

# CK-12 Life Science Middle School



# CK-12 Life Science For Middle School Teacher's Edition

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Jean Brainard, Ph.D.

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## CHAPTER

## 1

## TE MS Studying Life

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**Chapter Outline**

- 1.1 SCIENTIFIC WAYS OF THINKING**
  - 1.2 WHAT IS LIFE SCIENCE?**
  - 1.3 THE SCIENTIFIC METHOD**
  - 1.4 THE MICROSCOPE**
  - 1.5 SAFETY IN LIFE SCIENCE RESEARCH**
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**Contents: CK-12 MS Life Science**

- Chapter 1: Studying the Life Sciences
- Chapter 2: What is a Living Organism?
- Chapter 3: Cells and Their Structures
- Chapter 4: Cell Functions
- Chapter 5: Cell Division, Reproduction, and Protein Synthesis
- Chapter 6: Genetics
- Chapter 7: Evolution
- Chapter 8: Prokaryotes
- Chapter 9: Protists and Fungi
- Chapter 10: Plants
- Chapter 11: Introduction to Invertebrates
- Chapter 12: Other Invertebrates
- Chapter 13: Fishes, Amphibians, and Reptiles
- Chapter 14: Birds and Mammals
- Chapter 15: Behavior of Animals
- Chapter 16: Skin, Bones, and Muscles
- Chapter 17: Food and the Digestive System
- Chapter 18: Cardiovascular System
- Chapter 19: Respiratory and Excretory Systems
- Chapter 20: Controlling the Body
- Chapter 21: Diseases and the Body's Defenses
- Chapter 22: Reproductive Systems and Life Stages
- Chapter 23: Introduction to Ecology
- Chapter 24: Ecosystem Dynamics
- Chapter 25: Environmental Problems

Life Science Glossary

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**The Teacher's Edition**

The CK-12 Life Science for Middle School - Teacher's Edition complements CK-12's Life Science for Middle School FlexBook®. The TE comprises six strands: Teaching Strategies & Tips, Differentiated Instruction, En-

richment, Science Inquiry, Common Misconceptions, and Assessments. Each unit and chapter will have a general overview. Each chapter section will also include an introduction and teaching strategies. The majority of content will be presented by individual lesson. This Teacher's Edition will focus on eight subtopics for each lesson:

1. Key Concept
2. Standards
3. Lesson Objectives
4. Lesson Vocabulary
5. Check Your Understanding
6. Teaching Strategies
7. Reinforce and Review
8. Points to Consider

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## Pacing the Lesson

Each chapter has guidelines for the minimum number of class periods needed to teach each lesson. We have strived to keep each chapter under a week of class time, which would cover the complete FlexBook® resource in 25 weeks, providing ample time for flexibility. We realize this is a tremendous amount of material, and many teachers may choose not to utilize the complete FlexBook® resource, providing even more time for flexibility. As the teacher, you can determine if your class needs additional (or less) time on certain lessons/chapters, and adjust the pacing accordingly.

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## Science Notebook

For a year's study of Life Science, we recommend a science and/or lab notebook in which students may:

- Answer the *Check Your Understanding* questions.
- Answer/reflect on the *Points to Consider* questions.
- Write additional questions about an upcoming lesson, chapter, or unit of study.
- Draw pictures of living organisms and diagrams of life processes.
- Take notes and define academic vocabulary.
- Keep a record of pertinent web sites to access relevant information.
- Write up lab activities.
- Write up ideas for possible long-term projects.
- Keep reflections on what they have learned.

Students should date each entry and refer back to their ideas earlier in the year, reflecting on their deepening understanding.

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## Teaching Strategies

Throughout the TE, we will provide numerous examples of strategies that can be used to make the content accessible to students. Many strategies and activities have been included as web site links, and we recommend that these be previewed before assigning to the students. Traditional examples of general teaching strategies, differentiated instruction, enrichment, science inquiry, and reinforcement strategies will be provided.

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## Teaching Strategies: General

1. Appreciate what's difficult for students, helping them develop scientific ways of thinking.
2. Vary class activities, using a wide variety of resources to aid students in deepening their understanding of scientific issues.
3. Give students opportunities to participate in scientific investigations to understand “doing science.”

## The Scaffolding Strategy

As in any good teaching, bring up topics with which students are already familiar to give students a context to assimilate new understandings. Give these topics a “twist” to engage student’s motivation. Break complex tasks into smaller tasks, show examples of quality outcomes, offer hints or verbal cues, use mnemonic devices, chants and/or songs for activities requiring memorization of facts or procedures. Use graphic organizers such as concept maps; teach key vocabulary before reading the FlexBook® textbook. Continually ask questions to guide and facilitate students in making predication, or to encourage deeper investigations or thinking on a topic. Model activities before students participate. And, ask for student contributions about their past experiences in the field.

## Word Dissection

Life Science words can be intimidating for students to read, say, and talk about. As teacher, you can make a game of the words, and take a few minutes to do a daily or weekly dissection in class. Make sure students know that it is not a big deal to not know the word when you first come into contact with it, but to learn to break it down into pieces, figure out the meaning of each piece, and then put it all back together again to find the meaning.

## Reading to Learn

Teach your students how to read, comprehend, and summarize scientific text. Each lesson offers an opportunity to use different techniques to guide students to synthesize the core elements of the lesson. Try one or two different techniques each time:

- Model for your students skimming a section of text and summarizing.
- Remind students that they can read in different ways: scan, skim, annotate.
- Ask and discuss whether they read headlines, captions, or summary material first.
- Have the students write down all unfamiliar words.
- Have them summarize important points as bullets, phrases, or short sentences. You may want to assign small groups of students to work together to summarize a lesson, or conduct a large class discussion.
- Students may also summarize lesson points with a partner.
- You may choose to follow with a class discussion on summary points.

## Using Visuals

Use illustrations in the student edition as a tool for teaching content, exploring ideas, and probing students’ misunderstandings.

## Building Science Skills

Have students apply higher-level thinking or other relevant skills as they relate to lesson content (e.g., predicting, forming hypotheses, drawing conclusions, interpreting data, observing, classifying, making inferences, comparing

and contrasting, identifying cause and effect, analyzing). This might be achieved through a simple activity, answering questions, class discussion, and/or partner work.

## Discussion

Stimulate class discussion of a topic. This could include scripted questions to ask the class, with expected or sample answers. The discussion tips should be specific and focused. For example, don't write: "Discuss Darwin's theory of evolution." Instead, write: "Guide students in discussing why Darwin's theory was not widely accepted in his own lifetime." Ask: "How did Darwin's theory of evolution conflict with prevailing views of living things?"

## Demonstration

Do (and fully describe) an in-class demonstration to illustrate or explain a process, concept, etc. Keep in mind constraints on classroom time and resources. Include a concluding sentence or scripted question that relates the demonstration to the process or concept.

## Activity

Have students do a simple hands-on activity that will help them better understand a topic or process. Explain fully how the activity is to be done. This could be a pencil-and-paper activity or other activity that does not involve materials, although readily available classroom materials could be used. Again, conclude with a sentence or question that ties the activity with the topic or process being studied.

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## Teaching Strategies: Differentiated Instruction

*These strategies can be used for all three types of student populations that are typically addressed by DI (i.e., ELL, LPR, SN), but a particular population has been specified each time a strategy is used. The strategy can be tailored somewhat to that population, even if it's only by referring to the population type in the strategy (e.g., "Pair English language learners with native speakers of English").*

## KWL

Have students make a KWL chart, where K = Know, W = Want to Know, and L = Learned. Students should fill in the K and W columns before reading and the L column after reading a particular passage or lesson.

## Cloze Prompts

Give students cloze sentences (basically, fill-in-the-blank sentences) about important lesson concepts. Students are instructed to fill in the missing words as they read the lesson.

## Gallery Walk

Divide the class into groups and have the groups walk around the room to read and discuss posted questions or topics (each on a large sheet of paper). Each group (using a different color pen) answers the questions or writes comments about the topics. They also read and respond to answers/comments written by other groups. This is

followed by discussing the answers/comments with the class, reviewing misunderstandings they reveal, or by groups summarizing what they know about one or more questions/topics.

### Think-Pair-Share

Assign questions or topics to individual students to think about. Pair ELL students with native speakers and LPR students with more proficient readers to work together on answering the questions or discussing the topics.

### Framer Model

Assign this vocabulary strategy, which involves students drawing a large box and dividing it into four parts labeled “Definition,” “Drawing,” “Example,” and “Non-example.” Assign students a vocabulary word and tell them to fill in each part of the box for that word.

### Cluster Diagram

Have individual students, pairs, groups, or the class as a whole make a cluster diagram organizing lesson concepts.

### Concept Map

Have individual students, pairs, groups, or the class as a whole make a concept map organizing lesson concepts.

### Venn Diagram

Have individual students, pairs, groups, or the class as a whole make a Venn diagram organizing lesson concepts.

### Compare/Contrast Table

Have individual students, pairs, groups, or the class as a whole make a compare/contrast table for specific lesson concepts, processes, etc. (e.g., photosynthesis and cellular respiration; mitosis and meiosis). You may need to provide the column and row headings for the table.

### Cycle Diagram

Have individual students, pairs, groups, or the class as a whole make a cycle diagram to show the steps in a cyclical process (e.g., life cycle of amphibians).

### Flow Chart

Have individual students, pairs, groups, or the class as a whole make a flow chart to show the steps in a process (e.g., photosynthesis).

### Main Ideas/Details Chart

Have students divide a sheet of paper in half, on the left side write the main ideas from a passage or lesson (skipping several lines between the main ideas). On the right side, students are instructed to fill in important details about each main idea as they read.

## Word Wall

Post lesson vocabulary words and their definitions, examples, etc., on a bulletin board or wall. Refer students to the word wall as they study lesson content.

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## Teaching Strategies: Enrichment

*Although online and/or library research is always an option for enrichment, it tends to be overused. Avoid it unless it is really relevant and likely to be helpful for the other students in the class. Whatever students are assigned to do, they should be given a chance to share their work with the class through an informal oral presentation, a written report, etc. In some cases (e.g., making a board game or crossword puzzle), the product can be used by the class to reinforce or review lesson content.*

- Research a Topic
- Present a Role-Play
- Teach a Topic
- Create a Video
- Create a Poster
- Debate an Issue
- Interview an Expert
- Create a Model
- Demonstrate a Process
- Take a Survey
- Write an Essay
- Make a Board Game
- Make a Crossword Puzzle
- Create a Web Site
- Make a Diagram
- Make a Diorama
- Make a Display
- Write a Research Proposal
- Make a Video
- Write a Rap (Song)
- Present a PowerPoint Show
- Lead a Discussion

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## Teaching Strategies: Science Inquiry

*These strategies should get students involved in thinking or acting like a scientist. They should help the students learn lesson content by encouraging them to be actively engaged in scientific thinking and/or using scientific methods.*

- Ask a Research Question: e.g., based on hypothetical observations.
- Formulate a Hypothesis: e.g., based on a research question. Must be specific and testable; could also ask students to describe data that would support or disprove the hypothesis.
- Develop a Research Plan: e.g., to test a specific hypothesis. Could focus on types of variables, controls, etc.
- Analyze Data: Data could be in a graph or table that is provided in the SE or TE or students could find the data online.

- **Solve a Problem:** requiring application of lesson concepts, procedures, etc.

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## Reinforcement Activity

*In addition to online quizzes, this could be a quick teacher-directed activity or something students do alone or in pairs to make sure they understand lesson content. It should probably be aimed at the average to below-average students in the class, though reinforcement activities are important for all students. Some suggestions are listed below. The goal is to reveal to the teacher or to the students themselves what they know and what they still don't understand. The activity should include a sentence suggesting a way for students to learn what they don't know (e.g., "Find definitions in the FlexBook® textbook of any vocabulary words you did not know."). This can easily be preceded or followed with a Lesson Review. Either you or a student(s) leads a discussion to review the lesson. You can use the Lesson Summary from the student edition. Clarify any issues and answer any questions students may have.*

- **Take an Online Quiz:** Have students track their own level of mastery of concepts as measured by quizzes. Additionally, you could have students take the quiz before and after teaching the material and have them track their growth.
- **Make Flashcards:** This activity could be used for boldface vocabulary words or important concepts; have students use the flashcards to quiz a partner.
- **Label a Drawing:** The drawing could be art from the SE with the labels deleted.
- **Outline the Lesson:** This could be done with a partner or as a class using an overhead projector.
- **Ask Questions:** Each student turns in a question on an index card. Then, the teacher answers or reviews material relevant to those questions that are asked most frequently.
- **List and Discuss:** Students make a list of something (e.g., reproductive isolating mechanisms), and then partners compare and discuss their lists.
- **Use Vocabulary:** Students use the lesson vocabulary words in sentences or a brief paragraph.
- **Make a Quiz:** Students write a few fill-in, matching, or true/false questions and then use them to quiz a partner.
- **Make a Drawing:** Students create a simple sketch to demonstrate comprehension of a process (e.g., cell division).
- **Complete a Chart:** Students complete missing parts of a diagram or fill in cells of a table that have missing information.

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## Check Your Understanding

This section includes questions related to previously presented information that the authors consider important for **the student** to have access to the information in the current lesson.

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## Points to Consider

Questions in this section serve as a segue into the next lesson (or chapter). Ask students to read the Points to Consider at the end of the lesson in their FlexBook® textbook. They can be answered individually or as an opening to lead a class discussion. Use these questions to assess student understanding and misconceptions before beginning the next unit of study.

---

## Making the FlexBook® Textbook Flexible

An important advantage of the FlexBook® textbook is the ability it gives you, the teacher, to choose the chapters and lessons that you think are most important for your own classes. The following information is provided to help you decide whether to include this chapter or certain lessons in this chapter in your students' FlexBook® student edition. You should also consult the standards correlation table when selecting chapters and lessons to include in the FlexBook® resource textbook. As the introductory chapter in this FlexBook® resource, CK-12 recommends the inclusion of the material within this chapter in any course on Life Science. Students should read this entire chapter before reading the remaining chapters. It is recommended that you include all the lessons of this chapter.

---

## Contributors

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## Chapter Overview

This chapter introduces students to the nature of science, the difference between scientific laws and scientific theories, and the scope of life science. Steps of the scientific method are also delineated, along with the importance of the microscope in life science and how to stay safe while doing life science.

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## Online Resources

*See the following Web sites for appropriate laboratory activities:*

The consumer challenge lab at the following URLs allows students to apply the scientific method to a practical problem.

<http://sciencespot.net/Pages/classgen.html#Anchor-1>

<http://sciencespot.net/Media/consumerchall.pdf>

The ketchup lab at this link is a good way to acquaint students with experiments, including variables and controls.

<http://www.thesciencequeen.net/7Units.htm>

Use one of the introductory microscope labs at the first three URLs below when you teach students about this basic life science tool. The fourth URL provides tips for setting up a microscope lab.

<http://www.middleschoolscience.com/microscope.pdf>

[http://www.biologyjunction.com/microscope\\_lab1.htm](http://www.biologyjunction.com/microscope_lab1.htm)

[http://www.biologyjunction.com/microscope\\_lab.htm](http://www.biologyjunction.com/microscope_lab.htm)

<http://legacy.mos.org/sln/SEM/microlab.html>

*These Web sites may also be helpful:*

This URL provides a list of common student misconceptions about science and the process of scientific inquiry. It also gives suggestions for correcting the misconceptions.

<http://undsci.berkeley.edu/teaching/misconceptions.php>

You can find numerous resources for this chapter by searching "scientific method" and "lab safety" at the following URL. Resources include labs, activities, lesson plan links, worksheets, and word puzzles.

<http://sciencespot.net/Pages/classbio.html>

**TABLE 1.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
1.1 Scientific Ways of Thinking	0.5
1.2 What Is Life Science?	1.0
1.3 The Scientific Method	1.0
1.4 The Microscope	1.0
1.5 Safety in Life Science Research	0.5

---

# 1.1 Scientific Ways of Thinking

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## Key Concepts

- Definition of science
- Thinking like a scientist
- Scientific law vs. scientific theory

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## Standards

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## Lesson Objectives

- Define science.
- State what it means to think like a scientist.
- Distinguish between scientific laws and scientific theories.

---

## Lesson Vocabulary

- science: Way of learning about the natural world that depends on evidence, reasoning, and repeated testing.
- scientific law: Description of what always occurs under certain conditions in nature.
- scientific theory: Broad explanation that is widely accepted because it is supported by a great deal of evidence.

---

## Teaching Strategies

### Introducing the Lesson

Launch the course by helping students appreciate the relevance of science to their daily lives. Give them examples of some of the many scientific (or pseudo-scientific) messages they are likely to see or hear on a daily basis. Good examples include claims about consumer products such as diet, health-care, or grooming products. Show students examples of advertisements or commercials for such products. Explain how knowledge of science can help them make informed consumer decisions by providing standards for weighing the validity of such claims. Discuss with the class how the claims might be tested. For example, ask what data they could collect that would allow them to either reject or verify the claims.

## Building Science Skills

Follow up on the "Introducing the Lesson" theme with an applied group activity. It will help students become critical consumers of scientific information and develop the scientific attitude of skepticism. Give students copies of "Your Science Toolkit" from the URL below. The toolkit includes the following questions:

1. Are the views of the scientific community accurately portrayed?
2. Is the scientific community's confidence in the ideas accurately portrayed?
3. Is a controversy misrepresented or blown out of proportion?
4. Where can I get more information?
5. How strong is the evidence?

Have students apply the questions in the toolkit, using one or more of the following activities:

- Look for "hype headlines," such as "Miracle of gene therapy right around the corner," and discuss them with students. Start a bulletin board of examples that students find in the print media.
- Tell students to observe a series of commercials on television or print advertisements from magazines or the local newspaper. Have students apply appropriate questions from the toolkit and then discuss the ads in class.
- Suggest that students Google a topic such as "hamburger nutrition" and find examples of both reliable and unreliable resources. Ask them to explain how they assessed the reliability of the resources.
- Have students find a variety of media articles about a current controversial issue in science, such as causes of global warming or the health effects of GMO foods. Again, have them apply questions in the toolkit to assess the validity of the information.

Conclude by telling students that they should get in the habit of applying the toolkit questions to any science-related media they encounter rather than simply accepting the information at face value. Relate this attitude of questioning to the nature of science and what it means to "think like a scientist."

[http://undsci.berkeley.edu/images/science\\_toolkit.pdf](http://undsci.berkeley.edu/images/science_toolkit.pdf)

## Differentiated Instruction

A word wall is an excellent way to help students understand and remember important science vocabulary throughout the school year. The word wall will be especially beneficial for English language learners, less proficient readers, and other special needs students, but all students are likely to benefit from it. Have students start the word wall with this first lesson of the first chapter. Then have them add additional terms to it in successive lessons and chapters. The terms should include only the most significant words that they need for understanding multiple concepts and lessons. For the current lesson, select a few students to add the three vocabulary terms (science, scientific law, and scientific theory) to the word wall. Students can write each term on an index card and add the definition, an example, and a simple illustration of the term. The cards can be posted on a bulletin board or hung from string to create a mobile.

## Enrichment

Arrange for interested students to interview a life scientist. Possible interviewees might include scientists who work for a government agency, lab, zoo, botanical garden, museum, or college or university. Suggest that students prepare a list of questions in advance. Urge them to be creative in their questioning and try to elicit what it's really like to be a life scientist and how the scientist became interested in the career. Give the students an opportunity to share what they learn with the rest of the class.

## Science Inquiry

Use Lesson 1, "Inquiring Minds," at the following URL to introduce students to the nature of science and scientific inquiry. Students will do three simple, hands-on activities to model the scientific inquiry process and then make explicit connections to actual science inquiry. The Web site provides all needed materials and a teacher's guide for the lesson. It also provides background information for the teacher on using inquiry methods in science.

[http://science.education.nih.gov/supplements/nih6/inquiry/guide/guide\\_lessons\\_toc.htm](http://science.education.nih.gov/supplements/nih6/inquiry/guide/guide_lessons_toc.htm)

## Overcoming Misconceptions

Teacher knowledge of student misconceptions is one key to successfully teaching science. As American humorist Will Rogers put it, "It ain't what they don't know that gives them trouble; it's what they know that ain't so." In the context of the present lesson, for example, many students hold misconceptions such as these about scientific laws and theories:

- Laws are ideas that are based on facts and are the only truly reliable scientific knowledge.
- Theories are less well substantiated by evidence than laws and lack the validity of laws. With further proof, however, scientific theories may become scientific laws.

Make sure students understand that this hierarchical view of scientific knowledge is incorrect. Laws are descriptive, whereas theories are explanatory, so theories don't become laws with additional proof. Theories explain what laws describe. Stress that explanations gain the status of theories in science only if and when they have been subjected to repeated testing and are supported by a great deal of evidence.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 1.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 1.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Define science.
2. Identify traits of a good scientist.
3. Sometimes luck plays a role in science. What role did luck play in Miranda's and Jeanny's research?
4. Compare and contrast scientific theories and scientific laws. Give an example of each in life science.
5. Do you think that being a scientist requires creativity? Why or why not?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 1.1 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Most scientists specialize in just one area of science. An example is life science.

- What do you think life scientists study?
- What do you think might be some specializations within life science?

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## 1.2 What Is Life Science?

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### Key Concepts

- Scope of life science
- Fields within life science
- Cell theory and theory of evolution by natural selection.
- Aims of basic and applied life science

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### Standards

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### Lesson Objectives

- Describe the scope of life science.
- Identify the focus of specific fields within life science.
- Outline basic theories that underlie all the fields of life science.
- Distinguish between basic and applied life science.

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### Lesson Vocabulary

- applied science: Science that is undertaken to find solutions to practical problems.
- basic science: Science that is undertaken to discover new knowledge and gain a better understanding of the natural world, regardless of whether it has any practical use.
- life science: Study of life and living things.
- organism: Life form, or living thing.

---

### Teaching Strategies

#### Introducing the Lesson

Pique students' interest in learning about life by showing the class the astonishing world of undersea life in David Gallo's short, funny TED talk at the following URL. Students will be amazed by the underwater light shows of bioluminescent animals and the incredible ability of many animals to blend into their surroundings. Tell students they will learn many more amazing things about living things when they study life science.

[http://www.ted.com/talks/david\\_gallo\\_shows\\_underwater\\_astonishments](http://www.ted.com/talks/david_gallo_shows_underwater_astonishments)

## Discussion

Discuss the diversity of life and life science. First share these figures with students to help them appreciate how diverse life is:

- About 1.2 million different species of living things are currently known.
- On average, about 15,000 new species are discovered every year.
- As many as 8.7 million species may actually live on Earth.

Then discuss the range of foci that life science can take. Point out that the focus of life science can range from life at the level of a single-celled living thing, such as a bacterium, all the way up to the level of the biosphere, which includes all the living things on Earth.

## Differentiated Instruction

Have students make a Frayer model for the vocabulary term *organism*. A Frayer model is a vocabulary strategy in which students draw a large box and divide it into four parts labeled "Definition," "Drawing," "Example," and "Non-example." Then students fill in each part of the box for the assigned term. Select one of their completed Frayer models and add it to the word wall.

## Enrichment

Ask one or more students to explore careers in life science. The URL below is an excellent starting point. Have the students create a PowerPoint presentation, brochure, or poster to provide information to the rest of the class about some of the life science careers they think are most interesting. Tell them to include careers in different fields of life science and careers in both applied and basic life science.

<http://www.accessexcellence.org/RC/AB/WYW/wkbooks/OBAS/careers.php>

## Science Inquiry

Students are introduced to cell theory in this lesson. Give them an opportunity to view a diversity of cell types under a microscope. Alternatively, you can have them find images online of a diversity of cell types. Challenge students to draw general inferences about cells based on their observations. (*Sample responses:* Cells are very small; there is great variation in cells; cells have other structures inside of them.) Tell students they will learn much more about cells in a later chapter.

## Real-World Connection

Point out that life science has many practical applications in the real world. Real-world applications of life science include developing new drugs to treat disease, creating crops that can resist insect pests, and discovering bacteria that can consume oil spills. Urge students to go online and research additional real-world applications of life science.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 1.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 1.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What is life science?
2. Define organism.
3. List three different fields in life science. What is the focus of study in each of these fields?
4. Many scientists may work together on the same research problem. Explain which fields of life science you think might be involved in studying the effects of an oil spill in the ocean.
5. Explain why the cell theory is basic to all of the fields of life science.
6. How does the theory of evolution by natural selection explain the tremendous diversity of living things on Earth?
7. Relate basic and applied scientific research.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 1.1 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

The cell theory and the theory of evolution by natural selection are basic to all of the fields of life science.

- Do you think that the same basic methods are used in all of the fields of life science?
- How do you think life scientists increase their knowledge of living things?

