we hope to learn how to induce plants to grow in places where they normally wouldn't, or cure plants that are dying.

Find out about internships at the National Cancer Institute at the National Institutes of Health by visiting the site <http://genetics.ucla.edu>

The Authors...

Eric Strauss



In the years he has been teaching at Boston College, Eric Strauss has quadrupled enrollment in an introductory biology course for non-science majors. In addition, Eric helped start the Boston College Environmental Studies program and serves as

the program director. His dynamic approach to teaching biology extends beyond the college classroom. High school students, college undergraduates, and graduate students conduct original research on animal behavior and ecology at a Cape Cod field research station run by Eric and his former high school teacher.

Marylin Lisowski



Before becoming professor of science education at Eastern Illinois University, Marylin taught Biology, Environmental Science, and Middle Level Science. She also directed a marine research station. Marylin shares her research experience

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and others who have helped us

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The Big Idea: Scientists use careful observation and controlled experiments to study the natural world.

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The Big Idea: Life processes depend on breaking and forming chemical bonds in chemical reactions.

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The Big Idea: Life processes depend on the properties of water and the characteristics of solutions.

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The Big Idea: Cells of major groups of organisms can be distinguished by their structural differences.

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The Big Idea: Cells exchange materials with their environment by chemical and physical processes.

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The Big Idea: Energy from sunlight passes through a series of living organisms.

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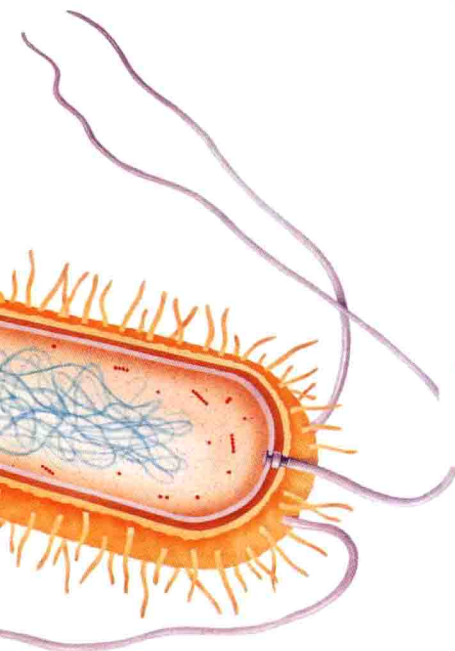
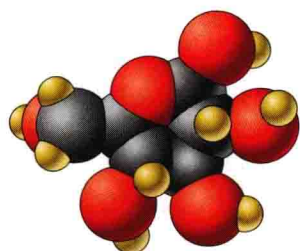
The Big Idea: Cell division is the basis of reproduction and development.

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The Big Idea: Chromosome number is reduced in meiosis.

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The Big Idea: There are patterns of inheritance that make some traits predictable.

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The Big Idea: Genes, sections of DNA that code for a specific trait, are linked together on chromosomes.

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The Big Idea: Genes are sequences of DNA bases that can be translated into proteins or parts of proteins when they are activated.

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- 8.2 Protein and Phenotype 188

The Big Idea: Changes in DNA can cause changes in phenotype.

- 8.3 Changes in Chromosomes 192
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The Big Idea: Genotypes can be changed through selective breeding and genetic engineering.

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- 9.2 Genetic Engineering 209

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