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## 1.3 The Scientific Method

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### Key Concepts

- Steps of the scientific method
- Definition of scientific hypothesis
- Nature of experimentation
- Independent and dependent variables and controls

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### Standards

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### Lesson Objectives

- Outline the steps of the scientific method.
- State the meaning of scientific hypothesis.
- Define experiment.
- Identify independent and dependent variables and controls.

---

### Lesson Vocabulary

- control: Factor that might affect a dependent variable so it is held constant in an experiment.
- dependent variable: Variable in an experiment that is affected by another variable, called the independent variable.
- experiment: Controlled scientific test of a hypothesis that often takes place in a lab and investigates the effects of an independent variable on a dependent variable.
- hypothesis: Potential, testable answer to a scientific question.

independent variable: Variable that is tested in an experiment to see whether it affects another variable, called the dependent variable.

- observation: Anything detected with the senses, which include sight, hearing, touch, smell, and taste.
- replication: Repeating a scientific investigation and getting the same results.
- scientific method: Series of logical steps that scientists use to guide their research, which generally include making observations, asking a question, forming a hypothesis, testing the hypothesis, drawing a conclusion, and communicating the results.

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## Teaching Strategies

### Introducing the Lesson

Show students a short MythBusters video clip (see first URL below) as a silly way of engaging them in the use of the scientific method to find answers to questions. Point out how the procedure used to investigate the myth is similar to a scientific investigation. After students learn about the scientific method, give them a copy of the worksheet at the second URL, and have them complete it to analyze the investigation in the video clip.

<http://www.discovery.com/tv-shows/mythbusters/2014-episodes.htm>

<http://sciencespot.net/Media/mythbusterswkst.pdf>

### Activity

Use the apple activity at the following URL to help students appreciate the importance of making observations in science. The activity can be done as a class or group activity.

<http://www.middleschoolscience.com/apple.htm>

### Building Science Skills

Have students join everyone's favorite Porifera (SpongeBob) and his friends as they do several science experiments. Students will apply lesson concepts by writing experimental procedures and identifying variables and controls. A student worksheet and answer key are provided at this URL:

<http://sciencespot.net/Media/scimthdexps.pdf>

### Differentiated Instruction

Write a series of open-ended cloze prompts for students to complete as they read the lesson. This will help them focus on the most important concepts. Examples of cloze prompts from the lesson are provided below, including sample completions in brackets. Make sure students know that completing each prompt adequately requires multiple words.

- The scientific method is [a series of logical steps for testing a possible answer to a scientific question].
- Observations refer to [anything detected with one or more of the senses.]
- A hypothesis is [a potential, testable answer to a scientific question.]
- An experiment is [a controlled scientific test that often takes place in a lab and investigates the effect of one variable on another.]
- Replication means [repeating a scientific investigation and getting the same results.]

### Enrichment

Assign the project at the URL below to students who need extra challenges. In the project, they will assume they are members of a team from a community health department. They will investigate a possible health problem in the local school district. To solve the problem, they must analyze a variety of public health data, propose possible sources of the health problem, and describe how the sources might be confirmed. Students should present their final report as a role-play for the rest of the class.

[http://science.education.nih.gov/supplements/nih6/inquiry/guide/guide\\_lessons\\_toc.htm](http://science.education.nih.gov/supplements/nih6/inquiry/guide/guide_lessons_toc.htm)

## Science Inquiry

The process of science inquiry is generally iterative and may be very complex. Engage the class in the group activity at the following URL so students will realize that doing science is seldom a simple, linear process. Students will use a scientific inquiry flowchart to plot the scientific journey of Walter Alvarez, who made the serendipitous discovery of what caused the dinosaurs to go extinct. Students will find that scientific inquiry often involves unanswered questions, surprising leaps, reinterpretation of data, and the unexpected. The Web site provides handouts and other materials needed for the activity.

[http://undsci.berkeley.edu/lessons/introducing\\_flow\\_ms.html](http://undsci.berkeley.edu/lessons/introducing_flow_ms.html)

## Overcoming Misconceptions

Students commonly think that there is a single scientific method that all scientists follow. Make sure students understand that the scientific method described in this lesson is actually a simplified representation of how scientists generally build knowledge. In fact, the process of science is exciting, complex, and unpredictable. It involves many different people, engaged in many different activities, in many different orders. Point out that many scientific discoveries have actually been made by accident. Students can find out about some of the many accidental discoveries in science at these URLs:

<http://www.pbs.org/wgbh/nova/body/accidental-discoveries.html>

<http://gizmodo.com/24-accidental-scientific-discoveries-that-changed-the-w-1463735328>

## Overcoming Misconceptions

A recent AAAS study found that nearly half of middle school students tested held the misconception that a given experiment can test for the effects of all variables included in the study, whether the variables are allowed to vary or are held constant. Discuss a specific example that shows why only one factor should vary while other factors should be controlled. For example, describe a fictitious study of the effects of diet on weight that allows both Calories consumed in food and Calories expended in exercise to vary among subjects studied. Then explain how the effects of diet on weight can only be determined by controlling other factors, including exercise, that are also likely to affect weight.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 1.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 1.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Outline the steps of the scientific method.
2. Define scientific hypothesis.
3. What is a scientific experiment? Define independent and dependent variables and controls.

4. How did the ACE gene researchers in the video above test the hypothesis that people with D genes and people with I genes respond differently to the same athletic training program? Identify independent and dependent variables in their study. What factors were controlled?
5. Summarize the results of the ACE gene study. How would you communicate the results?
6. What is replication in science? Why is it important?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 1.3 Quiz in *CK-12 MS Life Science Assessments*.

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### Points to Consider

Whether they do basic or applied research, many life scientists use microscopes as one of their most important tools.

- What is a microscope?
- Why do you think microscopes are so important in life science?

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## 1.4 The Microscope

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### Key Concepts

- What a microscope does
- Why the microscope is important in life science
- Invention of the microscope
- Light microscopes and electron microscopes

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### Standards

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### Lesson Objectives

- Define microscope.
- Explain why the microscope is so important in life science.
- Outline how the microscope was invented.
- Compare and contrast modern light microscopes and electron microscopes.

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### Lesson Vocabulary

- electron microscope: Type of microscope that can make images of extremely tiny objects by passing beams of electrons through or across them.
- light microscope: Type of microscope that uses lenses to refract visible light and make magnified images of small objects.
- microscope: Device that makes magnified images of small objects so they are visible to the human eye.

---

### Teaching Strategies

#### Introducing the Lesson

Engage students in learning about the microscope by challenging them to identify mystery photos of everyday objects that have been magnified. Photos and an answer key are provided at this URL:

<http://sciencespot.net/Media/micromyspic.pdf>

## Demonstration

Demonstrate to the class the proper way to use and care for a light microscope. During the demonstration, project images of prepared slides for students to view or allow students to view prepared slides directly through the microscope.

## Activity

If you don't have a microscope in the classroom or are short on time, provide each student with a copy of the virtual microscope tour activity at the following URL. As they complete the activity, they will learn about the parts of a light microscope, how to use it, what objects look like at different magnifications, and the history of the microscope. The activity can be done by individual students or groups of students. It could be done in the classroom, the school computer lab, or as a homework assignment if all students have computer and Internet access at home.

<http://edtech2.boisestate.edu/pattymcginnis/592/Files/506%20Lesson%201%20Virtual%20Tour%20of%20the%20Microscope.pdf>

## Differentiated Instruction

Create a gallery walk for the microscope. Divide the class into groups and have the groups walk around the room to read and discuss posted question (each on a large sheet of paper to allow room for multiple answers). Sample questions are listed below. Give each group a pen or marker with different-colored ink to answer the questions. They should also read and respond to answers written by other groups. Follow the activity with a class discussion of the answers. Correct any misinformation they reveal.

1. What are some living structures that you need a microscope in order to see?
2. Who invented the microscope, and when was it invented?
3. What contributions to science were made by Hooke and van Leeuwenhoek using the microscope?
4. What are electron microscopes? Why are they more powerful than light microscopes?

## Enrichment

Suggest to interested students that they learn more about the scanning electron microscope (SEM) at the following URL. They will learn how an SEM works and how samples are prepared for viewing. They will also be able to see variety of images created with an SEM at various magnifications. Ask the students to present a slideshow of SEM-magnified objects to the rest of the class. Challenge other students to identify the objects.

<http://legacy.mos.org/sln/SEM/seminfo.html>

## Science Inquiry

With the activity described at the URL below, students will use science inquiry and the scientific method to learn about and practice using the microscope. In the activity, students will design and carry out a simple experiment about the thickness of hair. They will ask a question, design a research procedure to answer the question, collect and record data, analyze the data, and draw conclusions.

[http://digitalcommons.imsa.edu/sci\\_pr/9/](http://digitalcommons.imsa.edu/sci_pr/9/)

## Overcoming Misconceptions

Students typically think of scientific observations as what they see directly with their own eyes. Explain that observations can also be made indirectly using tools such as thermometers, radar, and of course microscopes. In fact, such tools may do a better job of observing than our own senses do or even allow us to make types of observations that would be impossible with the human senses. Share examples of objects of interest to life science that can be seen only with a microscope, such as virtually all cells and all structures within cells.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 1.4 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 1.4 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What is a microscope?
2. Outline the contributions of Hooke and van Leeuwenhoek to the microscope and to life science.
3. Assume that you want to view a structure that is 400 nanometers wide. Explain which type of microscope you would use, a light microscope or an electron microscope.
4. Explain why the microscope is such an important tool in life science.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 1.4 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Microscopes are usually used in a lab setting. Science labs can be dangerous places unless you follow safety rules.

- Can you think of a danger you might be exposed to in a science lab?
- What might be a common-sense lab safety rule?

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## 1.5 Safety in Life Science Research

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### Key Concepts

- Common safety symbols and lab safety rules
- Safety in the field
- Reporting accidents

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### Standards

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### Lesson Objectives

- Identify common safety symbols and lab safety rules.
- Explain how to stay safe while doing field research.
- State what to do in case of an accident during scientific research.

---

### Lesson Vocabulary

- fieldwork: Scientific research that takes place in a natural setting rather than in a lab.

---

### Teaching Strategies

#### Introducing the Lesson

Use humor to engage students in science safety by giving them copies of the lab safety cartoon at the first URL below. Have them read the questions at the bottom of the page. Tell them they should be able to answer the questions after they read this lesson. Then revisit the page when you have covered lesson content. Have students gather in small groups to discuss and answer the questions.

<http://www.biologycorner.com/resources/safety.gif>

[http://www.biologycorner.com/worksheets/safety\\_teacher.html](http://www.biologycorner.com/worksheets/safety_teacher.html)

#### Demonstration

Demonstrate safe lab practices to the class. For example, show students how to safely add acid to water, use a Bunsen burner, and smell vapors. Also point out the location of any safety equipment in the classroom and explain when it is used.

## Building Science Skills

Staying safe while doing science is one of the most important science skills. Have students do the interactive lab safety tutorial at the following URL. Make sure they take the quiz at the end of the tutorial to assess their knowledge of lab safety.

<http://www.baruch.cuny.edu/tutorials/weissman/biolab/Template.html>

## Differentiated Instruction

Help students learn and remember lab safety rules by creating pictorial representations of them. Have them make a lab safety poster in which they illustrate at least three lab safety rules. They should state each rule and make a simple sketch to represent it. Display their posters in the classroom.

## Enrichment

Ask a few creative students to write a rap, song, or poem about staying safe while doing science. Give them an opportunity to perform their creation for the class.

## Science Inquiry

Divide the class into groups of three or four students each. Give each group a copy of the SpongeBob science safety worksheet at the URL below. Students will identify safety rules that SpongeBob and his pals broke as they performed experiments. The download includes notes for the teacher and an answer key.

<http://sciencespot.net/Media/scimthdsafety.pdf>

## Real-World Connection

Several lab safety symbols are commonly seen in real-world settings, so knowing what they mean may help students in real life. For example the chemical hazard (toxin) symbol might be found on pesticides around the home. The biohazard symbol is found on sharps containers in doctors' offices and hospitals. Radioactive hazard symbols may be found in hospital radiology departments. Tell students to watch for the symbols in these and other real-world settings.

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## Reinforce and Review

### Lesson Worksheets

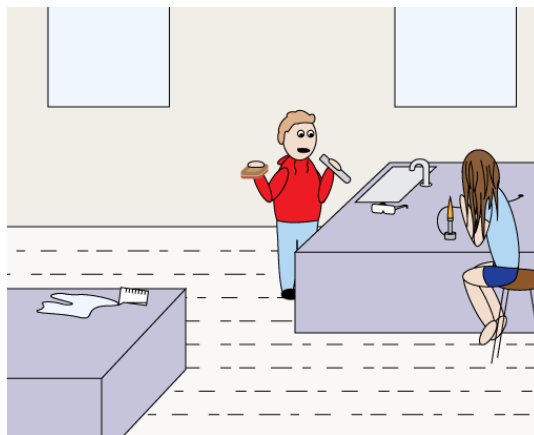
Copy and distribute the Lesson 1.5 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 1.5 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Look at the safety symbol in the picture below. What hazard does it represent?

2. Identify three safety rules that help prevent accidents in the lab.
3. Examine this sketch of students working in a lab. Identify at least three lab safety rules they are breaking.



4. Assume you are a field researcher studying ants. What risks might you face? How could you reduce or avoid these risks?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 1.5 Quiz in *CK-12 MS Life Science Assessments*.

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### Points to Consider

In this chapter, you learned that life science is the study of life and living things.

- What separates life from nonlife?
- What characteristics define living organisms?

## CHAPTER

## 2

# TE MS What is a Living Organism?

## Chapter Outline

**2.1 CHARACTERISTICS OF LIVING ORGANISMS**

**2.2 CHEMISTRY OF LIVING THINGS**

**2.3 CLASSIFICATION OF LIVING THINGS**

## Chapter Overview

This chapter identifies characteristics of living things, describes biochemical compounds and reactions, and explains how living things are classified.

## Online Resources

*See the following Web sites for appropriate laboratory activities:*

Students can investigate the characteristics of living organisms with the lab "Is Yeast Alive?" The first URL is the student edition. The second URL provides teacher notes for the lab.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/IsYeastAliveProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/IsYeastAliveProtocol.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/IsYeastAliveTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/IsYeastAliveTeachPrep.pdf)

The inquiry lab at the following URL allows students to develop a working definition of living things through observations they make at a series of stations set up in the classroom.

[https://www.ocps.net/cs/services/cs/currareas/sci/IR/lessonplans/MID\\_LP/Lab05\\_Living%20or%20Not%20Living\\_-\\_0910.pdf](https://www.ocps.net/cs/services/cs/currareas/sci/IR/lessonplans/MID_LP/Lab05_Living%20or%20Not%20Living_-_0910.pdf)

In this lab, students experiment with lactase to learn about enzymes. Students also apply the scientific method by interpreting evidence to test hypotheses and designing additional experiments to answer specific scientific questions about lactase. The first URL links to the student pages, and the second URL links to the teacher pages.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/EnzymeProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/EnzymeProtocol.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/EnzymeTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/EnzymeTeachPrep.pdf)

Have students do the lab "Evidence of Photosynthesis" at the following URL. They will test water for carbon dioxide as evidence that the water plant Elodea uses carbon dioxide in photosynthesis.

[http://science-class.net/archive/science-class/Lessons/Photosynthesis\\_Cell\\_Resp/evidence\\_of\\_photosynthesis.pdf](http://science-class.net/archive/science-class/Lessons/Photosynthesis_Cell_Resp/evidence_of_photosynthesis.pdf)

In the classification lab at the following URL, students will distinguish between living and nonliving specimens they collect in the "field" by considering features that define life. Then they will classify and organize specimens based on observable traits. They will also construct and use a dichotomous key for the collected field specimens.

<http://biology.wisc.edu/FamiliesPublic-ScientificActivities-WhatisLifeScavengerHunt.htm>

*These Web sites may also be helpful:*

For a fuller explanation of the chemistry of living things, access the problems and tutorials at this URL:

<http://www.biology.arizona.edu/biochemistry/biochemistry.html>

For a quick and entertaining review of taxonomy, watch the video at the following URL. You may want to recommend the video to your students as well.

[http://www.youtube.com/watch?v=F38BmgPcZ\\_I](http://www.youtube.com/watch?v=F38BmgPcZ_I)

You can find excellent, detailed animations of biological processes at the URL below. Animations relevant to the content of this chapter include "How Enzymes Act as Catalysts," "Enzyme Activity," and "Introduction to Metabolism," among others.

<http://www.learnerstv.com/animation/Free-biology-animations-page1.htm>

**TABLE 2.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
2.1 Characteristics of Living Organisms	2.5
2.2 Chemistry of Living Things	3.0
2.3 Classification of Living Things	1.5

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## 2.1 Characteristics of Living Organisms

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### Key Concepts

- Characteristics of living things
- Overview of cells
- Definition of stimulus and response
- Comparison of sexual and asexual reproduction
- Meaning of homeostasis

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### Standards

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### Lesson Objectives

- Identify characteristics of living organisms.
- Describe cells.
- Explain why living things need energy.
- Give an example of a stimulus and response.
- Compare sexual and asexual reproduction.
- Define homeostasis.

---

### Lesson Vocabulary

- cell: Unit of structure and function of all living things.
- energy: Ability to change or move matter.
- homeostasis: Condition in which an organism maintains a stable internal environment.
- reproduction: Production of offspring.
- response: Reaction to a stimulus by a living organism.
- stimulus: Something in the environment that causes a reaction in an organism.

---

### Teaching Strategies

#### Introducing the Lesson

Ask students to make a list of things that are alive and another list of things that are not alive. Call on volunteers to read their lists to the class. Guide students in comparing the two lists so they can start to develop a working definition of what it means to be alive. Ask the class what the living things on the list have in common and how they differ

from the things that aren't alive. Tell students they will learn the characteristics of living things when they read this lesson.

### Demonstration

Do the simple "Sewer Lice" demonstration described at the following URL for a light-hearted way to generate a discussion of the characteristics of living things. Students will be grossed out when you show them that the "lice" (actually raisins) are edible. The demonstration will definitely engage them, illustrate the importance of careful observations, and start them thinking about the distinction between living and nonliving things.

<http://www.nclark.net/SewerLice.pdf>

### Cooperative Learning

Challenge teams of students to invent a new organism. It should have structures for performing all of the functions of a living thing. Team members should make models or sketches of their organism and explain how it functions to the rest of the class.

### Building Science Skills

The activity at the link below can be done as a class project or an individual assignment. In the activity, students will read about and see videos of various organisms or living cells. Then they will identify and describe observable characteristics of life in the videos.

[http://www.exploratorium.edu/imaging-station/activities/classroom/characteristics/ca\\_characteristics.php](http://www.exploratorium.edu/imaging-station/activities/classroom/characteristics/ca_characteristics.php)

### Differentiated Instruction

Explain to students how acronyms can be used to remember information, particularly lists of related information. Share with them the popular acronym "MRS GREN." It can be used to remember the characteristics of living things:

**TABLE 2.2:** MRS\_GREN

<b>M</b>	Movement	All living things move, even plants
<b>R</b>	Respiration	Getting energy from food
<b>S</b>	Sensitivity	Detecting changes in the surroundings
<b>G</b>	Growth	All living things grow
<b>R</b>	Reproduction	Making more living things of the same type
<b>E</b>	Excretion	Getting rid of waste
<b>N</b>	Nutrition	Taking in and using food

### Enrichment

Select two small groups of students to research and debate the issue of whether viruses should be considered living things. The URLs below are excellent resources to start their research. Give the students an opportunity to debate the issue in front of the rest of the class.

<http://serc.carleton.edu/microbelife/yellowstone/viruslive.html>

<http://www.scientificamerican.com/article/are-viruses-alive-2004/>

<http://news.discovery.com/videos/are-viruses-alive.htm>

## Science Inquiry

Have groups of students do the "Moon Walkers" inquiry activity at the following URL. They will assume that they are scientists from the moon of another planet and that they have been sent to Earth to investigate possible new life forms. They will also assume that they have captured two specimens to observe and must determine whether the specimens are living or nonliving by observing them and applying the characteristics of life.

[http://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1001&context=middle\\_sci](http://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1001&context=middle_sci)

## Overcoming Misconceptions

Be sure to distinguish between the terms *living thing* and *alive*. Something that is alive is currently living. Generally, it refers to a whole organism. Living things make up a broader category that includes things that were once alive (but are now dead) as well as parts of things that are or once were alive. Discuss the following examples with students, and ask them to categorize them as living or nonliving things.

- Fallen leaves on a forest floor (Living things: they are now dead but were once parts of a living thing.)
- Your hair or fingernails (Living things: they consist of dead cells but they are parts of a living thing.)
- Your ancestors from long ago (Living things: they are living things that are now dead.)
- Cotton fabric or wooden floor (Nonliving things: they come from living things that are now dead but they have also been modified so they are no longer living things.)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 2.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 2.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. List five characteristics of living things.
2. Describe cells.
3. What is energy? How do organisms use energy?
4. Describe a response to an environmental stimulus that might save your life.
5. Discuss the role of reproduction in life.
6. Explain why having a fever when you are sick disrupts your body's homeostasis.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 2.1 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

In this lesson, you read that all living things consist of one or more cells.

- What are cells made of?
- Is there any matter that is smaller than a cell?

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## 2.2 Chemistry of Living Things

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### Key Concepts

- Definition of matter
- Four classes of biochemical compounds
- Role of biochemical reactions in living things

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### Standards

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### Lesson Objectives

- Describe the makeup of matter.
- Outline the four main classes of biochemical compounds.
- Explain the role of biochemical reactions in living things.

---

### Lesson Vocabulary

- atom: Smallest particle of an element that still has the properties of that element.
- biochemical compound: Any carbon-based compound that is found in living organisms; classes of biochemical compounds include carbohydrates, proteins, lipids, and nucleic acids.
- biochemical reaction: Any chemical reaction that takes place inside living things.
- carbohydrates: Class of biochemical compounds that includes sugar, starch, glycogen, and cellulose.
- cellulose: Complex carbohydrate that is a polymer of glucose and that makes up the cell wall of plants.
- chemical bond: Sharing of electrons between two atoms that holds the atoms together.
- chemical reaction: Process in which some substances, called reactants, change chemically into different substances, called products.
- compound: Unique type of matter in which two or more elements are combined chemically in a certain ratio.
- element: One of more than 100 pure substances that cannot be broken down into other substances.
- enzyme: Protein that increases the rate of a biochemical reaction.
- lipids: Class of biochemical compounds that includes fats, oils, and phospholipids.
- matter: Anything that has mass and takes up space.
- metabolism: Sum of all the biochemical reactions that take place in a living organism, including reactions that build up molecules and reactions that break down molecules.
- molecule: Smallest particle of a compound that still has that compound's properties.
- nucleic acids: Class of biochemical compounds that includes DNA and RNA.
- proteins: class of biochemical compounds that consist of chains of amino acids.

---

## Teaching Strategies

### Introducing the Lesson

Introduce the chemistry of life by showing students the amazing HD video at the URL below. The video is meant to be a motivational trailer to get students excited about biochemistry.

[http://youtu.be/tpBAmzQ\\_pUE](http://youtu.be/tpBAmzQ_pUE)

### Building Science Skills

Have students do the hands-on science activity described at the following URL. In the activity, baker's yeast is mixed with warm water (to activate the yeast), flour, and sugar in a container, which is then covered with a lid. The yeast quickly consumes the flour and sugar and produces carbon dioxide, which pops the lid off the container. Guide students in applying lesson concepts to infer the underlying biochemical processes that explain their observations. [Living heterotrophic cells (yeast cells) consume biochemical compounds (carbohydrates in flour and sugar) and break them down in the biochemical reactions of cellular respiration (as evidenced by the production of carbon dioxide gas).]

<http://mysteryofmatteroutreach.org/2013/01/middle-school-demo-biochemistry/>

### Differentiated Instruction

Have visual learners, less proficient readers, and English language learners use the interactive animations at the following URLs to learn about photosynthesis and cellular respiration.

<http://www.urmc.rochester.edu/MediaLibraries/URMCMedia/life-sciences-learning-center/media/photosynthesis.swf?ext=.swf>

<http://www.urmc.rochester.edu/MediaLibraries/URMCMedia/life-sciences-learning-center/media/respiration.swf?ext=.swf>

### Enrichment

Suggest that students play the free online game "Biochem Gems," which they can access at the following URL. Players are tasked with assembling basic biochemical compounds from their constituent pieces. Students use critical thinking skills to learn how to construct 17 different biochemical compounds.

<http://www.sciencegamecenter.org/games/biochem-gems>

### Science Inquiry

Have students do the inquiry activity "Who Took Jerell's iPod?" at the following URLs. The first URL is the student handout, and the second URL provides activity notes for teachers. In the activity, students learn how to test for triglycerides, glucose, starch, and protein. Then they use the tests to solve a mystery. The activity helps students understand the biological functions and food sources of these different types of biochemical compounds.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/WhoTookJerellsIpod.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/WhoTookJerellsIpod.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/WhoTookJerellsIpodTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/WhoTookJerellsIpodTeachPrep.pdf)

## Real-World Connection

With the class, do the activity described at the URL below so students can discover how biochemistry relates to their lives. In the activity, students use nutrition facts charts to identify dietary sources of carbohydrates, fats, and proteins in foods they like. They also discuss what these macromolecules do inside their body.

<http://teachingrealscience.com/2013/02/27/exploring-biochemistry-with-a-menu-planner-activity/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 2.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 2.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What are elements and compounds? What are their smallest particles?
2. Identify the four main classes of biochemical compounds. Give an example and list a function of each class.
3. Define metabolism
4. Lipids consist of fatty acids. Most nutrition experts agree that we should limit the amount of saturated fatty acids that we eat. They think that unsaturated fatty acids are healthier. To follow this advice, which foods should you limit? What foods are healthier choices?
5. Explain the relationship between nucleic acids and proteins.
6. Compare and contrast anabolic and catalytic reactions. Give an example of each type of reaction.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 2.2 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

All living things share many of the same biochemical compounds and biochemical reactions. Yet living things are extremely diverse.

- How do scientists make sense of the diversity of living things?
- How do modern scientists classify organisms? What types of traits do they use?

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## 2.3 Classification of Living Things

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### Key Concepts

- Definition of taxonomy
- Linnaeus' contributions to taxonomy
- Modern three-domain system of classification
- Classification of viruses

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### Standards

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### Lesson Objectives

- Define taxonomy.
- Outline Linnaeus' contributions to taxonomy.
- Describe the three-domain system of classification.
- Decide how viruses should be classified.

---

### Lesson Vocabulary

- binomial nomenclature: Method of naming species introduced by Linnaeus in which each species is given a unique two-word name consisting of its genus and species names.
- class: Taxon below the phylum in biological classification that consists of one or more orders.
- domain: Broadest taxon in modern biological classification that consists of one or more kingdoms.
- family: Taxon below the order in biological classification that consists of one or more genera.
- genus (genera, plural): Taxon below the family in biological classification that consists of one or more species.
- kingdom: Taxon below the domain in modern biological classification that consists of one or more phyla.
- Linnaeus: "Father of taxonomy" who introduced the system of classification that is the basis of modern biological classification and who also developed the method of naming species called binomial nomenclature.
- order: Taxon below the class in biological classification that consists of one or more families.
- phylum (phyla, plural): Taxon below the kingdom in biological classification that consists of one or more classes.
- species (singular and plural): Narrowest taxon in biological classification that consists only of organisms that can breed and produce fertile offspring with each other but not with members of other such groups.
- taxon (taxa, plural): Category in a biological classification system, such as the kingdom or species.
- taxonomy: Science of classifying living things.
- virus: DNA or RNA surrounded by a coat of proteins that uses living cells to reproduce and can evolve but which many scientists do not consider a living thing.

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## Teaching Strategies

### Introducing the Lesson

Introduce taxonomy and the classification process with a quick activity in which students classify familiar objects. As a class or in groups, have students discuss and complete copies of the worksheet found at the following URL. The worksheet lists several items typically found in a classroom (which can be modified as needed for your own classroom), and students are asked to classify the items into six categories. This requires students to consider the characteristics of the items and to select characteristics to use as the basis of their classification system. Discuss their completed taxonomies and relate them to the classification of living things.

<http://www.shellyssciencespot.com/Worksheets/Classification/ClassifyingClassroomObjects.pdf>

### Building Science Skills

Have students do the classification activity at the URL below. The activity could be done as a class project or homework assignment. In the activity, students must answer a series of questions based on an illustrated taxonomy chart that is included with the handout. By the time they have answered all of the questions, they will have become much more familiar with the hierarchy of biological classification, including the major taxa.

[http://www.biologycorner.com/worksheets/taxonomy\\_interpret.html](http://www.biologycorner.com/worksheets/taxonomy_interpret.html)

### Activity

Give students practice using the basic Linnaean classification system by asking them to create a classification poster for an organism of their choice. At the URL below, you can find a student worksheet for the project. It includes a grading rubric. Display their completed work in the classroom, and encourage students to examine each other's posters.

<http://www.shellyssciencespot.com/Worksheets/Classification/ClassificationPosterProject.pdf>

### Differentiated Instruction

Hands-on learners may get a better understanding of the hierarchical nature of biological classification systems by manipulating a three-dimensional hierarchy of boxes. Arrange boxes of different sizes by putting very small boxes inside larger boxes, which are placed inside still larger boxes, and so on. The largest box can represent a kingdom. The next smaller box or boxes then represent one or more phyla, and so on down to the smallest boxes, which represent the species within a single genus. You can label the boxes with their taxa (kingdom, phylum, etc.), or you can have students label them.

### Enrichment

Extend the lesson for students who need extra challenges by having them complete the project at the following URL. Students will learn about phylogenetic classification and cladograms as an alternative way to classify organisms. After reading about phylogeny and cladistics and examining a sample cladogram, students will apply what they learn by creating their own cladogram. You might want to have the students teach the topic to the rest of the class.

<http://www.biologycorner.com/worksheets/cladogram.html#.U8lHKf1OX3g>

## Science Inquiry

The project described at the following URL is a creative way for students to engage in the science of classification. The project is set in the future after Earth's organisms have undergone drastic changes. Student pretend to be aliens visiting Earth to study its living things. Their task is to create a taxonomic system to classify several fictitious organisms, give the organisms Latin-sounding names that follow the rules of binomial nomenclature, and create illustrations of the organisms. They will also create a dichotomous key so anyone else can classify the organisms. The project can be done by students individually or in groups.

<http://www.biologycorner.com/worksheets/taxonomyproject.html>

## Overcoming Misconceptions

Students commonly think that organisms should be classified on the basis of behavior and habitat. As a result, they may have the misconception that turtles are amphibians, bats are birds, and whales are fish. Have students compare the scientific descriptions of the phyla and classes of these animals to overcome the misconceptions.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 2.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 2.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What is taxonomy, and why is it important?
2. List the taxa in Linnaeus' system of classification, from the broadest taxon to the narrowest taxon.
3. Describe binomial nomenclature.
4. Apply the Linnaean classification system to the human species.
5. What is a domain? Explain why scientists added the domain to the Linnaean classification system.
6. Identify and compare the three domains of life.
7. How do you think viruses should be classified? Support your answer.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 2.3 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Cells are the basic units of living things. Some cells have a nucleus.

- Besides a nucleus, what are some other structures that cells contain?

- How do plant and animal cells differ?

## CHAPTER

## 3

# TE MS Cells and Their Structures

## Chapter Outline

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**3.1** LIFE'S BUILDING BLOCKS

**3.2** CELL STRUCTURES

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## Chapter Overview

This chapter introduces the fundamentals of cell biology, including cell theory, basic parts of all cells, and prokaryotic vs. eukaryotic cells. It describes cell structures and their functions and contrasts plant and animal cells.

## Online Resources

*See the following Web sites for appropriate laboratory activities:*

In the lab at the first URL below, students will stain and view under a microscope cells from the inside of their cheeks (animal cells) and cells from elodea (plant cells). They will sketch what they observe and identify the similarities and differences between the animal and plant cells. The second URL provides microphotos showing several types of cells so students will know what to look for under the microscope.

[http://www.biologycorner.com/worksheets/comparing\\_plant\\_animal.html](http://www.biologycorner.com/worksheets/comparing_plant_animal.html)

<http://www.nclark.net/CellPhotos>

If students do not have access to microscopes, they can do virtual animal and/or plant cell microscope labs using the resources at these URLs:

<http://www.biologycorner.com/worksheets/cheekcell-virtual.html>

<http://www.biologycorner.com/worksheets/plantcell-virtual.html>

*These Web sites may also be helpful:*

At this URL, you can find a detailed timeline showing how knowledge of cells and cell theory accumulated over time:

[http://www.softschools.com/timelines/cell\\_theory\\_timeline/96/](http://www.softschools.com/timelines/cell_theory_timeline/96/)

The Web site at the following URL provides links to many good games, sets of notes, templates, activities, and other materials all relating to cells.

<http://schools.southampton.k12.va.us/education/components/scrapbook/default.php?sectiondetailid=9448>

The URLs below provide large, detailed drawings of plant and animal cells that you can display in the classroom when you teach students about cells and cell structures.

<http://waynesword.palomar.edu/images/plant3.gif>

<http://waynesword.palomar.edu/images/animal4.gif>

This Web site provides interactive plant, animal, and bacterial cell models:

<http://www.cellsalive.com/cells/3dcell.htm>**TABLE 3.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
3.1 Life's Building Blocks	3.0
3.2 Cell Structures	2.5

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## 3.1 Life's Building Blocks

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### Key Concepts

- Discovery of cells and the cell theory
- Structures found in all cells
- Prokaryotic vs. eukaryotic cells
- Relationship of cell shape to cell function
- Levels of organization in living things
- Why cells are very small

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### Standards

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### Lesson Objectives

- Review the discovery of cells and the cell theory.
- Identify the basic parts of all cells.
- Compare and contrast prokaryotic and eukaryotic cells.
- Relate cell shape and cell function.
- Outline the levels of organization in living things.
- Explain why cells must be very small.

---

### Lesson Vocabulary

- cell membrane: Thin coat of phospholipids that surrounds a cell and controls what enters and leaves the cell.
- cell theory: Theory that all organisms consist of one or more cells; that cells are alive and the site of all life processes; and that all cells come from pre-existing cells.
- cytoplasm: Material inside the cell membrane, including the watery cytosol and other cell structures except the nucleus if one is present.
- eukaryote: Organism that has cells with a nucleus and is classified in the Eukarya Domain.
- eukaryotic cell: Cell in which most of the cell's DNA is enclosed in a nucleus and which has other membrane-bound organelles.
- nucleus: Organelle in a eukaryotic cell that contains most of the cell's DNA.
- organ: Structure composed of two or more types of tissues that work together to do a specific task.
- organelle: Any structure inside a eukaryotic cell that is enclosed by a membrane and does a special job inside the cell.
- organ system: Groups of organs that work together to do the same overall job.
- prokaryote: Single-celled organism that lacks a nucleus and other membrane-bound organelles; organism in the Archaea or Bacteria Domain.

- prokaryotic cell: Cell in which the cell's DNA is not enclosed within a nucleus and which lacks other membrane-bound organelles.
- ribosome: Structure found in the cytoplasm of all cells that consists of RNA and proteins and is the site of protein synthesis.
- tissue: Group of specialized cells of the same kind that perform the same function.

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## Teaching Strategies

### Introducing the Lesson

Show students the dramatic HD at the URL below to introduce them to the amazing microscopic world of cells. The video contains some incredible cell facts that will inspire your students to learn more about these basic building blocks of life.

<http://www.youtube.com/watch?v=gFuEo2ccTPA>

### Activity

Have students use the interactive online game "Rags to Riches" at the following URL to learn about or assess their knowledge of cell theory and how it developed. They will be presented with a series of questions that they must answer correctly in order to qualify for a cash prize and continue with the game. If they answer all the questions correctly and complete the game, they qualify for a cash prize of \$1 million. You might want to award them an actual cash prize by equating each \$1000 to a penny.

<http://www.quia.com/rr/369486.html>

### Demonstration

Use the sliding scale in the tool at the following URL to show students how the size of cells compares with other tiny structures. As you zoom in to smaller and smaller structures, point out all of the structures that are either individual cells (e.g., amoeba, paramecium, human egg and sperm cells, yeast cell, and red blood cell) or cells parts (e.g., lysosome, mitochondrion, and ribosome). Alternatively, students can manipulate the scale themselves to get a better understanding of how small cells and their parts are.

<http://learn.genetics.utah.edu/content/cells/scale/>

### Differentiated Instruction

Pair students who need extra help with other students, and ask partners to construct a Venn diagram comparing and contrasting prokaryotic and eukaryotic cells.

### Enrichment

Have students do the cell Web quest at the following URL. The worksheet will provide links and questions to guide them through a more detailed self-study of the cell and its structures.

[http://ellingtonschools.org/emslibrary/cell\\_webquest.htm](http://ellingtonschools.org/emslibrary/cell_webquest.htm)

## Science Inquiry

Have students do the surface-area-to-volume-ratio activity at the URL below so they will have a better understanding of why cells must be very small. Students will construct three different 3-D cell models with different dimensions and calculate their surface areas, volumes, and surface area/volume ratios. Then they will make inferences from their investigation about cell size and function.

[http://www.biologyjunction.com/cell\\_size.htm](http://www.biologyjunction.com/cell_size.htm)

## Overcoming Misconceptions

The following misconceptions have been documented by AAAS as being held by at least one third of middle school students. Use the misconceptions as an oral true-false quiz to determine how many of your students hold the misconceptions. Then discuss why the misconceptions are false. Provide specific examples that counter each misconception.

1. All cells are the same size and shape.
2. Cells of living organisms do not make molecules for their own growth and repair.
3. Some living parts of organisms are not made of cells.
4. Cells do not need a way to eliminate their own wastes.
5. No organisms consist of just one cell.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 3.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 3.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Identify discoveries that led to the cell theory.
2. What are the four basic parts found in all cells?
3. Apply the levels of organization of an organism to a human being. List the levels of organization in order from the atom to the organism, and give an example at each level.
4. Compare and contrast prokaryotic and eukaryotic cells.
5. Use examples to show how cell shape relates to cell function.
6. Explain what limits the size of cells.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 3.1 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

All eukaryotic cells have a nucleus and other organelles. Each organelle has a special job to do.

- What do you think some of the special jobs of organelles might be?
- Do you think that plant and animal cells might have different organelles?

---

## 3.2 Cell Structures

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### Key Concepts

- Structure and functions of the cell membrane
- Cytoplasm and cytoskeleton
- Eukaryotic organelles and their functions
- Special structures in plant cells

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### Standards

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### Lesson Objectives

- Describe the structure and functions of the cell membrane.
- Identify the parts and roles of the cytoplasm and cytoskeleton.
- List organelles in eukaryotic cells and their special jobs.
- Describe structures found in plant cells but not animal cells.

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### Lesson Vocabulary

ATP (adenosine triphosphate): Small molecule that cells use for energy.

- cell wall: Rigid layer that surrounds the cell membrane of a plant cell or fungal cell and that supports and protects the cell.
- central vacuole: Large storage sac found in the cells of plants.
- centriole: Organelle in animal cells that is located near the nucleus and organizes the DNA prior to cell division, ensuring that the DNA divides correctly when the nucleus divides.
- cytoskeleton: Structure in a cell consisting of filaments and tubules that crisscross the cytoplasm and help maintain the cell's shape.
- endoplasmic reticulum (ER): Organelle in eukaryotic cells that consists of folded membrane and that helps make and transport proteins and lipids; types include rough ER and smooth ER.
- Golgi apparatus: Organelle in eukaryotic cells that receives, labels, and sends proteins and lipids where they are needed.
- lysosome: Organelle in eukaryotic cells that uses enzymes to break down molecules so their components can be recycled.
- mitochondrion (mitochondria, pl): Organelle in eukaryotic cells that uses energy in glucose to make ATP, which cells can use for energy.
- vacuole: Sac-like organelle in a cell that stores materials in the cell.

- vesicle: Sac-like organelle smaller than a vacuole that may have a variety of functions, such as storing and transporting substances or providing a chamber for biochemical reactions.

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## Teaching Strategies

### Introducing the Lesson

Introduce cell structures with the entertaining cell song at the URL below. Tell students they will learn about all the structures referenced in the song as they study this lesson.

<http://www.youtube.com/watch?v=rABKB5aS2Zg>

### Cooperative Learning

Divide the class into groups, and assign each group a different cell structure or organelle to research and about which to become the class "experts." They should use the Internet to learn more about their assigned structure than is provided in the Flexbook lesson. Encourage them to find or create illustrations of their structure. Then have groups share their work.

### Building Science Skills

Challenge students to create a 3-D model of a cell and its organelles. You can use the activity at the following URL. It includes suggested materials, sample completed cell models, and a scoring rubric.

[http://www.biologycorner.com/worksheets/cellmodel.html#.U8vVg\\_1OX3g](http://www.biologycorner.com/worksheets/cellmodel.html#.U8vVg_1OX3g)

### Activity

Have students do the cell project at the URL below, in which they create a poster comparing plant and animal cells. At the URL, you will find a student handout with complete instructions for the project as well as a scoring rubric. You can post students' completed work in the classroom.

<http://www.shellyssciencepot.com/Worksheets/Cell/CellProject.pdf>

### Differentiated Instruction

Print the document at the following URL on cardstock. Then cut out and laminate the squares. Have students use the cards for an organelle review game by trying to match the name of each organelle with its description.

<http://www.shellyssciencepot.com/Worksheets/Cell/OrganelleMemoryCards.pdf>

### Differentiated Instruction

This activity is good for kinesthetic learners. Hand out copies of the worksheets at the following URLs. Then instruct students to use colored pencils or markers to color each of the organelles in different colors. Make sure they include the relevant colors in the key at the top of each worksheet and also summarize the organelle functions in the blanks at the bottom of each worksheet.

[http://www.biologycorner.com/worksheets/cellcolor.html#.U8v6s\\_1OX3g](http://www.biologycorner.com/worksheets/cellcolor.html#.U8v6s_1OX3g)

[http://www.biologycorner.com/worksheets/cell\\_color\\_plant.html](http://www.biologycorner.com/worksheets/cell_color_plant.html)

### Enrichment

Ask a small group of students to create a travel brochure for a cell (either plant or animal), as described at the URL below. This creative activity offers an alternative to cell models to help students understand cell organelles and their functions. Students are tasked with describing the cell as though it were a large exhibit or amusement park. They must accurately describe, draw, and explain at least eight organelles (attractions) and their functions. Encourage humor and creativity. Display their completed brochures in the classroom and give other students a chance to read them.

[http://www.accessexcellence.org/AE/AEC/AEF/1995/porter\\_cell.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/porter_cell.php)

### Science Inquiry

Analogies are useful ways to learn about structures and processes that are too small, complex, or abstract to study directly. When used in this way, analogies are a type of model. Have groups of students create analogies for a plant cell and its organelles. They can use the worksheet at the following URL. Urge students to be creative in developing their analogies but to also make the analogies helpful in explaining the cell and its parts, including their functions. After groups have completed the worksheet, call on a volunteer from each group to share their analogy with the class. Then hold a class discussion about the analogies, how helpful they are for understanding a plant cell and its functions, and which analogy they think is most helpful or accurate.

<http://www.smithlifescience.com/CellAnalogy.htm>

### Overcoming Misconceptions

Students often think of the cell as a static, two-dimensional collection of multiple independent parts. They may memorize the names and definitions of the parts without understanding how they function and work together to accomplish the multiple functions of a dynamic living cell. Students also often confuse different levels of organization such as molecules, organelles and cells. The teacher notes at the URL below provide key concepts and suggested activities that are designed to engage students in active learning and to overcome these misconceptions.

<http://serendip.brynmawr.edu/exchange/files/cell%20structure%20function.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 3.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 3.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Describe the composition of cytoplasm and list its functions.
2. What is the cytoskeleton? What does it do?

3. Identify three organelles in eukaryotic cells and state their roles.
4. Why is the nucleus like the control center of a cell?
5. Explain how the structure of the cell membrane controls what enters and leaves the cell.
6. Compare and contrast plant and animal cells.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 3.2 Quiz in *CK-12 MS Life Science Assessments*.

---

### Points to Consider

Molecules that enter or leave a cell must pass through the cell membrane. Some of these molecules may be hydrophilic. Other may be too large to squeeze between the phospholipid molecules of the membrane.

- How might hydrophilic molecules pass through the cell membrane?
- How might very large molecules pass through the cell membrane?

## CHAPTER

## 4

## TE MS Cell Functions

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Chapter Outline

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- 4.1     **TRANSPORT**
  - 4.2     **PHOTOSYNTHESIS**
  - 4.3     **CELLULAR RESPIRATION**
- 

---

Chapter Overview

This chapter describes in detail the processes of transport across the cell membrane, photosynthesis, and cellular respiration. It also explains the importance of these processes and how they are related.

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Online Resources

*See the following Web sites for appropriate laboratory activities:*

Students will observe the effects of osmosis and explain why osmosis occurs by doing the "Osmosis in Potatoes" lab at this URL:

<http://www.nclark.net/OsmosisPotatoes.htm>

In the "Diffusion of Water with Gummy Bears" lab, students observe, measure, and explain the effects of diffusion. The first URL below provides the student instructions and worksheet for the lab. The second URL provides teacher notes.

<http://pslc.ws/macrog/kidsmac/activity/bear.htm>

<http://pslc.ws/macrog/kidsmac/activity/tchrbear.htm>

In the photosynthesis lab accessible at the following URL, students will explore the production of oxygen by photosynthesis from an aquatic plant, phytoplankton, and cyanobacteria. They will also observe the consumption of oxygen by respiration.

<http://earthref.org/SCC/lessons/2010/biogeochemistry/photosynthesis/>

With the lab at the URLs below, students will design and carry out experiments to test how variables such as sugar concentration influence the rate of alcoholic fermentation in yeast.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/YeastProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/YeastProtocol.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/YeastTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/YeastTeachPrep.pdf)

*These Web sites may also be helpful:*

This Web site has many useful links for activities, labs, and other teaching materials relating to cell functions.

<http://www.nclark.net/Cells>

You can find excellent active and passive transport animations at this URL:

<http://www.northland.cc.mn.us/biology/Biology1111/animations/transport1.html>

The document at the following URL contains a collection of good inquiry activities on photosynthesis.

[http://www.saps.org.uk/attachments/article/134/SAPS\\_Photosynthesis\\_Survival\\_Guide\\_pupils\\_worksheets.pdf](http://www.saps.org.uk/attachments/article/134/SAPS_Photosynthesis_Survival_Guide_pupils_worksheets.pdf)

Go to the URL below for an extensive list of annotated links to educational sites on photosynthesis.

<http://bioenergy.asu.edu/photosyn/photoweb/education.html>

You can find cellular respiration resources for teachers at this highly recommended URL:

<http://www.ftexploring.com/links/respiration.html>

**TABLE 4.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
4.1 Transport	2.0
4.2 Photosynthesis	2.0
4.3 Cellular Respiration	2.0

---

## 4.1 Transport

---

### Key Concepts

- Structure of the cell membrane
- Methods of passive transport
- Methods of active transport

---

### Standards

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### Lesson Objectives

- Describe the structure of the cell membrane.
- Identify ways that passive transport occurs.
- Define and give examples of active transport.

---

### Lesson Vocabulary

- active transport: Passage of a substance through the cell membrane that requires energy because the substance is moving from a lower to higher concentration or has very large molecules.
- concentration: Number of particles of a substance in a given volume.
- diffusion: Natural movement of a substance from an area of higher to lower concentration without the need for added energy.
- facilitated diffusion: Passive transport of a substance through a membrane with the help of transport proteins.
- osmosis: Diffusion of water.
- passive transport: Passage of a substance through the cell membrane that requires no energy because the substance is moving from a higher to lower concentration.
- simple diffusion: Passive transport of a substance through a membrane without the help of transport proteins.
- transport: Passage of a substance through a cell membrane.
- transport protein: Protein in a cell membrane that helps molecules pass through the membrane, by either forming a channel for the molecules or carrying the molecules through the membrane.
- vesicle transport: Use of a vesicle to actively transport a substance across a cell membrane.

## Teaching Strategies

### Introducing the Lesson

Have students observe while you gently place a few drops of food coloring in a beaker of water. Tell them to keep watching as the food coloring diffuses throughout the water. Call on students to explain what they observed. Accept all reasonable responses at this point. Then state that the process is called diffusion and they will learn in this lesson why it occurs and why it is important for cells.

### Discussion

Show students the excellent animation of simple diffusion and osmosis at the following URL. Use the questions at the top of the Web page to generate a class discussion of these processes.

[http://zoology.okstate.edu/zoo\\_lrc/biol1114/tutorials/Flash/Osmosis\\_Animation.htm](http://zoology.okstate.edu/zoo_lrc/biol1114/tutorials/Flash/Osmosis_Animation.htm)

### Demonstration

Use the animation at the first URL below to demonstrate active transport. Discuss what is happening in each panel of the animation and why energy is needed for the molecules to cross the cell membrane and leave the cell. At the end of the demonstration, have students check their comprehension by completing the worksheet at the second URL.

[http://www.classzone.com/books/ml\\_science\\_share/vis\\_sim/dltm05\\_pg60\\_transport/dltm05\\_pg60\\_transport.html](http://www.classzone.com/books/ml_science_share/vis_sim/dltm05_pg60_transport/dltm05_pg60_transport.html)

<http://www.shellyssciencepot.com/Worksheets/Cell/ActiveTransport.pdf>

### Activity

Have students use the interactive animation at the following URL to see how various substances are transported across the cell membrane. Ask them to identify the mode of transport for each substance.

[http://www.pbslearningmedia.org/asset/tdc02\\_int\\_membraneweb/](http://www.pbslearningmedia.org/asset/tdc02_int_membraneweb/)

### Differentiated Instruction

Pair students who need extra help with other students. Tell partners to work together to create a compare/contrast table for passive and active transport. A sample table is shown below.

**TABLE 4.2:** short caption

Type of Transport	Specific Methods	Energy Needed?	Example of Substance Transported This Way
Passive Transport	Simple diffusion Facilitated diffusion Osmosis	No	Oxygen
Active Transport	Protein pump Endocytosis Exocytosis	Yes	Sodium

## Enrichment

Suggest to students who want to learn more about transport that they watch the entertaining, fast-paced video at the URL below. In addition to the contents of the Flexbook lesson, the video discusses hypotonic, hypertonic, and isotonic solutions; the role of ATP in active transport; discovery of the sodium-potassium pump; and pinocytosis.

<http://www.youtube.com/watch?v=dPKvHrD1eS4>

## Science Inquiry

Divide the class into groups and have them do the inquiry activity "Diffusion Across a Selectively Permeable Membrane." The first URL below is a student handout for the activity, and the second URL provides teacher notes. In the activity, students will investigate the diffusion of molecules across a synthetic, selectively permeable membrane that models the cell membrane. First students will predict which of four molecules will be able to cross the membrane. Then they will test their predictions.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/MembraneProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/MembraneProtocol.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/MembraneTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/MembraneTeachPrep.pdf)

## Overcoming Misconceptions

Common student misconceptions about diffusion are listed below. Discuss with your class why each of the misconceptions is false, and give them counter examples that illustrate the correct conceptions.

- Molecules move with a purpose. They "know" to move from areas of high concentration to areas of low concentration.
- Molecular motion stops when equilibrium is reached
- Diffusion always happens at the same speed and is not affected by concentration difference.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 4.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 4.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Describe the cell membrane.
2. Define diffusion.
3. What is simple diffusion? Give an example.
4. What is osmosis?
5. Assume that the concentration of a substance is lower outside than inside a cell. In which direction—into or out of the cell—can passive transport of the substance occur? Explain your answer.
6. Compare and contrast passive and active transport.
7. Explain how channel proteins and carrier proteins facilitate diffusion across a cell membrane.

## Lesson Quiz

Check students' mastery of the lesson with Lesson 4.1 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Glucose is a substance that passes across cell membranes by facilitated diffusion. All cells need glucose for energy.

- Where does glucose come from?
- What process produces glucose?

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## 4.2 Photosynthesis

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### Key Concepts

- Definition of photosynthesis
- Structure and function of the chloroplast
- Light reactions and the Calvin cycle

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### Standards

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### Lesson Objectives

- Define photosynthesis, and identify photosynthetic organisms.
- Describe the chloroplast and its role in photosynthesis.
- Outline what happens during the two stages of photosynthesis.

---

### Lesson Vocabulary

- autotroph: Organism that makes glucose ("self feeder").
- Calvin cycle: Second stage of photosynthesis in which carbon dioxide is used to produce glucose using energy in ATP and NADPH.
- chlorophyll: Green pigment in the chloroplasts of plants and plant-like protists that gives them their green color and absorbs light energy during the process of photosynthesis.
- chloroplast: Type of plastid, or plant organelle, that contains chlorophyll and is the site of photosynthesis.
- glucose: Simple sugar that all living things use to store and transport energy.
- heterotroph: Living thing that obtains glucose by eating other organisms ("other feeder").
- light reactions: First stage of photosynthesis in which energy from sunlight is absorbed by chlorophyll and temporarily transferred to ATP and NADPH.
- photosynthesis: Process in which glucose is made from carbon dioxide and water using the energy in light.
- stroma: Fluid-filled space inside a chloroplast where the second stage of photosynthesis (Calvin cycle) occurs.
- thylakoid: Flattened sac of membrane inside a chloroplast where the first stage of photosynthesis (light reactions ) occurs.

---

## Teaching Strategies

### Introducing the Lesson

If students read the chapter "What Is a Living Organism?", then they have prior knowledge of photosynthesis. Help them recall what they know. Go around the room, from one student to the next, and have each student state anything they know about photosynthesis. Continue until no new ideas are forthcoming. Tell students they will learn about photosynthesis in this lesson, including whether any of the statements are incorrect.

### Activity

The following URL is a detailed lesson plan for teaching middle school students about photosynthesis. Called "Fun Photosynthesis," it involves students in performing skits in which they learn about photosynthesis and act out the process using homemade props. Links are included to necessary materials and assessment files.

<http://www.beaconlearningcenter.com/Lessons/4266.htm>

### Differentiated Instruction

Work with students to create a simple flow chart of photosynthesis. You can find a sample flow chart at the following URL. The document includes a completed flow chart and a chart with blank boxes for students to fill in.

<http://www.talkabouttrees.org/docs/09-10.pdf>

### Enrichment

Challenge students to create a crossword puzzle that incorporates all of the lesson vocabulary terms. Make copies of their completed puzzles, and have other students try to complete them as a review of lesson vocabulary. They can make puzzles by hand or use this free puzzle maker:

<http://www.discoveryeducation.com/free-puzzlemaker/>

### Science Inquiry

Use the set of worksheets at the URL below for an inquiry approach to learning about photosynthesis. Students will read about the scientific research that led to the discovery of the nature of photosynthesis. As they do, they will analyze data from the research, draw diagrams of research setups, and make inferences from the research results. They will apply the scientific method, consider variables and controls, and summarize what they learned.

[http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/LRRView/7397/applets/Living\\_Things\\_Database/livingthings/pdf/lesson7.pdf](http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/LRRView/7397/applets/Living_Things_Database/livingthings/pdf/lesson7.pdf)

### Overcoming Misconceptions

A common misconception is that plants obtain their "food" from the soil. This idea probably originates mainly from observations of plants in nature. It is an idea of long duration. In the 1600s, van Helmont attempted to determine whether plants obtain food from the soil. Describe his experiment to students (you can learn more at the first URL below.) Then have students complete the worksheet at the second URL. They will analyze van Helmont's data and determine for themselves that plants do not obtain "food" from the soil.

<http://www.bbc.co.uk/learningzone/clips/van-helmonts-experiments-on-plant-growth/12895.html>

<http://www.franklin.k12.ma.us/hs/Helmont%20Expt.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 4.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 4.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What is glucose? Why is it important?
2. Write the overall chemical equation for photosynthesis. What does the equation mean in words?
3. Describe the structure and function of a chloroplast.
4. Identify what happens during the light reactions and the Calvin cycle.
5. A plant in a pot of soil is placed in bright sunlight for 12 hours a day. The plant is located near an open window with good air circulation. If the plant is left alone for a month, will it produce glucose? Why or why not?
6. Compare and contrast autotrophs and heterotrophs. Give examples of each type of living things.
7. Explain how the raw materials needed for photosynthesis get to the site of photosynthesis in plants.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 4.2 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

The flow of energy through living things begins with photosynthesis. This process stores energy from sunlight in the chemical bonds of glucose. All cells take up glucose for energy.

- How do you think cells get energy from glucose?
- How do they use that energy?

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## 4.3 Cellular Respiration

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### Key Concepts

- Stages of cellular respiration
- Relationship between cellular respiration and photosynthesis
- Types of fermentation
- Aerobic vs. anaerobic respiration

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### Standards

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### Lesson Objectives

- Summarize what happens during cellular respiration and where it takes place.
- Outline the three stages of cellular respiration and how much ATP is made in each stage.
- Explain how cellular respiration and photosynthesis are related.
- Describe two types of fermentation.
- Identify advantages of aerobic and anaerobic respiration.

---

### Lesson Vocabulary

- aerobic: Relating to any organism or process that requires oxygen.
- anaerobic: Relating to any organism or process that does not require oxygen.
- cellular respiration: Process in which cells break down glucose, release the stored energy, and use the energy to make ATP.
- electron transport: Third stage of cellular respiration, which occurs on the inner membrane of mitochondria, requires oxygen, and produces up to 34 molecules of ATP.
- fermentation: Form of respiration that takes place without oxygen in bacteria, yeast, and some other cells; types include lactic acid and alcoholic fermentation.
- glycolysis: First stage of cellular respiration, which occurs in the cytoplasm, requires no oxygen, and produces two molecules of ATP.
- Krebs cycle: Second stage of cellular respiration, which occurs in the matrix of mitochondria, requires oxygen, and produces two molecules of ATP.

---

## Teaching Strategies

### Introducing the Lesson

Play the clever, teacher-written-and-performed song at the following URL to introduce cellular respiration to your class. Tell students they will learn about the process of cellular respiration in this lesson.

<http://www.youtube.com/watch?v=3aZrkdzrd04&feature=youtu.be>

### Discussion

Discuss the differences between aerobic and anaerobic respiration. Use the flowchart at the following URL to help stimulate discussion of the similarities and differences between the two processes.

<http://www.shellyssciencespot.com/Worksheets/Cell/CellRespiration-FermentationFlowChartAnswerKey.pdf>

### Differentiated Instruction

Have any English language learners and less proficient readers make a main ideas/details chart for the lesson. They should divide a sheet of paper in half and write the main ideas from the lesson on the left side of the sheet, skipping several lines after each main idea. Then, as they read the lesson, they should fill in important details about each main idea on the right side of the sheet.

### Enrichment

Students who need extra challenges can delve more deeply into the chemistry of cellular respiration at the URLs below. Urge them to share what they learn with a diagram or other visual that they explain to the class.

<http://hyperphysics.phy-astr.gsu.edu/hbase/biology/celres.html>

<http://www.sumanasinc.com/webcontent/animations/content/cellularrespiration.html>

<http://www.hartnell.edu/tutorials/biology/cellularrespiration.html>

### Science Inquiry

Have students do the hands-on inquiry at the following URL. They will add yeast to water in two containers, to one of which they will also add sugar. Then they will stretch balloons over the tops of the containers and observe the balloon inflate over the container with the sugar. Students will be asked to explain their observations in terms of fermentation.

<http://www.shellyssciencespot.com/Worksheets/Cell/InvestigatingFermentation.pdf>

### Overcoming Misconceptions

Students commonly think that animals breathe in oxygen and breathe out carbon dioxide, while plants breathe in carbon dioxide and breathe out oxygen. Make sure your students understand that all organisms undergo respiration, including plants, which need oxygen for cellular respiration just like other aerobic organisms do. However, plants do not breathe.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 4.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 4.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Define cellular respiration, and state where it takes place.
2. Identify the three stages of cellular respiration. How many molecules of ATP are produced in each stage?
3. What is fermentation?
4. Many bacteria live in the human intestines. Like all other cells, these bacteria must obtain ATP from glucose. Do you think intestinal bacteria use aerobic or anaerobic respiration for this purpose? Explain your answer.
5. Explain how cellular respiration and photosynthesis are related.
6. Compare and contrast aerobic and anaerobic respiration.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 4.3 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Obtaining energy from glucose is one of the basic functions of cells. Another basic function of living cells is dividing.

- How does a cell divide?
- Do all cells divide the same way?

## CHAPTER

## 5

# MS Cell Division, Reproduction, and Protein Synthesis

## Chapter Outline

- 5.1 CELL DIVISION
- 5.2 REPRODUCTION
- 5.3 PROTEIN SYNTHESIS

## Chapter Overview

This chapter describes cell division in prokaryotic and eukaryotic cells, asexual and sexual methods of reproduction, and the process of protein synthesis.

## Online Resources

*See the following Web sites for appropriate laboratory activities:*

In the tasty lab at the following URL, students will use cookies and candy sprinkles to model the stages of mitosis. They will draw and describe each stage they create with their model and also reflect on limitations of the model. Then they can eat their model!

[http://science-class.net/archive/science-class/Lessons/Cells/Cell%20Division/modeling\\_mitosis\\_cookies.pdf](http://science-class.net/archive/science-class/Lessons/Cells/Cell%20Division/modeling_mitosis_cookies.pdf)

Students can model meiosis and fertilization in a mythical organism with the lab at the URL below. They will use modeling clay, yarn, and a few other simple materials for their models. At the end of the lab, they should be able to differentiate between haploid and diploid cells, the processes of mitosis and meiosis, and the characteristics of somatic cells and sex cells. They should also be able to explain how crossing-over produces genetic variation in a species, describe the steps of meiosis, and how fertilization occurs to produce diploid offspring.

<http://naturalsciences.sdsu.edu/classes/lab2.5/lab2.5.html#anchor29709092>

Have students do the protein synthesis simulation lab at the following URL. Students will play the parts of RNA, DNA, and amino acids, and they will literally walk through the coding of a protein in order to understand how codons and anticodons work inside a living cell.

[http://www.accessexcellence.org/AE/AEPC/WWC/1994/protein\\_synthesis.php](http://www.accessexcellence.org/AE/AEPC/WWC/1994/protein_synthesis.php)

*These Web sites may also be helpful:*

This URL has links to many resources relating to cell division, the cell cycle, mitosis, and meiosis. Resources include lesson plans, animations, games, videos, study aids, quizzes, and worksheets.

<http://schools.southampton.k12.va.us/education/components/scrapbook/default.php?sectiondetailid=9448>

The following URL has many links to excellent activities, labs, and simulations of mitosis and meiosis.

<http://www.nclark.net/MitosisMeiosis>

You can find a complete hands-on curriculum for protein synthesis at the URL below. It includes a materials list, setup instructions, background information for teachers, a lesson plan, ideas for assessment, sources, and standards.

<http://www.mysciencebox.org/proteinfactory>

**TABLE 5.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
5.1 Cell Division	3.0
5.2 Reproduction	3.0
5.3 Protein Synthesis	2.5

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## 5.1 Cell Division

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### Key Concepts

- DNA replication
  - Cell division in prokaryotic and eukaryotic cells
  - Phases of mitosis
  - Stages of the cell cycle in prokaryotic and eukaryotic cells
- 

### Standards

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### Lesson Objectives

- Outline the process of DNA replication.
  - Compare and contrast cell division in prokaryotic and eukaryotic cells.
  - Describe the four phases of mitosis in eukaryotic cells.
  - Identify the stages of the cell cycle in prokaryotic and eukaryotic cells.
- 

### Lesson Vocabulary

- anaphase: Third phase of mitosis in which spindle fibers shorten and pull sister chromatids to opposite poles of the cell.
- binary fission: Method of asexual reproduction in prokaryotes and some single-celled eukaryotes in which DNA replicates and the parent cell splits into two daughter cells.
- cell cycle: Series of stages that a cell goes through during its lifetime, including growth, DNA replication, and cell division.
- cell division: Process in which a cell divides to form daughter cells.
- chromosome: Structure present in cells during cell division in which the cell's DNA and protein molecules coil into a definite shape visible with a light microscope.
- cytokinesis: Last event in cell division, when the cell membrane grows into the middle of the cell, the cytoplasm divides, and daughter cells form.
- DNA (deoxyribonucleic acid): Double-stranded nucleic acid that stores genetic information in its sequence of nitrogen bases.
- DNA replication: Process occurring before cell division in which DNA is copied.
- interphase: Major phase of the eukaryotic cell cycle that incorporates all phases of the cell except cell division and includes growth phase 1 (G1), synthesis phase (S), and growth phase 2 (G2).
- metaphase: Second phase of mitosis when spindle fibers attach to centromeres of sister chromatids, which line up at the center of the cell.

- mitosis: Division of the nucleus in a eukaryotic cell, which occurs in four phases: prophase, metaphase, anaphase, and telophase.
- prophase: First phase of mitosis in which chromosomes form, the nuclear membrane breaks down, centrioles move to opposite poles of the cell (in an animal cell), and spindles form between centrioles.
- telophase: Final phase of mitosis in which chromosomes uncoil, spindle fibers break down, and new nuclear membranes form.

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## Teaching Strategies

### Introducing the Lesson

Use the remarkable HD video at the following URL to introduce students to the lesson. The video is dramatic and choreographed to powerful music. It introduces students to the wonder of cell division and the cell cycle. It is designed as a motivational "trailer" to inspire students to want to learn more about the topics.

<http://www.youtube.com/watch?v=Q6ucKWIIFmg>

### Activity

Have students use the interactive animations at the URLs below to see how mitosis occurs and what happens in the entire cell cycle of a eukaryotic cell. The stages of the cell cycle and of mitosis are also described in words below the animations.

<http://www.cellsalive.com/mitosis.htm>

[http://www.cellsalive.com/cell\\_cycle.htm](http://www.cellsalive.com/cell_cycle.htm)

### Differentiated Instruction

Visual learners can test their knowledge of the stages of mitosis with the worksheet at the following URL. They will match the name of each stage of mitosis to a picture of a cell in that stage. Then they will describe what is happening in that stage.

<http://www.cellsalive.com/worksheets/MitosisPhases.pdf>

### Enrichment

Extend the lesson for interested students by having them learn about checkpoints in the cell cycle that prevent cells from dividing if problems arise. Students can explore the topic with the excellent animations at this URL:

<http://outreach.mcb.harvard.edu/animations/checkpoints.swf>

### Science Inquiry

Use the virtual microscopy project at the URL below to help students learn about mitosis in plant and animal cells. For each type of cell, they will name and sketch the stages of mitosis. They will also answer several questions about the cells as they view them.

<http://www.biologycorner.com/projects/mitosis.html>

## Overcoming Misconceptions

Students commonly hold the misconception that interphase in the eukaryotic cell cycle is a resting phase for the cell. Make sure students realize that a cell is not resting when it is in interphase. Explain that during the first part of interphase, called growth 1 (G1), cells are carrying out metabolic activities and rapid growth to prepare for cell division. During the synthesis (S) phase, DNA is replicated. During last part of interphase, called growth 2 (G2), cells complete the preparations for dividing. For example, they reserve energy and make proteins and other molecules needed for cell division.

## Overcoming Misconceptions

Another common misconception is that mitosis produces two new daughter cells. Point out that mitosis only divides the nucleus and that the cell actually divides during cytokinesis.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 5.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 5.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What is DNA replication? When and why does it occur?
2. What are chromosomes? When do chromosomes form?
3. Identify the steps of cell division in a prokaryotic cell.
4. List the phases of mitosis and what happens during each phase.
5. A single-celled organism belongs to the Eukarya Domain. Apply lesson concepts to describe how the organism divides.
6. Explain why cell division is more complicated in eukaryotic than prokaryotic cells.
7. Compare and contrast the cell cycles of prokaryotic and eukaryotic cells.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 5.1 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Cell division is how organisms grow and replace worn out or damaged cells. It's also how they produce offspring. Producing offspring is known as reproduction.

- How do you think prokaryotes reproduce?
- How do you think multicellular eukaryotes reproduce?

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## 5.2 Reproduction

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### Key Concepts

- Methods of asexual reproduction
- Overview of sexual reproduction
- Meiosis
- Advantages of asexual and sexual reproduction

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### Standards

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### Lesson Objectives

- Identify three methods of asexual reproduction.
- Give an overview of sexual reproduction.
- Explain how meiosis produces haploid gametes.
- State advantages of asexual and sexual reproduction.

---

### Lesson Vocabulary

- asexual reproduction: Production of genetically identical offspring by a single parent through a method such as binary fission, fragmentation, or budding.
- diploid: Referring to the total number of chromosomes in a sexually reproducing species, which is twice the haploid number of chromosomes.
- egg: Gamete produced by a female parent.
- fertilization: Union of two gametes during sexual reproduction.
- gamete: Special reproductive cell with the haploid number of chromosomes that is produced by meiosis during sexual reproduction.
- haploid: Referring to the number of different chromosomes in a sexually reproducing species or to the number of chromosomes in a gamete.
- homologous chromosomes: Two members of a given pair of chromosomes, which have the same genes in the same locations.
- meiosis: Special type of cell division in which a cell divides twice and produces four haploid daughter cells.
- sexual reproduction: Production of offspring by two parents through the production and fertilization of gametes.
- sperm: Gamete produced by a male parent.
- zygote: Cell with the diploid number of chromosomes that forms when two gametes unite during fertilization.

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## Teaching Strategies

### Introducing the Lesson

It will be easy to engage students in learning about reproduction by showing them the video below. It presents ten of the weirdest mating rituals in the Animal Kingdom. Tell the class that before mating occurs, animals must produce gametes in a special type of cell division, which they will read about in this lesson.

<http://www.youtube.com/watch?v=6NKtuTS8eFA>

### Activity

Have students use the interactive animation at the URL below to see how meiosis occurs in a eukaryotic cell. The stages of meiosis are also described in words below the animation.

<http://www.cellsalive.com/meiosis.htm>

### Activity

Make reviewing lesson content fun. Have students play either or both of the games at the following URLs. They must correctly answer questions about reproduction to score points in the games. Suggest that students select a partner and see which one can get a higher score.

<http://www.quia.com/ba/201530.html>

[http://www.quia.com/files/quia/users/stephene/cell\\_division\\_invaders.swf](http://www.quia.com/files/quia/users/stephene/cell_division_invaders.swf)

### Demonstration

If students have mastered how mitosis occurs, it is relatively easy for them to master meiosis, once they see how it differs from mitosis. Use the excellent animation at this URL to demonstrate how meiosis and mitosis differ:

<http://www.pbs.org/wgbh/nova/body/how-cells-divide.html>

### Differentiated Instruction

Assign each of several pairs of students one of the lesson vocabulary terms to add to the word wall. Good choices of terms include diploid, haploid, gamete, and zygote.

### Enrichment

Challenge students with the intriguing essay at the URL below. It deals with the question: Why have sex? In other words, why did sexual reproduction evolve? The essay is an excellent reading for illustrating how scientific ideas evolve over time and the nature of scientific evidence.

<http://www.pbs.org/wgbh/evolution/sex/advantage/page06.html>

### Science Inquiry

In the inquiry activity at the following URL, students will assume they are ecologists investigating the advantages of different reproductive strategies. They will work in pairs to compare five aspects of an organism that reproduces

sexually with one that reproduces asexually. Then, as a class, students will share their comparisons and generate a list of general characteristics for each mode of reproduction. Finally, they will discuss the advantages and disadvantages of each mode of reproduction.

<http://teach.genetics.utah.edu/content/begin/traits/ReproductiveStrategies.pdf>

### Overcoming Misconceptions

Students commonly think that the stages of meiosis (and mitosis) are discrete events. Explain that they are actually continuous events. Show the class an animation of meiosis, like the one at this URL, which presents it as a smooth and continuous process:

<http://www.johnkyrk.com/meiosis.html>

### Overcoming Misconception

Another common misconception about meiosis is that it occurs in all cells. Make sure students realize that only special reproductive cells undergo meiosis to produce gametes. In human beings, for example, these cells are in the ovaries and testes of adult females and males, respectively.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 5.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 5.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What are three methods of asexual reproduction? For each method, give an example of an organism that can reproduce that way.
2. Briefly describe sexual reproduction.
3. Define haploid and diploid numbers. Which cells are haploid and which are diploid?
4. If you don't have an identical twin, how likely is it that a brother or sister would be just like you?
5. Explain how meiosis produces four haploid daughter cells.
6. Some organisms can reproduce sexually or asexually. Under what conditions might each type of reproduction be an advantage?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 5.2 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

All of our cells contain DNA. Meiosis ensures that each gamete receives a copy of each chromosome.

- Why do cells need DNA?
- What specific role does DNA play?

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## 5.3 Protein Synthesis

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### Key Concepts

- Structure and functions of RNA
- Genetic code
- Processes of protein synthesis
- Mutations

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### Standards

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### Lesson Objectives

- Identify the structure and functions of RNA.
- Describe the genetic code and how to read it.
- Explain how proteins are made.
- List causes and effects of mutations.

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### Lesson Vocabulary

- codon: Group of three nitrogen bases in RNA or DNA that is the genetic code word for a single amino acid or for a start or stop signal.
- genetic code: Code of nitrogen bases in DNA that contains the information for making proteins in cells.
- mutagen: Any factor in the environment, such as radiation or a chemical, that causes mutations.
- mutation: Random change in the nitrogen base sequence of DNA or RNA.
- protein synthesis: Process in which a protein is made, consisting of transcription of DNA to RNA in the nucleus and translation of RNA to a protein at a ribosome in the cytoplasm.
- RNA (ribonucleic acid): Single-stranded nucleic acid that transcribes and translates the genetic code in DNA to make proteins, among other functions.
- transcription: First of two steps of protein synthesis in which RNA makes a copy of the genetic code in DNA in the nucleus of a cell.
- translation: Second of two steps of protein synthesis in which the genetic code in RNA is read and amino acids are joined together to form a protein at a ribosome in the cytoplasm.

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## Teaching Strategies

### Introducing the Lesson

Show students the remarkable HD video at the URL below. It is meant to be a motivational "trailer" for introducing students to protein synthesis. After showing the video, help students recall what they already know about proteins and nucleic acids. Ask them to describe the structure and identify functions of both types of biochemical compounds. Tell the class they will learn in this lesson how proteins are made, using instructions encoded in nucleic acids.

<http://www.youtube.com/watch?v=suN-sV0cT6c>

### Building Science Skills

Have students model transcription and translation with the activity at the following URL. They will build a sentence ("polypeptide") from words ("amino acids"). This is a good kinesthetic and visual activity to introduce protein synthesis. All materials required for the activity are included in the pdf document.

[http://www.lessonplansinc.com/lessonplans/protein\\_synthesis\\_sentence\\_activity.pdf](http://www.lessonplansinc.com/lessonplans/protein_synthesis_sentence_activity.pdf)

### Demonstration

At the following URL, you can watch a whiteboard demonstration of protein synthesis that you can do for your class. Be sure to read the text below the video for ideas about how to implement the whiteboard demonstration in the classroom.

<http://www.sciencefix.com/home/2010/1/25/video-demo-whiteboard-protein-synthesis-demo.html>

### Differentiated Instruction

Pair English language learners of differing English language proficiency, and have partners make a flow chart for the process of protein synthesis. The flow chart should include what happens in the different parts of the process as well as where each part occurs. Ask partners to share their flow charts with the rest of the class.

### Enrichment

Ask a few interested students to work together to create a Web site about a specific genetic disorder that interests them. Some examples of disorders they might choose are listed below. Topics they might cover include frequency of the disorder, mutation(s) that cause(s) it, signs and symptoms of the disorder, and how it is diagnosed and treated.

- ALS (amyotrophic lateral sclerosis)
- alkaptonuria
- hemophilia
- phenylketonuria
- sickle-cell disease
- Tay-Sachs disease
- galactosemia
- achondroplasia
- albinism
- cystic fibrosis
- Marfan syndrome

- cri du chat syndrome

## Science Inquiry

The inquiry activity at the URL below is a great hands-on way for students to learn about protein synthesis and related concepts. By doing the activity, students will understand how RNA is transcribed from DNA and then translated into a protein. They will also see how a point mutation can cause a disease like sickle cell anemia, gain an appreciation for the redundancy of the genetic code, and learn how gene therapy might cure genetic diseases.

<http://www.greatscience.com/media/2765/6-2-3-bmt-puzzle-of-life-pdf.pdf>

## Overcoming Misconceptions

Students commonly think that all mutations have drastic and negative effects on traits of individuals, probably because that's how mutations are often presented in fiction. When discussing mutations, make it clear that redundancy in the genetic code results in many mutations having no effects on encoded proteins or the traits of individuals. Also stress that some mutations are actually beneficial. Provide examples, such as the mutation that allowed human adults to digest lactose (i.e., to be lactose tolerant). Discuss why this mutation was beneficial.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 5.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 5.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What are three types of RNA? What role does each type play in protein synthesis?
2. Describe the genetic code and its characteristics.
3. Give an overview of the transcription step of protein synthesis. Where does it take place?
4. What is a mutation? What are some causes of mutations?
5. Use Figure 5.19 to translate the following sequence of RNA bases into a chain of amino acids: AUGUACCC-CACAGACUAA.
6. Compare and contrast RNA and DNA.
7. Explain what happens during the translation step of protein synthesis.
8. Why is a single base insertion or deletion likely to drastically change how the rest of the genetic code is read?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 5.3 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Offspring generally resemble their parents. This is true even when the offspring are not genetically identical to the parents.

- Can you apply your knowledge of reproduction and protein synthesis to explain why offspring and parents have similar traits?

## CHAPTER

## 6

## TE MS Genetics

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Chapter Outline

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- 6.1 MENDEL'S DISCOVERIES
  - 6.2 INTRODUCTION TO GENETICS
  - 6.3 ADVANCES IN GENETICS
- 

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Chapter Overview

This chapter describes Mendel's experiments and his laws of heredity. It also explains the inheritance of traits in terms of modern genetics and outlines recent advances in genetics.

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Online Resources

*See the following Web sites for appropriate laboratory activities:*

In the lab "Cootie Genetics," accessible at the URL below, students will simulate the work of Gregor Mendel to investigate how traits are inherited. Students mate "cootie" organisms with different true-breeding traits and explore trait behaviors (dominant, recessive) and trait probabilities. The activity is best done before students learn genetic terminology and Punnett squares in Lesson 6.2.

<http://biotech.bio5.org/cooties>

Students will enjoy studying genetics when the subjects are dragons! With the lab activity at the following URLs, students will study the patterns of inheritance of multiple genes on different chromosomes. They will gain a better understanding of the law of independent assortment and see that patterns of inheritance are determined by the behavior of chromosomes during meiosis and fertilization. The first URL is a student handout for the lab. The second URL provides notes for teachers.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/DragonGeneticsIProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/DragonGeneticsIProtocol.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/DragonGeneticsITeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/DragonGeneticsITeachPrep.pdf)

The Virtual Genetics Lab (VGLII) available at the URL below is a simulation of genetics that approximates the hypothesis-testing approach of actual genetics research. Students will cross hypothetical creatures and examine their offspring in order to determine the mode of inheritance of a particular trait. As in actual research, students must decide for themselves when they have collected enough data to be sure of their answer. The goal is for students to gain an understanding of the logic of genetic analysis as well as to reinforce their understanding of genetics and the transmission of traits.

<http://vgl.umb.edu/>

In the lab at the following URL, students will use maize as a model and collect data to test one of Mendel's laws of inheritance. Then they will collect data on human inheritance from students in class. They will observe variation in genetic traits and explore genetic variation in a population.

[http://labcenter.dnalc.org/labs/mendeliangenetics/mendeliangenetics\\_d.html](http://labcenter.dnalc.org/labs/mendeliangenetics/mendeliangenetics_d.html)

Students can investigate transgenic manipulation with the computer simulation lab "Engineer a Crop: Transgenic Manipulation" at this URL:

<http://www.pbs.org/wgbh/harvest/engineer/transgen.html>

With the lab "Kiwi DNA Extraction," which is accessible at the URL below, students will extract DNA from kiwifruit. They will learn how DNA can be isolated for further analysis, such as DNA fingerprinting. The lab will also reinforce students' understanding of cell structure and biological macromolecules.

<http://biotech.bio5.org/jrbiotech>

*These Web sites may also be helpful:*

At the URL below, you can find a link to a document containing a summary of major genetics concepts and student activities in genetics.

<http://serendip.brynmawr.edu/exchange/bioactivities/GeneticsConcepts>

The following URL provides five easy-to-implement classroom activities that teach the basics of heritable traits. Three take-home activities help students share what they're learning with their family.

<http://teach.genetics.utah.edu/content/heredity/>

The URLs below have links to many good resources for teaching genetics. The resources include interactive tutorials, videos, animations, and articles.

[http://geneed.nlm.nih.gov/topic\\_subtopic.php?tid=5&sid=6](http://geneed.nlm.nih.gov/topic_subtopic.php?tid=5&sid=6)

<http://www.nclark.net/Genetics>

At the following URL, you can download an entire module for teaching students about the Human Genome Project. Resources include an interactive timeline, animations, articles, videos, and activities.

<http://www.genome.gov/25019879>

The activity-based curriculum at this URL provides many excellent resources for teaching biotechnology to middle school students:

[http://www.beyondbenign.org/K12education/biotech\\_ms.html](http://www.beyondbenign.org/K12education/biotech_ms.html)

The URL below has links to numerous articles, videos, and other resources about GMO foods that were chosen specifically for middle school students.

[http://barrms.nanuetsd.org/res\\_view\\_folder.aspx?id=80ca921e-f6b9-4d32-a7a0-bceb9f86042e&userGroupId=2b57440f-ad2b-4792-a64a-13a96d089046&userGroupType=C](http://barrms.nanuetsd.org/res_view_folder.aspx?id=80ca921e-f6b9-4d32-a7a0-bceb9f86042e&userGroupId=2b57440f-ad2b-4792-a64a-13a96d089046&userGroupType=C)

**TABLE 6.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
6.1 Mendel's Discoveries	2.0
6.2 Introduction to Genetics	2.5
6.3 Advances in Genetics	2.0

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## 6.1 Mendel's Discoveries

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### Key Concepts

- Overview of Mendel and his work with peas
- Mendel's experiments
- Mendel's laws of segregation and independent assortment
- Mendel's scientific legacy

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### Standards

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### Lesson Objectives

- Identify Mendel, and explain why peas were good plants for him to study.
- Outline Mendel's experiments, and state his laws of heredity.
- Summarize Mendel's scientific legacy.

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### Lesson Vocabulary

- dominant: Referring to an allele that masks the presence of another allele (called recessive) for the same gene when both are present in a heterozygote; or referring to a trait controlled by such an allele.
- genetics: Science of heredity, or how traits are passed from parents to offspring.
- law of independent assortment: Mendel's second law of inheritance that states that factors (alleles) controlling different traits go to gametes independently of each other.
- law of segregation: Mendel's first law of inheritance that states that factors (alleles) that control a given trait separate and go to different gametes.
- Mendel: Austrian monk who lived in the 1800s and discovered the laws of inheritance by careful, repeated experiments with pea plants; called the "father of genetics".
- pollination: Process by which pollen is transferred from a male reproductive structure of a plant to a female reproductive structure of the same plant or a different plant of the same species so fertilization can occur.
- recessive: Referring to an allele that is masked by the presence of another allele (called dominant) for the same gene when both are present in a heterozygote; or referring to a trait controlled by such an allele.

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## Teaching Strategies

### Introducing the Lesson

Introduce Mendel and his work with the brief re-enactment video at the following URL. Bill Nye provides the narration. After the video, tell students they will learn more about Mendel's research and his important discoveries when they read this lesson.

<http://www.sciencechannel.com/tv-shows/greatest-discoveries/videos/100-greatest-discoveries-shorts-genetics.htm>

### Activity

Have students use the series of brief texts and related animations at the URL below for an interactive way of learning about Mendel, his research, and classical genetics. This is a good activity for visual learners.

<http://www.dnafb.org/1/index.html>

### Differentiated Instruction

Students who need extra help can work through an interactive online tutorial on Mendel, his research, and his laws at the first URL below. This allows students to proceed at their own pace and go back to review slides as needed until they understand the material. After students finish the tutorial, they can test their comprehension with the quiz at the second URL. Answers are provided at the third URL.

<http://www.cccoe.net/genetics/mendel.html>

<http://www.cccoe.net/genetics/teacher/MENDEL1.DOC.pdf>

<http://www.cccoe.net/genetics/teacher/MENDEL1A.DOC.pdf>

### Enrichment

Have students who want to learn more about Mendel and his life read the excellent article at the first URL below and/or watch the clever video at the second URL.

[http://peer.tamu.edu/curriculum\\_modules/Cell\\_Biology/module\\_4/storytime.htm](http://peer.tamu.edu/curriculum_modules/Cell_Biology/module_4/storytime.htm)

<http://www.youtube.com/watch?v=GTiOETaZg4w>

### Science Inquiry

In the hands-on activity at the following URL, students will track and record the passage of colored pom-pom "traits" through three generations of gingerbread "people." Students will observe for themselves what Mendel observed in his research on peas. They will see how traits are passed from parents to offspring and that siblings receive different combinations of traits from their parents. The student handouts are provided in Spanish as well as English.

<http://www.nclark.net/traitsgenerations.pdf>

### Overcoming Misconceptions

Knowledge of Mendel's work may result in a number of misconceptions about genetics and traits, especially when they are applied to human beings. Just three such misconceptions are listed and discussed below.

1. The path from genotype to phenotype is deterministic.
2. Mendel's "heritable factors" were deterministic in which traits were exhibited. However, the connection between genes and traits is generally not so clear-cut. For example, people discovering they have the BRCA1 mutation might worry that they will definitely get breast cancer. However, having a disease-associated genotype is not deterministic; rather, it only predisposes or increases risk for developing that condition.
3. Every trait is the product of a single gene.
4. Mendel got lucky with the pea traits he studied because they were single-gene traits. However, most human traits are the product of many genes and their interactions with the environment.
5. There are only two possible variations of a gene.
6. When you're a pea, you can be only green or yellow. But for most traits, multiple alleles are probably the rule rather than the exception. ABO blood type is a common example in people.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 6.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 6.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Who was Gregor Mendel?
2. Why were peas a good choice of plants for Mendel to study?
3. State Mendel's laws.
4. Some plants reproduce asexually. What results would Mendel have obtained if he had chosen to study these plants instead of peas?
5. Why did Mendel need to grow two offspring generations (F1 and F2) to develop his law of segregation?
6. Explain how the results of Mendel's second set of experiments led to his law of independent assortment.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 6.1 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Mendel's research revealed that traits are controlled by "factors" that parents pass to their offspring. Today, we know that Mendel's "factors" are genes.

- What are genes?
- How do genes control traits?

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## 6.2 Introduction to Genetics

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### Key Concepts

- Definition of gene and allele
- Relationship between genotype and phenotype
- Using Punnett squares to predict genotype and phenotype ratios in offspring
- Non-Mendelian inheritance
- Inheritance of sex-linked traits

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### Standards

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### Lesson Objectives

- Define gene and allele.
- Describe the relationship between genotype and phenotype.
- Show how to use Punnett squares to predict genotype and phenotype ratios in offspring for simple traits.
- Identify ways traits may be more complex than those studied by Mendel.
- Explain how sex-linked traits are inherited.

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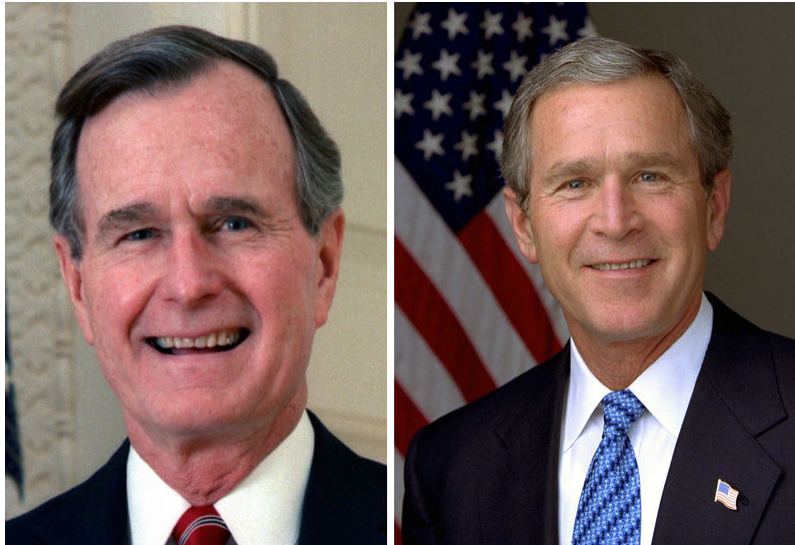
### Lesson Vocabulary

- allele: One of the alternate versions of a particular gene.
- autosome: Any chromosome that is not a sex chromosome.
- genotype: Combination of alleles that an individual inherits for a given gene.
- heterozygote: Type of genotype in which an individual has two different alleles for a gene.
- homozygote: Type of genotype in which an individual has two of the same allele for a gene.
- phenotype: Expression of an organism's genotype as a trait in the organism.
- Punnett square: Chart for determining the possible genotypes and their likely ratios in offspring of two parents of given genotypes.
- sex chromosome: One of two chromosomes (in humans, X or Y chromosomes) that determine the sex of an individual in a sexually reproducing species.
- sex-linked trait: trait controlled by a gene on a sex chromosome.

## Teaching Strategies

### Introducing the Lesson

Show the class pictures of a parent and offspring that have similar features, such as the pictures of the two Bush presidents below. Call on volunteers to describe traits the two individuals share. Then ask students to name traits that they share with their own parents. Ask them how they think the traits are inherited. Tell students that most human traits have more complex patterns of inheritance than the traits Mendel studied in peas. They'll find out how some of them are inherited when they read this lesson.



### Activity

Make learning about genetics fun with the SpongeBob Squarepants genetics worksheets at the URL below. Have pairs of students complete the worksheets to determine genotypes and phenotypes of SpongeBob and his pals. Students will also gain practice using Punnett squares to determine genotypes and phenotypes of offspring. An answer key is included. The first worksheet deals with Mendelian traits that involve simple dominance. The second worksheet deals with traits that involve incomplete dominance.

[http://sciencespot.net/Media/gen\\_spbobgenetics.pdf](http://sciencespot.net/Media/gen_spbobgenetics.pdf)

[http://sciencespot.net/Media/gen\\_spbobincdom.pdf](http://sciencespot.net/Media/gen_spbobincdom.pdf)

### Cooperative Learning

Have pairs of students do the "Genetics with a Smile" activity at the following URLs. Students will flip coins to determine which forms of various traits their smiley-face "offspring" will inherit. Then they will draw a picture of their offspring. The first two URLs are student handouts for the activity. The third URL provides activity notes for teachers.

[http://sciencespot.net/Media/gen\\_smilewkst1.pdf](http://sciencespot.net/Media/gen_smilewkst1.pdf)

[http://sciencespot.net/Media/gen\\_smilewkst2.pdf](http://sciencespot.net/Media/gen_smilewkst2.pdf)

[http://sciencespot.net/Media/gen\\_smilenotes.pdf](http://sciencespot.net/Media/gen_smilenotes.pdf)

## Building Science Skills

With the activity at the following URL, students will review and become familiar with basic genetic concepts and terms and then apply them to magical abilities in Harry Potter characters. They will examine inheritance patterns of the magical traits and identify possible genotypes of the characters.

<http://www.nlm.nih.gov/exhibition/harrypottersworld/education/lessonplans/science.html>

## Differentiated Instruction

The card game available at the URL below is a fun way for students to learn or review genetics vocabulary. Each card in the deck has a target vocabulary word and two related taboo words that students may not use as they give clues to other students in their group, who must try to guess the target word.

<http://serendip.brynmawr.edu/exchange/bioactivities/GeneticsVocabGame>

## Enrichment

Ask students who have a good grasp of lesson content to create a Jeopardy-type game to quiz other students in the class. Set aside class time for student volunteers to play the game. Other students can be assigned roles of time keeper and moderator. You may want to provide token prizes for winners.

## Science Inquiry

Challenge small groups of students to apply Mendel's laws to the inheritance of albinism in people. Distribute copies of the worksheet at the first URL below. It contains all the needed background information and problems for students to solve. It includes a coin-toss activity that will help students understand that Punnett squares determine only the most likely genotype ratios of offspring of a given mating type and not the actual genotype ratios in a given family. The second URL provides teacher notes for the project.

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/GeneticsProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/GeneticsProtocol.pdf)

[http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/GeneticsTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/GeneticsTeachPrep.pdf)

## Real-World Connection

Students will appreciate the real-world significance of genetic traits when they play the award-winning blood-typing game at the following URL. Students will find out what happens if a patient gets a blood transfusion with the wrong type of blood. In the game, students will try to save patients' lives by correctly typing their blood. They will learn about human blood types in the process.

<http://www.nobelprize.org/educational/medicine/bloodtypinggame/index.html>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 6.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

## Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 6.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Write a short paragraph in which you correctly use the concepts chromosome, gene, allele, locus, and trait.
2. What are codominance and incomplete dominance? Give an example of each.
3. What is the difference between a multiple allele trait and a polygenic trait?
4. Use a Punnett square to determine the possible offspring genotypes of parents with the genotypes Bb and bb. Assume that B is the dominant allele for violet flower color in peas and b is the recessive allele for white flower color. What is the expected ratio of violet-flowered to white-flowered offspring based on your Punnett square?
5. Compare and contrast genotype and phenotype.
6. Explain why it is the father rather than the mother who determines the sex of their offspring.

## Lesson Quiz

Check students' mastery of the lesson with Lesson 6.2 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Genetics began with the rediscovery of Mendel's laws in 1900. There have been many advances in genetics since then.

- What are some recent advances in genetics?
- What do we now know about human genes?

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## 6.3 Advances in Genetics

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### Key Concepts

- Human Genome Project
- Human genetic disorders
- Methods and uses of biotechnology

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### Standards

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### Lesson Objectives

- Explain the significance of the Human Genome Project.
- Describe human genetic disorders.
- Identify methods and uses of biotechnology.

---

### Lesson Vocabulary

- biotechnology: Use of technology to change the genetic makeup of living things for human purposes.
- gene therapy: Treatment of a genetic disorder by inserting a normal gene into a patient with a defective gene.
- genetically modified organism (GMO): Organism that has been given one or more new genes so it will have traits that make it more useful to people:
- genetic disorder: Disease caused by a mutation.
- genome: All the genetic information of a species.
- Human Genome Project: International effort to sequence all 3 billion bases in human DNA, which began in 1990 and achieved its goal by 2003.

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### Teaching Strategies

#### Introducing the Lesson

Introduce biotechnology by showing the class the short video about "frankenfoods" at the following URL. The video concerns the addition of genetically modified organisms (GMOs) to food products that are not labeled as such. Tell students they will learn more about GMOs and other advances in genetics when they read this lesson.

<http://abcnews.go.com/Health/video?id=2337659>

## Discussion

Launch a discussion of GMOs in food products with the video below. It focuses specifically on the ethical and sociopolitical issues of such genetically engineered products. After you show the video, discuss these issues with the class. Encourage students to follow the issues in the media and to take an informed stand on them.

<http://www.pbslearningmedia.org/resource/27fbffb2-1a29-4df4-9c16-4679fcbd60b6/next-meal-engineering-food/>

## Differentiated Instruction

Have students create a KWL chart for the biotechnology section of the lesson. Before they read, they should fill in the K and W columns with what they already know and want to know about biotechnology. Then, after reading the section, they should fill in the L column of the chart. Ask students if they learned everything they wanted to know. If not, discuss any remaining questions they have about biotechnology.

## Enrichment

Challenge students to select one or more of the articles about genetic engineering at the following URL. The articles have been modified to be suitable for middle-school students. After they read their choice of article(s), have the students do the task and answer the questions outlined at the Web site. These are thought-provoking questions that require students to consider the pros and cons of specific applications of biotechnology, from designer babies to cloning humans or extinct organisms such as woolly mammoths.

<https://ast-middle-science.wikispaces.com/Genetic+Engineering>

## Science Inquiry

In the inquiry activity at the URL below, students will take a hands-on approach to learning about the Human Genome Project. They will do an interactive Web activity that simulates the process scientists use to determine the sequence of DNA bases in chromosomes. Then they will learn how teams of scientists raced to decode the human genome. Next they will explore a stretch of sequenced DNA on the Web to learn about the function of different sections of the DNA code. They will learn how knowledge of the human genome is being applied to medicine. They will also learn about genetic variation among humans and between humans and other species. Finally, they will assess what they have learned about the Human Genome Project by playing a game of Jeopardy. The activity was written for high school students, but with sufficient guidance, middle school students can also complete it successfully.

[http://vitalny.pbslearningmedia.org/resource/tdc02.sci.life.gen.lp\\_hgpwhat/the-human-genome-project/](http://vitalny.pbslearningmedia.org/resource/tdc02.sci.life.gen.lp_hgpwhat/the-human-genome-project/)

## Overcoming Misconceptions

Students are likely to have many misconceptions about biotechnology. A common misconception is that only GMO foods have food safety issues. Correct this misconception by sharing with students some of the other issues in food safety, such as microbial contamination, chemical residues from pesticides, allergens (as in peanuts), and toxins produced by molds.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 6.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 6.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Define genome.
2. What was the Human Genome Project? What had it accomplished by 2003?
3. Identify and describe an example of an autosomal recessive genetic disorder.
4. Pedigrees show that a certain genetic disorder passes from mothers to about half of their sons or from fathers to all of their daughters. Only males are actually affected by the disorder. What type of disorder is it?
5. Compare and contrast the polymerase chain reaction and gene cloning.
6. Weigh the pros and cons of producing and using genetically modified organisms.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 6.3 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Biotechnology can be used to artificially change the genetic makeup of organisms in a species.

- How can the genetic makeup of a species change naturally?
- What might be the outcome of this type of change?

## CHAPTER

## 7

## TE MS Evolution

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Chapter Outline

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- 7.1 DARWIN'S THEORY OF EVOLUTION
  - 7.2 EVIDENCE FOR EVOLUTION
  - 7.3 THE SCALE OF EVOLUTION
  - 7.4 HISTORY OF LIFE ON EARTH
  - 7.5 REFERENCES
- 

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Chapter Overview

This chapter describes Darwin's observations and explains how he developed his theory of evolution by natural selection. It also identifies different types of evidence for evolution and the processes of microevolution and macroevolution. In addition, the chapter gives an overview of the history of life on Earth.

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Online Resources

*See the following Web sites for appropriate laboratory activities:*

The "Evolution Lab" at the first URL below is an online natural selection simulation. Students can work independently at computers, or you can use a projector to show the simulation to the class. The second URL is a worksheet to go with the simulation.

<http://biologyinmotion.com/evol/index.html>

<http://www.biologycorner.com/worksheets/evolutionlab.html>

You can find another natural selection simulation lab at the following URL. Students will investigate industrial melanism in peppered moths. They will learn the importance of coloration in avoiding predation, relate environmental changes to the evolution of organisms, and explain how natural selection causes populations to change.

[http://www.biologycorner.com/worksheets/peppermoth\\_paper.html](http://www.biologycorner.com/worksheets/peppermoth_paper.html)

The "Mystery Fossil Bones Activity" at the URL below requires groups of students to work together to reassemble fossil bones and identify the organism they represent. After completing the lab, groups will compare their reconstructed organisms. The lab will help students appreciate the role of subjectivity and interpretation in scientific research.

<http://mjksciteachingideas.com/pdf/MysteryBones.pdf>

In the "Creating Coacervates" lab the following URL, students will use relatively simple materials to create coacervates. These are amoeba-like objects, which change shape, flow, merge, divide, form "vacuoles," release "vacuole" contents, and exhibit other life-like properties. The principal concept they will gain from the lab is that under suitable conditions, life-like structures can form naturally.

<http://www.indiana.edu/~ensiweb/lessons/coacerv.html>

*These Web sites may also be helpful:*

The following URL provides access to the self-proclaimed "one-stop source for information on evolution." Included are links to an in-depth course on the science of evolution, resources for teachers, and an archive of articles, tutorials, and interactive investigations.

<http://evolution.berkeley.edu/>

At the URL below, you can download a free copy of the publication *Teaching about Evolution and the Nature of Science*, published by the National Academy of Sciences. The book includes activities for teaching evolution.

[http://www.nap.edu/openbook.php?record\\_id=5787](http://www.nap.edu/openbook.php?record_id=5787)

Go to the following URL for "Evolution on the Front Line: An Abbreviated Guide for Teaching Evolution, from Project 2061 at AAAS."

<http://www.project2061.org/publications/guides/evolution.pdf?txtRef=http%3A%2F%2Fwww%2Enclark%2Enet%2FEvolution&txtURIId=%2Fpublications%2F2061connections%2F2006%2Fmedia%2Fevo%5Fhandout%5Fteachers%2Epdf>

At the URLs below, you can find many resources for teaching evolution, including videos, readings, and Flash and Shockwave interactive segments. Free registration is required to access the site.

[http://www.teachersdomain.org/9-12/sci/life/evo/lp\\_howevowork/index.html](http://www.teachersdomain.org/9-12/sci/life/evo/lp_howevowork/index.html)

[http://www.teachersdomain.org/9-12/sci/life/evo/lp\\_fossilevid/index.html](http://www.teachersdomain.org/9-12/sci/life/evo/lp_fossilevid/index.html)

[http://www.teachersdomain.org/9-12/sci/life/evo/lp\\_speciation/index.html](http://www.teachersdomain.org/9-12/sci/life/evo/lp_speciation/index.html)

[http://www.teachersdomain.org/9-12/sci/life/evo/lp\\_newspecies/index.html](http://www.teachersdomain.org/9-12/sci/life/evo/lp_newspecies/index.html)

[http://www.teachersdomain.org/9-12/sci/life/evo/lp\\_humanevo/index.html](http://www.teachersdomain.org/9-12/sci/life/evo/lp_humanevo/index.html)

An annotated list of links to numerous resources for teaching evolution is available at this URL:

<http://www.nclark.net/Evolution>

At the following URLs, you can find links to many student videos addressing various aspects of evolution:

<http://www.pbs.org/wgbh/evolution/educators/teachstuds/svideos.html>

<http://www.pbs.org/wgbh/nova/evolution/>

Visit the URL below for articles, activities, and tutorials on evolution.

[http://evolution.berkeley.edu/evosite/search/search\\_lessons.php?sort\\_by=audience\\_rank&audience\\_level%5B3%5D=9-12&topic\\_id=13&keywords=&Submit=Search](http://evolution.berkeley.edu/evosite/search/search_lessons.php?sort_by=audience_rank&audience_level%5B3%5D=9-12&topic_id=13&keywords=&Submit=Search)

The following URL contains links to a digital resource package for teaching evolution.

<http://nsdl.org/resource-packages/evolution>

Go to the URL below for a series of interactive modules that explore the history of life on Earth, with a focus on the process of science. Each module contains suggested lesson plans and an extensive teacher's guide.

<http://www.ucmp.berkeley.edu/education/explotime.html>

**TABLE 7.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
7.1 Darwin's Theory of Evolution	1.5
7.2 Evidence for Evolution	2.0
7.3 The Scale of Evolution	1.5
7.4 History of Life on Earth	3.0

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## 7.1 Darwin's Theory of Evolution

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### Key Concepts

- Darwin's theory of evolution by natural selection
- Darwin's voyage on the *Beagle*
- Other influences on Darwin
- How Darwin developed his theory

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### Standards

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### Lesson Objectives

- State Darwin's theory of evolution by natural selection.
- Describe Darwin's voyage on the *Beagle*.
- Identify other influences on Darwin.
- Explain how Darwin arrived at his theory.

---

### Lesson Vocabulary

- Darwin: 19<sup>th</sup> century scientist who is best known for his theory of evolution by natural selection.
- evolution: Change in the inherited traits of organisms over time.
- Galápagos Islands: Group of 16 islands lying off the west coast of South America that Darwin visited during his voyage on the *Beagle* and that are home to giant tortoises and Darwin's finches.
- natural selection: Process in which living things with beneficial traits survive longer and produce more offspring so their traits increase in a population over time.
- theory of evolution by natural selection: Theory first proposed by Charles Darwin stating that inherited traits of organisms change over time because organisms with beneficial traits survive longer and produce more offspring so their traits increase in frequency.

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### Teaching Strategies

#### Introducing the Lesson

Introduce Darwin and evolutionary theory by playing the NSTA-approved "Evolution Rocks" by the rock band Overman. You can find a free video of the band recording the song at the first URL below. The second URL has the lyrics, so students can sing along, as well as information on where to download the song.

<http://www.overman.info/video.html>

<http://www.overman.info/evolutionrocks.html>

### Activity

Have students read the cartoon and complete the worksheet at the following URL to gain an appreciation for what "survival of the fittest" really means. They'll learn that the biggest and strongest don't always have the advantage in the race to survive and reproduce. Sometimes the sneakiest win!

<http://www.nclark.net/SurvivaloftheSneakiest.doc>

### Building Science Skills

With the origami bird activity at the URL below, students will learn the role of genetic variation in evolution by natural selection. The PDF document includes instructions, a student worksheet, and an answer key. This is a good activity for groups of students.

<http://www.indiana.edu/~ensiweb/lessons/origam.pdf>

### Differentiated Instruction

Assign two pairs of students the vocabulary terms *evolution* and *natural selection* to add to the word wall. Have partners create a card for their term that includes a definition, an example, and a simple sketch to illustrate the term.

### Enrichment

Ask a few interested students to investigate why Darwin waited so long to publish his theory of evolution by natural selection. They can start their research with the links below. Have them summarize some of the factors historians think were involved in an oral report to the class.

[http://darwin200.christs.cam.ac.uk/pages/index.php?page\\_id=b9](http://darwin200.christs.cam.ac.uk/pages/index.php?page_id=b9)

<http://www.npr.org/templates/story/story.php?storyId=100597929>

<http://www.butterfliesandwheels.org/2011/darwins-delay/>

### Science Inquiry

With the bird beak activity at the URL below (which can readily be related to Darwin's observations of Galápagos finches), students will learn through inquiry about variation, reproductive isolation, natural selection, and adaptation.

<http://www.ucmp.berkeley.edu/education/lessons/clipbirds/>

### Overcoming Misconceptions

Students may hold the popular misconception that evolution is "just a theory." Show them the brief video at the following URL to help them appreciate that many ideas they routinely take for granted are called theories in science and that, like the theory of evolution, are supported by vast amounts of evidence.

[http://www.pbs.org/wgbh/evolution/library/11/2/quicktime/e\\_s\\_1.html](http://www.pbs.org/wgbh/evolution/library/11/2/quicktime/e_s_1.html)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 7.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 7.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. State Darwin's theory of evolution by natural selection.
2. Identify three scientists who influenced Darwin and their contributions to his theory.
3. Apply the concept of artificial selection to explain how different dog breeds come about.
4. Explain how Darwin's observations on the Galápagos Islands helped him form his theory of evolution by natural selection.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 7.1 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

On his voyage, Darwin saw fossils of ancient organisms. They showed him that living things had changed over time.

- What are fossils?
- How do fossils form?

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## 7.2 Evidence for Evolution

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### Key Concepts

- Formation and dating of fossils
- Evidence for evolution from living organisms
- Recent evolution in Darwin's finches

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### Standards

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### Lesson Objectives

- Explain what fossils are, how they form, and how they are dated.
- Identify evidence for evolution provided by living organisms.
- Describe recent evolution by natural selection in Darwin's finches.

---

### Lesson Vocabulary

- absolute dating: Any method of dating fossils or rocks, such as carbon-14 dating, that gives the specimen an approximate age in years.
- fossil: Preserved remains or traces of an organism that lived during an earlier age.
- molecular clock: Molecule such as protein or DNA that is compared in different species to gauge how recently they shared a common ancestor.
- paleontologist: Scientist who studies fossils to learn about the evolution of living things.
- relative dating: Method of dating fossils based on their position in rock layers that determines only which fossils are older or younger but not their age in years.
- vestigial structure: Inherited structure that is no longer used but is still present in a modern organism who inherited it from an ancestor that used the structure.

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### Teaching Strategies

#### Introducing the Lesson

Do the teacher-developed, open-ended activity at the URL below to introduce your students to fossils as evidence for evolution. Students will examine, discuss, and identify a real fossil or fossil cast. The hands-on activity is excellent for launching a discussion of several important concepts relating to the fossil record. Discussion questions are included in the teacher notes at the URL.

[http://www.fossils-facts-and-finds.com/fossil\\_lesson\\_plan.html](http://www.fossils-facts-and-finds.com/fossil_lesson_plan.html)

### Cooperative Learning

Let teams of students play paleontologists with the dinosaur activity at the following URLs. Each team will receive a picture of a fossil dinosaur skeleton that supposedly has just been discovered. Team members will be tasked with using the fossil to write a report on the newly discovered dinosaur. The first URL is the project worksheet, and the second URL provides pictures of fossil dinosaur skeletons you can use for the activity.

<http://www.nclark.net/DesignasaurusProject.doc>

<http://www.nclark.net/Designasaurus.doc>

### Building Science Skills

In the activity at the following URL, students will compare banding patterns on human and ape chromosomes and observe striking evidence for their recent common ancestry. From this engaging inquiry, students will gain an appreciation of molecular evidence for evolution and the importance of multiple lines of evidence for evolution. The Web page has links to all needed materials.

<http://www.indiana.edu/~ensiweb/lessons/chr.con2.html>

### Differentiated Instruction

Kinesthetic learners may have a better understanding of how fossils form if they make their own "fossil" mold and cast. You can find simple directions in Activity 6 at the URL below. Introduce the activity by showing students actual or replica fossil molds and casts. After students make their "fossils," discuss the activity questions with them, including how their "fossils" differ from real fossils.

[http://www.desertmuseum.org/center/edu/docs/6-9\\_Prehistoric\\_6.pdf](http://www.desertmuseum.org/center/edu/docs/6-9_Prehistoric_6.pdf)

### Enrichment

Challenge interested students to create a poster or PowerPoint presentation in which they show how fossils have been used to reconstruct the evolutionary history of the horse. The URLs below provide a good introduction.

<http://www.amnh.org/exhibitions/past-exhibitions/horse/the-evolution-of-horses>

<http://chem.tufts.edu/science/evolution/horseevolution.htm>

### Science Inquiry

The multi-part inquiry activity at the following URL will help students understand relative and absolute dating of rocks and fossils. In the activity, they will determine the relative age of a geologically complex area, learn how to use the half-life of radioactive decay to date rocks, and discover the importance of sample size in the reliability of evidence. The Web site provides all the materials needed for the activity, including teacher notes. If time is an issue, you can pick and choose which parts of the activity you want your students to do.

[http://www.most.org/curriculum\\_project/Earth\\_Science/Middle\\_School/Post/Determining\\_Age\\_of\\_Rocks\\_&\\_Fossils.pdf](http://www.most.org/curriculum_project/Earth_Science/Middle_School/Post/Determining_Age_of_Rocks_&_Fossils.pdf)

## Overcoming Misconceptions

Three common student misconceptions about fossils are listed below. Explain to your class why each misconception is incorrect. Some suggestions are given in brackets.

- Fossils are actual pieces of dead animals and plants.
- [Fossils are remains of organisms that have been mineralized and turned to rock. Alternatively, they may be impressions or molds of the remains in rock. Fossils also may be traces—rather than remains—of dead organisms, such as foot prints or animal burrows.]
- Fossils represent only bones or teeth, never soft tissues.
- [Although most fossils represent bones or teeth, soft tissues are sometimes preserved. This may occur if an organism is covered with tar, tree sap (amber), or ice. Point out the picture of the insect in amber in the Flexbook lesson. Tell students that insects don't have any bones or teeth yet this specimen is almost completely preserved.]
- Fossils of tropical plants cannot be found in cold or dry areas (in other words, the current climate of a place determines the types of organisms that lived there in the past).
- [Earth's climates have changed dramatically and repeatedly over the history of the planet. As a result, many fossils are found in places where they are incongruous with the current climate. In fact, fossils can often provide evidence of what past climates were like.]

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 7.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 7.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Describe how fossils usually form.
2. What are vestigial structures? Give an example.
3. Apply the molecular clock concept to the data in the table below. Explain which of the three species in the table shared the most recent common ancestor with the human species.

**TABLE 7.2:** Molecular Clock

Species	Percent of DNA that Is the Same as Human DNA
African gorilla	98.4
Orangutan	97
Rhesus monkey	93

4. Compare and contrast relative and absolute dating.
5. How did scientists use fossils to solve the mystery of whale evolution?
6. Explain why Peter and Rosemary Grant were eyewitnesses to evolution.

## Lesson Quiz

Check students' mastery of the lesson with Lesson 7.2 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Understanding how evolution occurs requires knowledge of genetics.

- How is variation in traits within a species related to genes?
- How would you define evolution in genetic terms?

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## 7.3 The Scale of Evolution

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### Key Concepts

- Microevolution vs. macroevolution
- Forces of evolution in populations
- Processes of macroevolution
- Variation in the rate of evolution

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### Standards

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### Lesson Objectives

- Compare and contrast microevolution and macroevolution.
- Identify forces that change allele frequencies in populations.
- Explain how speciation, convergent evolution, and coevolution can occur.
- Describe variation in the rate of evolution.

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### Lesson Vocabulary

- allele frequency: Number of copies of an allele divided by the total number of alleles for the gene in a gene pool.
- coevolution: Evolution of two interacting species in which the evolution of traits in one of the species results in the other species evolving matching traits.
- convergent evolution: Independent evolution of the same traits in species that live in similar habitats.
- gene flow: Change in allele frequencies in a gene pool that occurs when genes move into or out of the gene pool because individuals migrate into or out of the population.
- gene pool: All the genes in all of the members of a population.
- genetic drift: Change in allele frequencies in a gene pool that occurs by chance in a small population.
- macroevolution: Change in inherited traits of organisms that occurs over a long period of time above the level of the species.
- microevolution: Change in inherited traits of an organism that occurs over a relatively short period of time at the level of the population.
- population: Group of organisms of the same species that live in the same area; unit of microevolution.
- speciation: Evolution of a new species.

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## Teaching Strategies

### Introducing the Lesson

Use the dramatic HD video at the following URL to introduce students to the processes of evolution. The video is designed as a motivational "trailer" for life science and biology students who are studying how species evolve over time.

<http://www.youtube.com/watch?v=FpfAZaVhx3k>

### Activity

Have students play the online game at the URL below to gain an appreciation for the role of mutations in evolution. In the game, they will change the environment of fictitious organisms and see how random mutations help them survive.

<http://www.pbs.org/wgbh/nova/evolution/evolution-action.html>

### Building Science Skills

Genetic drift is a difficult concept for many students to understand. The simple simulation model of drift at the following URL will help your students see how drift can change allele frequencies in a small population. The Web page has links to a manual version of the simulation, teacher notes, a student worksheet, and other helpful resources.

<http://www.biology.arizona.edu/evolution/act/drift/drift.html>

### Differentiated Instruction

Work with students to create a cluster (cloud) diagram to organize lesson content on microevolution. You can learn more about cluster diagrams and many other types of graphic organizers at this URL:

<http://www.enchantedlearning.com/graphicorganizers/cloud/>

### Enrichment

Interested students can learn more about genetic drift with the interactive animation at the URL below. The animation illustrates examples of the special case of genetic drift called founder effect.

<http://www.dnalc.org/resources/genescreen/population-genetics.html>

### Science Inquiry

Evolution of anole lizards is described in the Flexbook lesson as an example of macroevolution. The activity at the following URL is a great way to extend the lesson. In the activity, students will try to determine how anole lizards on the Greater Antilles may have evolved. They will begin by observing the body structures and habitats of different anole species and plot the data on a map of the islands to look for patterns in their distribution. From the patterns they observe, students will develop hypotheses about how the lizards colonized the islands and evolved. To test their hypotheses, they will use a lizard phylogeny in addition to their own trait-distribution data.

<http://www.paleobio.org/education/anolis/anolis.html>

## Overcoming Misconceptions

Students may believe that microevolution occurs because it has been observed directly, but they may be less certain about macroevolution. Explain to your class that the difference between microevolution and macroevolution is only a matter of scale and that the same evolutionary forces act at both scales. Given sufficient time, microevolutionary processes (mutation, natural selection, gene flow, and genetic drift) produce enough change between two populations of the same species that they become separate species.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 7.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 7.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. List the four major forces of evolution.
2. Define coevolution and give an example.
3. Calculate allele frequencies for the gene pool represented by the data in the table below.

**TABLE 7.3:** Gene Pool

Genotype	Number in Population
AA	10
Aa	20
aa	20
Total	50

4. Whales and bats have the trait of echolocation. This is the ability to locate objects in the dark by bouncing sound waves off them. The most recent common ancestor of whales and bats did not have this trait. Apply lesson concepts to explain how the trait evolved in whales and bats.
5. Compare and contrast microevolution and macroevolution.
6. Explain how speciation can occur.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 7.3 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Evolution has been taking place since life first evolved on Earth.

- How old is planet Earth?
- How long has life been evolving on Earth?

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## 7.4 History of Life on Earth

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### Key Concepts

- Geologic time and the geologic time scale
- Origin of life
- Evolution during the Paleozoic Era
- Evolution during the Mesozoic Era
- Evolution during the Cenozoic Era

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### Standards

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### Lesson Objectives

- Describe geologic time and the geologic time scale.
- Give an overview of life's origins and the Precambrian.
- Explain how life evolved during the Paleozoic Era.
- Outline major events in evolution during the Mesozoic Era.
- Describe evolution during the Cenozoic Era.

---

### Lesson Vocabulary

- Cenozoic Era: Last era of the geologic time scale that began 65 million years ago and continues to the present and is called the age of mammals.
- extinction: Complete dying out of a species.
- geologic time scale: Tool for understanding the history of Earth and its life that divides Earth's history into eons, eras, and periods on the basis of major changes in geology, climate, and the evolution of life.
- Last Universal Common Ancestor (LUCA): Cell that existed around 3.5 billion years ago and that gave rise to all of the following life on Earth.
- mass extinction: One of six similar events in the history of life on Earth during which the majority of species died out.
- Mesozoic Era: Era of the geologic time scale that lasted from 245 to 65 million years ago and is called the age of dinosaurs.
- Paleozoic Era: Era of the geologic time scale that lasted from 544 to 245 million years ago and during which most major groups of multicellular organisms evolved.
- Precambrian: Supereon at the beginning of the geologic time scale that lasted from 4.6 billion years ago when Earth formed to 544 million years ago and during which life first evolved on Earth.

## Teaching Strategies

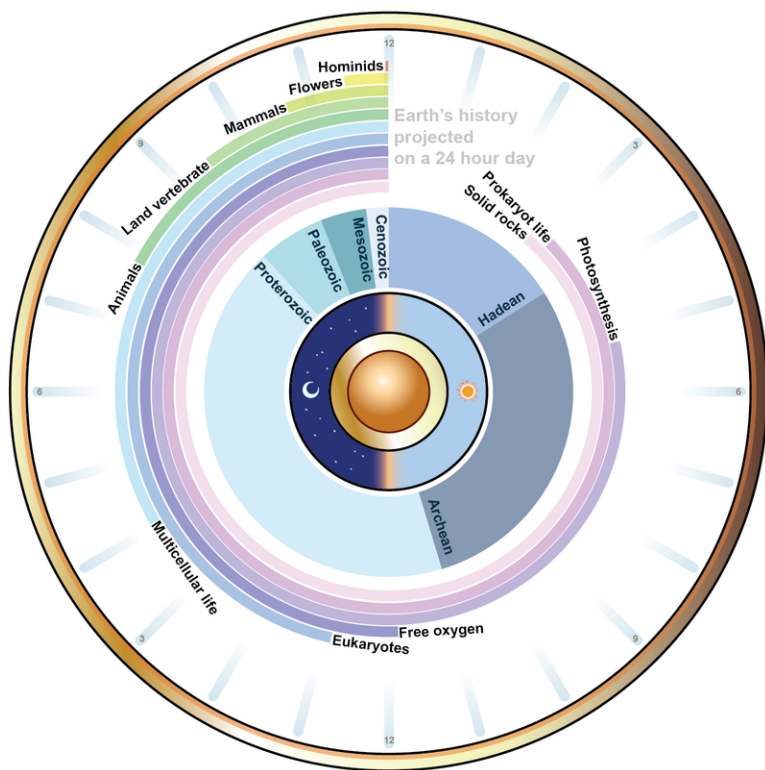
### Introducing the Lesson

Introduce the origin and evolution of life by showing students the remarkable video at the URL below. It is meant to be a motivational "trailer" to be shown to students as a visual introduction to the topic of how life began. After the video, tell students they will learn when and how life may have first begun on Earth when they read this lesson.

<http://www.youtube.com/watch?v=XvMgoelauLQ>

### Using Visuals

Help students appreciate the vastness of geologic time and the recency of human origins by having them look closely at **Figure 7.1** in the Flexbook lesson. It shows Earth's history as a 24-hour day. Ask students to find a few major events in biological evolution in the figure, culminating with the first hominids, who appear only at the end of the last hour of the day.



**FIGURE 7.1**

Earth's history in a day

### Cooperative Learning

Have groups of students do the geologic time scale activity at the following URL. After completing a questionnaire to assess their prior knowledge and guide their background preparation for the time scale, they will make a 5-meter long paper time line that is divided, to scale, into the major subdivisions of geologic time. Then they will place several major events in biological evolution in the correct place on the time line. Display at least one of the completed

time lines in the classroom. Students can refer to it as they study the rest of the lesson as well as the evolution of organisms throughout remaining chapters of the Flexbook.

<http://www.geology.wisc.edu/~museum/hughes/GeoTimeScale1.html>

### Activity

Students can use the Smithsonian's interactive tree of life at the URL below to learn more details about the evolution of vertebrates, starting with the evolution of hagfish in the Paleozoic Era and ending with the evolution of birds in the Cenozoic Era. This is a good activity for visual learners.

[http://paleobiology.si.edu/dinosaurs/interactives/tree\\_life/tree.html](http://paleobiology.si.edu/dinosaurs/interactives/tree_life/tree.html)

### Building Science Skills

Have students do the virtual dinosaur dig with the interactive simulation from the Smithsonian at the following URL. In the simulation, students will find and excavate a virtual dinosaur fossil; learn about the dinosaur's anatomy, habitat, and diet; and view pictures showing how the dinosaur may have looked.

<http://paleobiology.si.edu/dinosaurs/interactives/dig/dinodig.html>

### Differentiated Instruction

Create a gallery walk on the history of life from the Paleozoic to the present. On different walls of the classroom, post three large sheets of paper and write the name of each geologic era on a different sheet. Divide the class into groups, each of which includes students of a range of abilities. Have groups move around the room, from sheet to sheet, writing anything they know about each era. They should also note any errors they see in the contributions of other groups. Give each group a different-colored marker or pen for this purpose. After the gallery walk, read aloud and discuss the notes of all the groups for each era. Point out the most important information.

### Enrichment

Students can adopt a dinosaur with the activity at the URLs below. In the activity, students will search the Web for facts about their adopted dinosaur. Then they will use the information to complete a fact sheet about and make a drawing of their dinosaur. Have the students create at least one question for their classmates from their project. If several students do the project, you can use the questions to create a dinosaur scavenger hunt, in which the rest of the class explores all the projects to find the answers.

<http://sciencespot.net/Media/dinosheet.pdf>

<http://sciencespot.net/Media/dinoinfo.pdf>

<http://sciencespot.net/Media/dinograde.pdf>

### Science Inquiry

When you discuss human evolution during the Cenozoic Era, have students do the inquiry activity at the following URL. In the activity, pairs of students will investigate how the human hand is adapted for the actions it performs. First they will perform several common actions that require manual dexterity and an opposable thumb. Then they will change their hand so it resembles that of a non-primate animal and determine whether they can still perform the same actions. At the conclusion of the activity, discuss what human advances are unlikely to have occurred without the human hand.

<http://www.nclark.net/AdaptationOfTheHumanHand.doc>

## Overcoming Misconceptions

A very common misconception is that evolution is a theory about the origin of life. Make sure students understand that evolutionary theory does encompass ideas and evidence regarding life's origins (e.g., whether or not it happened near a deep-sea vent, whether organic molecules or cells came first, etc.), but that this is not the central focus of evolutionary theory. Rather, the central focus of evolutionary theory is on how life changed after it began, regardless of how it started.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 7.4 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 7.4 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What is the geologic time scale?
2. List important events in the evolution of life that occurred during the Precambrian.
3. Identify major groups of organisms that first appeared during the Paleozoic Era.
4. Pretend that you have been transported in a time machine to the Mesozoic Era. Describe what you might see.
5. Discuss how past mass extinctions generally affected the evolution of life on Earth.
6. All the major groups of mammals appeared during the Mesozoic Era. Why is the Cenozoic Era called the age of mammals?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 7.4 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

The first living things to evolve in the Precambrian were single-celled prokaryotes.

- When did they evolve?
- In which domain(s) of life are they placed?

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## 7.5 References

1. LadyofHats. [Earth's history in aday](#) . CC-BY-NC-SA 3.0

## CHAPTER

## 8

## TE MS Prokaryotes

## Chapter Outline

- 
- 8.1 INTRODUCTION TO PROKARYOTES
  - 8.2 BACTERIA
  - 8.3 ARCHAEA
- 

## Chapter Overview

This chapter describes the classification, evolution, traits, habitats, and reproduction of prokaryotes. It outlines how bacteria are classified and their relationships with people. It also identifies types of archaean extremophiles and the range of habitats and ecological roles of archaeans.

## Online Resources

*See the following Web sites for appropriate laboratory activities:*

In the lab at the following URL, students will take samples of bacteria from around their school, grow them on media in Petri dishes, and use their results to find out where bacteria live and the environmental conditions that encourage their growth. In some school districts, labs involving live bacteria are no longer allowed, so check with your school district before using this lab.

<http://www.middleschoolscience.com/bacterialab.htm>

Students can simulate the growth of bacteria with the lab at the URL below. Using grains of rice to represent bacterial cells, students will apply a sampling method to estimate the number of "bacteria" in a bag of rice. Then they will use math to calculate the number of bacteria produced by binary fission in a given period of time.

<http://www.shellyssciencepot.com/Worksheets/Bacteria-Viruses/MegaMultiplesofMicrobes.pdf>

*These Web sites may also be helpful:*

When you teach the class about prokaryotic cell structure and reproduction, you can use the slides at this URL:

<http://i-biology.net/ibdpbio/02-cells/prokaryotes/>

You can refresh your own knowledge of bacteria with the article and links at the following URL:

<http://www.actionbioscience.org/biodiversity/wassenaar.html>

The URL below is an excellent resource for you and/or your students to learn more about bacteria.

<http://www.bacteriamuseum.org/>

You and/or your students can learn more about archaea at this URL:

<http://archives.microbeworld.org/microbes/archaea/>

**TABLE 8.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
8.1 Introduction to Prokaryotes	2.5
8.2 Bacteria	2.0
8.3 Archaea	1.5

---

## 8.1 Introduction to Prokaryotes

---

### Key Concepts

- Classification and evolution of prokaryotes
- Structure of prokaryotic cells
- Prokaryote metabolism and habitats
- Prokaryote reproduction and genetic transfer

---

### Standards

---

### Lesson Objectives

- Outline the classification and evolution of prokaryotes.
- Describe the structure of prokaryotic cells.
- Identify variation in the metabolism and habitats of prokaryotes.
- Explain how prokaryotes reproduce and increase genetic variation.

---

### Lesson Vocabulary

- Archaea Domain: One of two domains of prokaryotes, which are single-celled organisms that lack a nucleus and other membrane-bound organelles.
- Bacteria Domain: One of two domains of prokaryotes, which are single-celled organisms that lack a nucleus and other membrane-bound organelles.
- biofilm: Colony of prokaryotes that is stuck to a surface.
- cyanobacteria: Type of bacteria that carry out photosynthesis and are important producers in aquatic ecosystems.
- flagellum (flagella, plural): Whip-like extension on the surface of a cell that helps the cell move.
- genetic transfer: Exchange of plasmid DNA between prokaryotic cells that increases genetic variation in asexually reproducing cells.
- plasmid: Small loop of DNA found inside most prokaryotic cells and exchanged between cells during genetic transfer.

---

## Teaching Strategies

### Introducing the Lesson

Introduce prokaryotes by calling on students to recall what they already know about prokaryotic cells. With leading questions as needed, they should remember that prokaryotic cells lack a nucleus and other membrane-bound organelles and that all prokaryotic cells are single-celled organisms in the Bacteria or Archaea Domains. If you want to give students a refresher on prokaryotic vs. eukaryotic cells, the animated video below by the "Amoeba Sisters" is an excellent resource. Tell students they will learn more about prokaryotes in this lesson.

<http://www.youtube.com/watch?v=ruBAHij4EA>

### Introducing the Lesson

Another way to introduce the lesson is by impressing students with the total number and mass of prokaryotes on Earth. Share these facts and figures with your class:

- The total number of prokaryotes on Earth is estimated to be  $5 \times 10^{30}$ . How big a number is this? If you had that many pennies, they would make a stack a trillion light years high!
- Although an individual prokaryote weighs less than a quadrillionth of a gram, all of them together weigh as much as all the plants in the world, which is about a gigaton.
- Prokaryotes exhibit amazing biodiversity. For example, a single gram of soil may contain as many as 4000 different species of bacteria.

### Demonstration

Use the short video at the following URL for a good visual demonstration and explanation of the structure of prokaryotic cells.

<http://www.brightstorm.com/science/biology/parts-of-a-cell/prokaryotic-cells/>

### Discussion

Discuss microbial biofilms with the class. Start the discussion by showing students the magnified biofilms on household objects in the slide show at the first URL below. Students are likely to be amazed (and possibly disgusted) by the biofilms covering objects ranging from showerheads to infant pacifiers. The second URL provides background information on many aspects of biofilms to share with your students. Focus the discussion on the pros and cons to ecosystems and people of microbial biofilms.

<http://www.biofilm.montana.edu/content/household-biofilms>

<http://www.biofilm.montana.edu/biofilm-basics.html>

### Differentiated Instruction

Have students make a Frayer model for the term *prokaryote*. In a Frayer model, students divide a sheet of paper into four squares, which are labeled "Definition," "Drawing," "Example," and "Non-example." Then they fill in each square for the term in question.

## Enrichment

Advanced students can investigate the endosymbiotic theory of the evolution of eukaryotic cells. Suggest that they start with the URLs below. After they complete their research, ask them to teach the topic to the rest of the class. Tell them to include original diagrams or sketches in their class presentation.

<http://learn.genetics.utah.edu/content/cells/organelles/>

[http://encyclopedia.kids.net.au/page/en/Endosymbiotic\\_hypothesis](http://encyclopedia.kids.net.au/page/en/Endosymbiotic_hypothesis)

## Science Inquiry

Have groups of students do the activities in the prokaryote module at the following URL. Students will learn that prokaryotes are the simplest cells but exhibit all the characteristics of living things. They will observe prokaryotic cells under a microscope and hypothesize about their structures. They will also make a model of a typical prokaryotic cell and explain the function of each part.

<http://www.pdesas.org/module/content/resources/14033/view.ashx>

## Overcoming Misconceptions

Students generally fail to appreciate the ubiquity, importance, and metabolic sophistication of prokaryotes. They may also use the terms *bacteria* and *prokaryotes* interchangeably. Make sure you impress students with the numbers and significance of prokaryotes and the complex processes that take place within their cells. Also call students' attention to the important differences between the Archaea and Bacteria Domains. Point out that the differences between these two domains are far more basic than those between the Plant and Animal Kingdoms. Be careful that your own use of the terms *bacteria* and *prokaryotes* is accurate and consistent.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 8.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 8.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. How are prokaryotes classified?
2. Identify traits of prokaryotes.
3. What is a biofilm? Give an example.
4. A certain prokaryote lives inside the gut of an animal that has a body temperature of about 37 °C. Classify the prokaryote in terms of its need for oxygen and its temperature preference.
5. Compare and contrast aerobic and anaerobic prokaryotes.
6. Explain how and why ideas about the relationships of the Bacteria, Archaea, and Eukarya Domains have changed.
7. Why is genetic transfer important for the evolution of prokaryotes?

## Lesson Quiz

Check students' mastery of the lesson with Lesson 8.1 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Prokaryotes in the Bacteria Domain cause many diseases in humans.

- What are some bacterial diseases?
- How can they be treated?

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## 8.2 Bacteria

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### Key Concepts

- Abundance of bacteria
- Classification of bacteria
- Bacteria and people

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### Standards

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### Lesson Objectives

- Describe the abundance of bacteria on Earth.
- Outline how bacteria are classified.
- Identify relationships between bacteria and people.

---

### Lesson Vocabulary

- antibiotic drug: Drug developed to kill bacteria and cure bacterial diseases or infections.
- antibiotic resistance: Ability of bacteria to resist the effects of one or more antibiotic drugs, which evolves through natural selection.
- bacteria (bacterium, singular): Single-celled prokaryotic organism that is a member of the Bacteria Domain.
- pathogen: Any organism that causes disease.
- vector: Organism, commonly an insect, that spreads bacteria or other pathogens.

---

### Teaching Strategies

#### Introducing the Lesson

Share these interesting facts about bacteria with your class to pique their interest about these organisms. Tell the class you are describing a certain type of organism, and they should raise their hand when they think they know what it is. See how many of the following hints you need to give them before they guess that the answer is a bacterium.

- It has 0.001 times as much DNA as a eukaryotic cell.
- It has a "motor" for swimming, but the motor can run in only two directions and at one speed, and it can't be stopped.
- It can "learn," but it divides every twenty minutes and has to start learning all over again each time.

- Humans are using it as a research tool.
- Humans thought drugs would kill it, but now it may have evolved resistance to the drugs.
- Humans think this is their era, but this is actually the age of the \_\_\_\_\_. [bacterium]

### Introducing the Lesson

Another option for introducing the lesson that is sure to generate student interest is to show the following video. It reveals some of the trillions of bacteria that live in or on the human body. It shows that we are more microbe than human.

[http://www.smithsonianmag.com/videos/category/3play\\_1/the-microbes-were-made-of/?no-ist](http://www.smithsonianmag.com/videos/category/3play_1/the-microbes-were-made-of/?no-ist)

### Building Science Skills

Have students use the interactive bacterial cell model at the following URL to investigate the structures in a typical bacterial cell. They can also see the differences between gram-positive and gram-negative bacteria in the animation.

<http://www.cellsalive.com/cells/bactcell.htm>

### Activity

For a fun way to learn about the ecology of bacteria, have students visit the "Microbe Zoo" at the URL below. With this interactive activity, students can discover the many hidden worlds of bacteria, including "DirtLand," where soil bacteria live, and the "Animal Pavilion," where bacteria interact with animals. Ask students to write a short report on what they learn at the "zoo."

<http://commtechlab.msu.edu/sites/dlc-me/zoo/index.html>

### Differentiated Instruction

Guide students in completing the worksheet on bacteria at the URL below. The first page of the worksheet is a cluster diagram for organizing lesson content. The second page is a T chart for comparing the pros and cons of bacteria from a human perspective.

<http://www.shellyssciencepot.com/Worksheets/Bacteria-Viruses/BacteriaGraphicOrganizer.pdf>

### Enrichment

Ask interested students to select a particular pathogenic bacterium and create a "wanted poster" of their choice. You can have students follow the activity guidelines at the following URL.

<http://www.accessexcellence.org/AE/ATG/data/released/0210-JoyceCalo/index.php>

### Enrichment

As an alternative enrichment activity, suggest that students learn about the bacterium *Yersinia pestis* and the disease it causes, the bubonic plague. A good resource is this URL:

<http://www.livinghealthy360.com/index.php/yersinia-pestis-and-the-bubonic-plague-3-44329/>

## Science Inquiry

Have groups of students do Activity 3 on Worksheet 1 at the URL below. In the activity, they will design an experiment to show why composting is a good idea at their school. The activity is meant to show students how bacteria can be beneficial. You may want students to do some or all of the other activities as well.

<http://www.actionbioscience.org/biodiversity/lessons/wassenaarlessons.pdf>

## Overcoming Misconceptions

A common misconception is that all bacteria are harmful to humans. Tell students that the majority of bacteria are harmless and some are highly beneficial to humans. Adding to the confusion is the fact that certain bacteria can be beneficial to some animals but pathogenic to others. Explain that pathogenic bacteria are generally harmful only to a limited number of hosts, or even only to one, whereas they live happily within other hosts without causing trouble.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 8.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 8.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. How numerous are bacteria?
2. Describe two ways of classifying bacteria.
3. Identify benefits of bacteria to ecosystems.
4. What are some uses of bacteria to people?
5. Apply the concepts of pathogen and vector to explain what causes Lyme disease and how it is spread.
6. Discuss how the first appearance of cyanobacteria on early Earth changed the course of evolution forever.
7. Explain how bacteria evolve resistance to antibiotic drugs.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 8.2 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Many Archaea live in extreme conditions. For example, some of them live in boiling hot water.

- In what other extreme conditions do you think Archaea live?
- Why might Archaea have evolved to live in extreme conditions?

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## 8.3 Archaea

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### Key Concepts

- Definition of archaean
- Types of archaean extremophiles
- Habitats and ecological roles of archaeans

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### Standards

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### Lesson Objectives

- Define archaean.
- Identify types of archaean extremophiles.
- Describe the range of habitats and ecological roles of archaeans.

---

### Lesson Vocabulary

- archaean: Single-celled prokaryotic organism that is a member of the Archaea Domain.
- extremophile: Organism that lives in extreme conditions, such as very hot, salty, acidic, or basic conditions.
- methanogen: Type of archaean prokaryote that produces methane gas as a waste product of anaerobic respiration.

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### Teaching Strategies

#### Introducing the Lesson

Introduce archaeans by telling students that astrobiologists are studying them to learn about potential life forms on other planets. Because archaeans inhabit places previously considered incompatible with life, they may provide clues that will help scientists detect extraterrestrial life. New research suggests that archaeans may even be capable of space travel by meteorite. This is one way that life could have begun on Earth. Tell students they will learn more about these fascinating, ancient organisms when they read this lesson.

#### Discussion

Discuss the evolutionary significance of archaeans. In your discussion, include these main points:

- Archaeans are among the earliest forms of life to appear on Earth.
- Archaea and bacteria appear to have evolved separately from a common ancestor nearly 4 billion years ago.
- Millions of years later, the ancestors of today's eukaryotes split off from the archaea, so eukaryotes are more closely related to archaeans than to bacteria.

### Differentiated Instruction

Suggest that students make a table comparing and contrasting the different types of extremophiles described in the Flexbook lesson. A sample table is given below.

**TABLE 8.2:** Extremophiles

Type of Extremophile	Extreme It Can Tolerate	Example of Where It Is Found
Halophile	Salt	Great Salt Lake, Utah
Hyperthermophile	Heat	Hot springs
Acidophile	Acid	Acid mine drainage
Alkaliphile	Base	Mono Lake, California

### Enrichment

Ask students who need extra challenges to learn more about methanogenesis, the process by which some archaeans break down carbon compounds and produce methane gas. They can start with the articles at the following URLs.

<http://en.wikipedia.org/wiki/Methanogenesis>

<http://www.daviddarling.info/encyclopedia/M/methanogen.html>

### Science Inquiry

Have students do Activity 4 in the NASA activity book at the URL below. In the activity, students will first play a card game similar to Rummy, in which the goal is to create a matched set. For each set, they will match an extremophile, an extreme habitat on Earth, and an extraterrestrial habitat that may be similar to the Earth habitat. Then they will assemble a crew of extremophiles and target them to specific locations on a planet or moon.

<http://astrobiology.nasa.gov/media/medialibrary/2013/10/Astrobiology-Educator-Guide-2007.pdf>

### Overcoming Misconceptions

Discuss the following potential misconceptions about archaeans. Some ideas for discussion are included in brackets.

- Archaeans are a type of bacteria.
- [Before scientists knew much about archaeans, they were classified as bacteria, called Archaeobacteria. As more archaeans were discovered and their traits analyzed, scientists realized they were too different from bacteria to be placed in the same kingdom or even the same domain. They are more different from bacteria than plants are from animals.]
- Archaeans are found only in extreme environments.
- [This misconception arises because archaeans were first discovered in extreme environments and were overlooked in other places. We now know that archaeans live virtually everywhere on Earth. Many live in the ocean; some even live inside of us.]
- Some archaeans carry out photosynthesis like plants.
- [While it is true that some archaeans get energy from sunlight, they don't use the energy to make carbon compounds as plants and other photosynthetic organisms do. Specific differences include the fact that archaeans

use a pigment called bacteriorhodopsin, rather than chlorophyll, to capture light; the process takes place in the cell membrane, rather than in a chloroplast; and the product is ATP rather than glucose.]

- All microbes—whether bacteria or archaeans—are "germs" (i.e., cause human disease).
- [Unlike many bacteria, which do cause human disease, no archaeans are known to make people sick. In fact, they generally do no harm and often provide a benefit in their many close relationships with other organisms. A good example of a mutualistic relationship involving archaeans is the methanogen-ungulate relationship described in the Flexbook lesson.]

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 8.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 8.3 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What are archaeans?
2. Define extremophile.
3. Identify four types of archaean extremophiles.
4. You have a stomach ache and diarrhea. You think you have been infected by a prokaryote. Which type of prokaryote is it likely to be, a bacterium or an archaean? Explain your answer.
5. Explain the ecological role of methanogens that live in animals like cows.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 8.3 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

All prokaryotes are single-celled organisms.

- Are all single-celled organisms prokaryotes?
- Are any eukaryotes single-celled organisms? If there are, what are they?

## CHAPTER

## 9

## TE MS Protists and Fungi

## Chapter Outline

9.1 PROTISTS

9.2 FUNGI

## Chapter Overview

This chapter describes the classification and evolution of protists. It compares and contrasts different types of protists and identifies human diseases caused by protists. The chapter also explains how fungi are classified and how they evolved. It describes fungi reproduction, their roles in ecosystems, and their relationships with human beings.

## Online Resources

See the following Web sites for appropriate laboratory activities:

In the "Fun with Protists" lab at the following URL, students will prepare their own wet-mount slides, gain practice using a microscope, and observe microorganisms found in pond water. Students will also identify the form and function of protozoa, classify organisms as unicellular or multicellular, and differentiate the movements and activity of various protists.

<http://www2.mcdaniel.edu/Biology/PGclass/donna/funlabs.htm>

The purpose of the "Mushroom Dissection Lab" at the URL below is to acquaint students with the parts of a multicellular fungus while practicing observation skills.

[http://www.namyco.org/images/pdf\\_files/dc020618.pdf](http://www.namyco.org/images/pdf_files/dc020618.pdf)

These Web sites may also be helpful:

This URL has hundreds of micro-videos of a great diversity of protists:

<http://www.nhm.ac.uk/research-curation/research/projects/protistvideo/list.dsml?list=gallery>

You can find a large collection of teaching resources on fungi at this URL:

<http://www.namyco.org/education/k-12.html>

**TABLE 9.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
9.1 Protists	1.5
9.2 Fungi	2.5

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## 9.1 Protists

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### Key Concepts

- Classification and evolution of protists
- General traits of protists
- Different types of protists
- Protists and human disease

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### Standards

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### Lesson Objectives

- Outline the classification and evolution of protists.
- Describe general traits of protists.
- Compare and contrast different types of protists.
- Identify human diseases caused by protists.

---

### Lesson Vocabulary

- alga (algae, plural): Common name of a plant-like protist, which contains chloroplasts and makes food by photosynthesis.
- cilium (cilia, plural): Short, hair-like projections on a cell.
- life cycle: Cycle of phases that an organism goes through until it returns to the starting phase and that may include one or more generations.
- protist: Eukaryotic organism in the Protist Kingdom.
- Protist Kingdom: Kingdom in the Eukarya Domain that includes mainly single-celled organisms, including animal-like, plant-like, and fungus-like protists.
- protozoan (protozoa, plural): Animal-like, usually single-celled organism in the eukaryotic Protist kingdom.
- pseudopod: temporary Extension of the cytoplasm of a protozoan that is used for movement.

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### Teaching Strategies

#### Introducing the Lesson

Introduce protists by showing the class the short motivational "trailer" at the URL below. It was created specifically to introduce students to the study of the Protist Kingdom. After the video, tell students they will learn more about

these very interesting organisms when they read this lesson.

<http://www.youtube.com/watch?v=0-6dzU4gOJo>

### Activity

Have students use the animation at the following URL as they begin to study protists. The animation shows sketches of six different protists commonly found in pond water. Students will view each organism as through a virtual microscope and read informational text about it. Students are likely to be surprised that such "invisible" organisms live in ordinary pond water. This is a good activity to use in conjunction with, or in lieu of, students viewing real protists in pond water through an actual microscope.

<http://prisms.mmsa.org/review.php?rid=1227>

### Building Science Skills

In the inquiry-based project at the URL below, students will learn about the diversity of protists and create a foldable describing a variety of protists. They will label their organelles, methods of movement, metabolic processes, and reproduction methods.

<http://www.learnnc.org/lp/editions/proto-zoo-ology/7475>

### Differentiated Instruction

Guide students in making an outline of the lesson. Show them how to use the headings and subheadings in the lesson for the framework of their outline. Then they can fill in supporting details.

### Enrichment

Ask a few students to create a cycle diagram of a protist life cycle that includes alternation of generations (which is also characteristic of plants). A sample diagram is shown below, followed by two URLs where students can learn more about protist life cycles. Sample protist life cycle with alternation of generations:

<https://www.boundless.com/biology/protists/characteristics-of-protists/life-cycles-and-habitats/>

[http://kisdwebs.katyisd.org/campuses/MRHS/teacherweb/hallk/Teacher%20Documents/AP%20Biology%20Materials/Diversity/Alternation%20of%20Generation/28\\_A01s.swf](http://kisdwebs.katyisd.org/campuses/MRHS/teacherweb/hallk/Teacher%20Documents/AP%20Biology%20Materials/Diversity/Alternation%20of%20Generation/28_A01s.swf)

### Science Inquiry

Have students do "The Fabulous Life of Protists: An Inquiry Project" at the URL below. Students will use inquiry skills to observe and research protists and develop and test hypotheses about them.

[http://csip.cornell.edu/Curriculum\\_Resources/CSIP/Olsson/Olsson\\_Protist.html](http://csip.cornell.edu/Curriculum_Resources/CSIP/Olsson/Olsson_Protist.html)

### Overcoming Misconceptions

Students may hold the misconception that all protists are single-celled organisms. Be sure to stress that although many protists are unicellular, many others spend at least part of their life cycle as multicellular organisms. For example, some single-celled forms, such as Volvox, form large colonies; and algae such as giant kelp contain billions of cells and grow longer than 100 meters.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 9.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 9.1 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. Define protist.
2. List general traits of most protists.
3. What human diseases are caused by protists?
4. Create a table comparing and contrasting the three types of protists.
5. Explain how protists are thought to have evolved.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 9.1 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Fungus-like protists resemble fungi.

- What are fungi?
- How do fungi differ from plants and animals?

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## 9.2 Fungi

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### Key Concepts

- Definition and examples of fungi
- Classification and evolution of fungi
- Fungal hyphae and mycelia
- Reproduction in fungi
- Ecosystem roles of fungi
- Human uses of fungi and fungal diseases

---

### Standards

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### Lesson Objectives

- Define and give examples of fungi.
- Explain how fungi are classified and how they evolved.
- Describe fungal hyphae and mycelia.
- Outline how fungi reproduce.
- Identify roles of fungi in ecosystems.
- List human uses of fungi and examples of fungal diseases.

---

### Lesson Vocabulary

- chitin: Tough carbohydrate that makes up the cell walls of fungi and the external skeleton of insects.
- Fungus (fungi, plural): Eukaryotic organism in the Fungus Kingdom.
- Fungus Kingdom: Kingdom in the Eukarya Domain that consists of both single-celled and multicellular organisms and includes mushrooms and yeasts.
- hypha (hyphae, plural): Multicellular, thread-like structure in a fungus that resembles the root of a plant.
- lichen: Symbiotic relationship between a fungus and cyanobacteria or green algae.
- mold: Type of fungus that grows in the form of multicellular filaments called hyphae.
- mycelium (mycelia, plural): Mass of hyphae that make up the body of a fungus, which may range in size from microscopic to enormous.
- mycorrhiza: Symbiotic relationship between a fungus and a plant.
- spore: Reproductive cell produced by fungi or plants.
- yeast: Type of fungus that exists as a single-celled organism.

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## Teaching Strategies

### Introducing the Lesson

Share these amazing fungi facts and figures with your students to engage their interest in fungi:

- For every person on Earth, there are more than 2 tons of fungi.
- The biggest individual fungus weighs as much as a blue whale, which is the largest animal on Earth.
- There are as many as 1.5 million species of fungi, and only a small fraction of them have been identified.
- Fungi spores (reproductive cells) are so tough that they may be able to survive space travel.
- Fungi come in every color of the rainbow, and some even glow in the dark.
- Some fungi are predators that trap small worms and digest them from the inside out, leaving only the skin.

### Activity

Use the multi-part activity "Adventures in Molds and Yeasts" at the following URL to expand student knowledge of fungi and illustrate some of their properties. Materials lists, teacher instructions, and extension ideas are provided.

[http://www.namycology.org/images/fungus\\_files/2.2%20Adventures%20in%20Moulds%20and%20Yeasts.pdf](http://www.namycology.org/images/fungus_files/2.2%20Adventures%20in%20Moulds%20and%20Yeasts.pdf)

### Differentiated Instruction

Guide students in making a concept map for fungi that organizes important lesson content. A sample concept map is shown below.

### Enrichment

With parent or guardian permission, students can use yeast to make a loaf of bread. They should find and follow a simple yeast-bread recipe and carefully record their observations as they would when doing a science experiment. Ask the students to share with the rest of the class what they did and observed and to explain the role of yeast in the process. Students can share the bread with their classmates if they wish.

### Science Inquiry

Using Activity 7 at the URL below for guidance, have groups of students plan and carry out research to investigate how different conditions affect the growth of fungi.

[http://www.fungi4schools.org/GBF\\_web/Teachers%20notes.htm](http://www.fungi4schools.org/GBF_web/Teachers%20notes.htm)

### Overcoming Misconceptions

Students commonly think that fungi such as mushrooms are plants. Explain to the class that mushrooms may look like plants, have cell walls, and grow in soil, but they are very different from plants. Mushrooms do not have chlorophyll or chloroplasts, so unlike plants they cannot carry out photosynthesis to feed themselves. They also lack roots, stems, and leaves, which are basic plant organs. In addition, their cell walls are made of chitin instead of cellulose.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 9.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 9.2 in *CK-12 MS Life Science Flexbook*. Answers are provided below.

1. What are fungi? What are two examples of fungi?
2. Describe the hyphae and mycelium of a fungus.
3. Give an overview of fungi reproduction.
4. What are some ways that people use fungi?
5. Assume that you notice fungi growing on a wooden fence in your backyard. You want the fence to last as long as possible. Should you remove the fungi or leave them alone? Explain your answer.
6. Fungi used to be placed in the Plant Kingdom. Explain why they are now placed in their own kingdom.
7. Compare and contrast mycorrhiza and lichen.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 9.2 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Fungi share certain traits with plants.

- How do plants differ from fungi?
- What are some other traits of plants?

# CHAPTER 10

# TE MS Plants

## Chapter Outline

- 10.1 INTRODUCTION TO PLANTS**
- 10.2 EVOLUTION AND CLASSIFICATION OF PLANTS**
- 10.3 PLANT RESPONSES AND SPECIAL ADAPTATIONS**

## Chapter Overview

This chapter introduces the Plant Kingdom, describes major plant tissues and organs, and explains how plants grow and reproduce. It also outlines the evolution and classification of plants and identifies plant responses and specialized adaptations.

## Online Resources

*See the following Web sites for appropriate laboratory activities:*

In the lab at the following URL, students will dissect flowers and observe their parts with a hand lens. They will also form and test hypotheses about how particular plant specimens are pollinated. If a dissecting or compound microscope is available, the lab can be extended to include preparation of thin tissue samples so students can identify the ovules in an ovary and the pollen sacs in an anther. They can also estimate how many seeds the flower could produce by counting the number of ovules in the ovary.

<http://www.discoveryeducation.com/teachers/free-lesson-plans/plant-pollination.cfm>

The lab at the URL below allows students to observe the structure of a seed and undertake two experiments to show the function of the cotyledons in providing nourishment to the plant during the early stages after germination.

<http://mypages.iit.edu/~smile/bi9417.html>

With the lab activity at the following URL, students will simulate plant pollination by bees, identify the bee structures involved in pollination, and demonstrate how pollen moves from the male stamen to the female stigma.

[http://www.smithsonianeducation.org/educators/lesson\\_plans/partners\\_in\\_pollination/lesson1\\_main.html](http://www.smithsonianeducation.org/educators/lesson_plans/partners_in_pollination/lesson1_main.html)

The lab at the URL below tasks pairs of students with developing a hypothesis about how a specific variable affects germination and seedling growth. Students will then design and carry out (with teacher approval) an experiment to test their hypothesis. Data will be collected and summarized in charts, tables, and/or graphs. An optional requirement is for each student to write two- to four-page lab report that summarizes their results.

[http://cibt.bio.cornell.edu/labs\\_and\\_activities/images/Becoming\\_a\\_Plant.pdf](http://cibt.bio.cornell.edu/labs_and_activities/images/Becoming_a_Plant.pdf)

*These Web sites may also be helpful:*

The URL below is an educator's guide to the world's plants. It includes many links to podcasts and videos.

[http://www.fieldmuseum.org/sites/default/files/PlantHallEducatorGuide\\_Final%20\(1\).pdf](http://www.fieldmuseum.org/sites/default/files/PlantHallEducatorGuide_Final%20(1).pdf)

This URL has links to a wide range of resources for teaching students about plants:

<http://botany.org/outreach/WebLinks.php>

This Web site from the Missouri Botanical Gardens contains basic information about plants as well as lesson plans and videos:

<http://www.mbgnet.net/bioplants/main.html>

The Web site at this URL is a good source of information and images relating to pollination:

<http://pollinator.com/>

**TABLE 10.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
10.1 Introduction to Plants	3.0
10.2 Evolution and Classification of Plants	3.0
10.3 Plant Responses and Special Adaptations	2.0

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## 10.1 Introduction to Plants

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### Key Concepts

- Importance and needs of plants
- Types of plant tissues
- Roots, stems, and leaves
- Plant growth
- Life cycle of plants

---

### Standards

---

### Lesson Objectives

- Describe plants, their needs, and their importance.
- Identify three major types of plant tissues.
- Describe the structure and function of roots, stems, and leaves.
- Explain how plants grow.
- Outline the general life cycle of plants.

---

### Lesson Vocabulary

- alternation of generations: Type of life cycle characteristic of plants (and some protists), in which the organism alternates between haploid and diploid generations.
- dermal tissue: Type of tissue in plants that covers the outside of the plant like skin and secretes waxy cuticle, which helps prevent water loss and damage to the plant.
- gametophyte: Plant in the haploid generation that forms from a haploid spore and reproduces sexually by producing haploid gametes by mitosis.
- ground tissue: Type of tissue in plants that makes up much of the inside of a plant, where most biochemical reactions take place and where food or water may be stored.
- leaf: Plant organ with the primary role of collecting sunlight and making food by photosynthesis.
- plant: Multicellular eukaryote that is placed in the Plant Kingdom.
- Plant Kingdom: Kingdom in the Eukarya Domain that consists of multicellular organisms with cell walls of cellulose and chloroplasts for photosynthesis.
- root: Plant organ that generally grows down into the soil to absorb water and nutrients from the soil.
- sporophyte: Plant in the diploid generation that forms from the fertilization of gametes and reproduces asexually by producing haploid spores by meiosis.
- stem: Organ of a plant that holds the plant upright to get light and air and may also bear leaves, flowers, and/or cones.

- stoma (stomata, plural): Tiny pore in the leaf of a plant that can open and close to control the movement of gases between the leaf and the air.
- transpiration: Release of water vapor into the atmosphere from stomata in the leaves of plants.
- vascular tissue: Type of tissue in plants that transports fluid throughout the plant; consists of xylem, which carries fluid from the roots to the leaves, and phloem, which carries fluid from the leaves to the rest of the plant.

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## Teaching Strategies

### Introducing the Lesson

Introduce students to plants and their importance by having them complete the worksheet at the following URL. Students will see pictures of common items (e.g., book, hamburger, honey) and trace them back to their connections with plants. After students complete the worksheet, discuss their answers and point out any connections they missed. Then tell students they will learn about plants and additional reasons why they are important when they read this lesson.

<http://www.shellyssciencespot.com/Worksheets/Plantae/TracingBack.pdf>

### Discussion

Hold a discussion of the needs of plants by comparing them with the needs of students. The document at the URL below provides a step-by-step lesson plan for the discussion, including a Venn diagram for comparing and contrasting plant and student needs and a worksheet for students to complete at the end of the discussion to check their comprehension. An extension investigation is also described in the document.

<https://www.ffa.org/documents/learn/MS.PS.1.2.pdf>

### Demonstration

Use the activity described at the following URL to demonstrate vascular tissue and how it functions. Students will observe how water containing food coloring travels upward through the vascular tissue inside celery stalks. Then they will complete a worksheet about their observations.

<http://www.shellyssciencespot.com/Worksheets/Plantae/CeleryExperiment.pdf>

### Cooperative Learning

Use the lesson plan and teaching materials at the following URL to help students learn the structure and function of roots, stems, flowers, fruits, and seeds. In the lesson, students will learn about these plant parts cooperatively, both in groups and as a class.

<https://www.ffa.org/documents/learn/MS.PS.1.1.pdf>

### Differentiated Instruction

Pair English language learners and/or visual learners with other students, and ask partners to make a table comparing and contrasting roots, stems, and leaves. A sample table is provided below.

**TABLE 10.2:** Roots\_stems\_leaves

Organs	Description	Functions
Roots	Underground parts of a plant that are covered with tiny hairs	Absorb water and nutrients from soil Anchor plant to the ground Store food
Stems	Above-ground stalks that connect roots to leaves	Hold plant up to reach air and light Bear leaves, flowers, and/or other organs Transport fluids from roots to leaves Store food or water
Leaves	Flat, green structures that contain chloroplasts and stomata	Capture sunlight Carry out photosynthesis Allow gases to move in and out of plant

### Enrichment

Have students do the project outlined at the URL below. They will investigate vegetative propagation in plants and try to grow a new plant by this method of reproduction. The project will take about 6 to 8 weeks to complete. Students will keep a journal during the project and write a summary when the project is finished.

<http://sciencenetlinks.com/lessons/plants-2-plant-propagation/>

### Science Inquiry

In the second activity at the following URL, students will investigate the effects of nutrients (in fertilizer) on plant growth and how this relates to seed structure. Students will also get practice expressing and interpreting data with graphs.

<http://mypages.iit.edu/~smile/bi9710.html>

### Overcoming Misconceptions

The following items are among the most common student misconceptions about plants. Use the list as a true-false quiz. For any items that students think are true, call on other students to help you explain why they are false.

1. Plants obtain their energy directly from the sun.
2. Plants have multiple sources of food (heterotrophic as well as autotrophic).
3. Carbon dioxide, water, and minerals are food for plants
4. Plants use heat (rather than light) from the sun as a source of energy for photosynthesis.
5. Sunlight is food for plants.
6. Sunlight is composed of molecules that plants use.
7. Sunlight is consumed by plants when they undergo photosynthesis.
8. Plants absorb water through their leaves.
9. Plants produce oxygen for our benefit.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 10.1 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 10.1 in *CK-12 MS Life Science Workbook*. Answers are provided below.

1. What are plants? What do plants need?
2. How do plants grow?
3. Outline the general life cycle of a plant.
4. Choose one of the three main organs of plants: roots, stems, or leaves. State the primary function of the organ. Then explain how the organ's structure suits it for its function.
5. A certain plant spends most of its life cycle as a haploid organism. Is the plant a flowering plant such as a daisy or is it a species of moss?
6. Compare and contrast dermal, ground, and vascular tissues of plants.
7. Why would life as we know it be impossible without plants?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 10.1 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

The earliest plants were similar to green algae and lived in water.

- What do you think the earliest plants might have been like?
- What traits might plants have evolved after they colonized the land?

---

## 10.2 Evolution and Classification of Plants

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### Key Concepts

- Earliest plants
- Colonization of land by plants
- Evolution of vascular plants
- Evolution of seed plants
- Evolution of flowering plants
- Classification of modern plants

---

### Standards

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### Lesson Objectives

- Describe the first plants.
- Discuss colonization of land by plants.
- Describe the early evolution of vascular plants.
- Explain why the evolution of seeds was such an important event.
- Explain why the evolution of flowers made flowering plants so successful.
- Outline the classification of modern plants.

---

### Lesson Vocabulary

- angiosperm: Type of modern seed plant that produces seeds in the ovaries of flowers.
- cone: Reproductive structure in gymnosperms that is made of overlapping scales and where pollen or eggs form and naked seeds develop.
- embryo: Very early stage in the development of an organism following the zygote stage and during which initial growth and development take place.
- flower: Plant structure in angiosperms that contains male and/or female reproductive organs.
- fruit: Structure containing seeds that forms from the ovary of a flower in an angiosperm.
- germination: Early growth and development of a plant embryo inside a seed.
- gymnosperm: Type of modern seed plant that produces naked seeds in cones rather than flowers.
- petal: Part of a flower that may be large, showy, and brightly colored to attract pollinators.
- pistil: Female reproductive organ in a flower that consists of a stigma, style, and ovary where eggs form and seeds develop.
- pollen: Tiny male gametophyte in seed plants that is enclosed in a tough capsule and that carries sperm to an ovule containing eggs or the stigma of a flower.

- pollinator: Animal such as an insect or bat that picks up pollen on its body and carries it to another flower of the same species for pollination.
- seed: Reproductive structure produced by a seed plant that contains an embryo and food supply enclosed within a hull.
- stamen: Male reproductive organ in a flower that has a stalk-like filament and ends in an anther where pollen forms.

---

## Teaching Strategies

### Introducing the Lesson

Show students an apple and a pine cone. Pass the two objects around the room for students to inspect. Ask the class what the two objects have in common. (Both come from trees, are structures involved in reproduction, and contain seeds.) Accept all reasonable responses at this point. Tell students that the items represent two major types of plants called angiosperms and gymnosperms, which diverged at least 200 million years ago. Tell students they will learn how plants evolved—as well as what an apple and pine cone have in common—when they read this lesson.

### Building Science Skills

The activity at the following URL tasks students with investigating pollinators and the plants they pollinate. Students will identify adaptations that flowers have evolved to encourage pollination.

[http://www.smithsonianeducation.org/educators/lesson\\_plans/partners\\_in\\_pollination/lesson3\\_main.html](http://www.smithsonianeducation.org/educators/lesson_plans/partners_in_pollination/lesson3_main.html)

### Differentiated Instruction

Use the worksheet at the URL below to help students compare and contrast gymnosperms and angiosperms. The worksheet includes a Venn diagram for students to complete for these two major groups of seed plants.

<http://www.shellyssciencepot.com/Worksheets/Plantae/ComparingGymnosperms&Angiosperms.pdf>

### Enrichment

Ask one or more students to create a crossword puzzle using all of the lesson vocabulary terms. Make a copy of the puzzle for other students to solve as a review of the terms. Students can make the puzzle by hand or use the puzzle maker at this URL:

<http://www.discoveryeducation.com/free-puzzlemaker/>

### Science Inquiry

Have pairs of students do the two-part activity at the URL below. In the first part of the activity, students will dissect a fruit (an apple) to help them see how fruits form from flowers. In the second part of the activity, students will examine a variety of fruits and try to determine the methods of dispersal for which they are adapted. Students will then complete a reading assignment that reinforces what they learned through inquiry.

[http://www.bgci.org/files/Worldwide/US\\_Files/lesson\\_5seeds\\_fruits\\_and\\_their\\_dispersers.pdf](http://www.bgci.org/files/Worldwide/US_Files/lesson_5seeds_fruits_and_their_dispersers.pdf)

## Overcoming Misconceptions

Many middle school students think that seeds are not alive. Counter this common misconception by explaining to your class how seeds meet the criteria for living things. For example, seeds need nutrients and air to survive. Tell students that seeds may lie dormant for a long time until conditions are right for germination. They may appear nonliving or dead during dormancy, but the fact that they can later develop into a living plant shows they are living things and still alive.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 10.2 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 10.2 in *CK-12 MS Life Science Workbook*. Answers are provided below.

1. List traits of the first plants.
2. What hazards did plants face when they colonized the land?
3. Identify the parts of a typical flower and their role in reproduction.
4. Plants that are pollinated by wind rather than pollinators may have modest or insignificant flowers. Apply lesson concepts to explain why.
5. Why was the evolution of vascular tissue such an important adaptation for life on land?
6. Explain why a dominant diploid generation is adaptive for plants that live on land.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 10.2 Quiz in *CK-12 MS Life Science Assessments*.

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## Points to Consider

Plants can't move away from danger.

- Does this mean that plants are helpless?
- How might plants be able to protect themselves from pathogens?

---

## 10.3 Plant Responses and Special Adaptations

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### Key Concepts

- Plant responses to stimuli
- Special adaptations in plants

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### Standards

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### Lesson Objectives

- Explain how plants respond to stimuli in their environment.
- Identify special adaptations in plants.

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### Lesson Vocabulary

- aquatic plant: type of plant that lives in the water, such as a water lily or cattail.
- carnivorous plant: type of plant that gets some or most of its nutrients from other organisms, usually insects or protozoa, by trapping and digesting them.
- epiphyte: type of plant that is adapted to grow on other plants for support and to obtain moisture from the air instead of the soil.
- gravitropism: growing downward in response to gravity by the roots of a plant.
- phototropism: growing toward light by the stems and leaves of a plant.
- tropism: turning toward, or away from, a stimulus in the environment.
- xerophyte: type of plant that is adapted to a very dry environment.

---

### Teaching Strategies

#### Introducing the Lesson

Show students the short, dramatic video at the URL below, in which a Venus flytrap catches and digests a fly. It will be sure to pique their interest in plants with specialized adaptations. Explain that plants like the Venus flytrap can live where soils are very poor in nutrients because they get extra nutrients from organisms such as insects. Tell students they will learn in this lesson about this and other specialized adaptations that allow certain plants to live where conditions are too difficult for most other plants to survive.

<http://www.discovery.com/tv-shows/life/videos/venus-flytrap-catches-flies.htm>

## Cooperative Learning

Use the group activity at the following URL so students can learn more about special adaptations of plants in a range of different biomes. Each group will be assigned a different biome to research. They will identify adaptations of plants in their specific biome and explain how the adaptations help the plants survive. Then groups will share their discoveries.

<http://www.discoveryeducation.com/teachers/free-lesson-plans/unique-plants-of-the-biomes.cfm>

## Activity

In the activity at the URL below, students will learn many ways that people rely on wild plants and then focus on one of the most important "practical" reasons for conserving plants, which is finding new medicines. The activity will conclude with a discussion of why plants produce so many useful medicinal compounds.

[http://www.bgci.org/files/Worldwide/US\\_Files/lesson\\_2how\\_we\\_depend\\_on\\_plants.pdf](http://www.bgci.org/files/Worldwide/US_Files/lesson_2how_we_depend_on_plants.pdf)

## Differentiated Instruction

Help students decipher lesson vocabulary terms as well as learn a useful skill for figuring out the meaning of new words. Tell them the meaning of some of the prefixes and suffixes used in the vocabulary terms. They include *gravi-* (gravity), *photo-* (light), *xero-* (dry), *epi-* (upon), and *-phyte* (plant). Give students examples of other terms with the same prefixes or suffix, such as gravitation, photograph, xeroderma, epidermis, and phytoplankton. Help them use the meanings of the prefixes or suffix to define the terms.

## Enrichment

Students can do a simple experiment to demonstrate another phototropic plant response: light-induced chloroplast movement in leaves. The URL below provides background information and instructions for the experiment. Have the students show their completed project to the class (a leaf with a pale spot caused by placing an object on the leaf to block sunlight). Also ask them to describe how they did the project and to explain how and why this adaptive response occurs.

<http://plantsinmotion.bio.indiana.edu/plantmotion/projects/projects.html>

## Science Inquiry

The science fair project described at the URL below also makes a great classroom inquiry activity. In the project, students will construct a simple device to hold germinating seeds. The device will let them observe how the growing rootlets respond as the device is rotated, which effectively alters the direction of gravity.

[http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/PlantBio\\_p034.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/PlantBio_p034.shtml)

## Overcoming Misconceptions

Students may develop the misconception that tropisms are always positive responses. Tell the class that tropisms may also be negative. For example, gravitropism may be positive or negative. While roots grow toward gravity (positive gravitropism), shoots grow away from gravity (negative gravitropism).

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 10.3 worksheets in *CK-12 MS Life Science Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 10.3 in *CK-12 MS Life Science Workbook*. Answers are provided below.

1. What is a tropism? What are two types of tropisms in plants?
2. How do plants respond to daily and seasonal changes?
3. Define and give examples of xerophytes and epiphytes.
4. Many modern medicines have been discovered in trees and other plants. Why do you think so many disease-fighting compounds are found in plants?
5. Identify two challenges faced by aquatic plants. Explain how they have evolved to adapt to the challenges.
6. Carnivorous plants are classified as producers. Why aren't they classified as consumers?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 10.3 Quiz in *CK-12 MS Life Science Assessments*.

---

## Points to Consider

Like plants, animals are multicellular eukaryotes. However, animals differ from plants in other important ways.

- What are some ways that animals differ from plants?
- The most basic division of plants is between vascular and nonvascular plants. How are animals divided?

## CHAPTER

## 11

## TE MS Introduction to Animals

## Chapter Outline

11.1 WHAT ARE ANIMALS?

11.2 HOW ANIMALS EVOLVED

## Chapter Overview

This chapter introduces basic animal traits, explains how animals are classified, and outlines major events in animal evolution, including evolution of the first vertebrates and the first land animals.

## Online Resources

See the following Web site for an appropriate laboratory activity:

Introduce the Animal Kingdom with the “Animal Kingdom Survey Lab” at the first URL below. Students will visit each of several stations in the classroom to observe and answer questions about animal specimens (either living or preserved). Alternately, students may view the online slides of animals at the second URL. [http://www.biologycorner.com/worksheets/animal\\_kingdom.html](http://www.biologycorner.com/worksheets/animal_kingdom.html) [http://www.biologycorner.com/resources/slideshows/animal\\_kingdom/index.html](http://www.biologycorner.com/resources/slideshows/animal_kingdom/index.html)

These Web sites may also be helpful:

These Web sites are excellent resources for images and information about a diversity of animal species in different phyla of the Animal Kingdom: <http://animaldiversity.ummz.umich.edu/> <http://seaworld.org/en/animal-info/> <http://www.enature.com/home/>

The National Zoo has live Web cams of several of its animals. Go to this URL to find links: <http://nationalzoo.si.edu/Animals/WebCams/>

TABLE 11.1: Lesson Pacing

Lesson	Class Period(s) (60 min)
11.1 What Are Animals?	1.5
11.2 How Animals Evolved	3.0

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## 11.1 What Are Animals?

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### Key Concepts

- Basic animal traits
- Classification of animals

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### Standards

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### Lesson Objectives

- Identify basic traits of animals.
- Outline the classification of animals.

---

### Lesson Vocabulary

- animal: multicellular, heterotrophic eukaryote with specialized cells; member of the Animal Kingdom
- Animal Kingdom: kingdom in the Eukarya Domain that consists of multicellular heterotrophs with specialized cells
- invertebrate: animal that lacks a vertebral column, or backbone
- larva (larvae, plural): distinct juvenile form that many animals go through before becoming an adult
- vertebral column: backbone; defining characteristic of the subphylum of animals called vertebrates
- vertebrate: animal in Phylum Chordata that has a vertebral column, or backbone

---

### Teaching Strategies

#### Introducing the Lesson

Introduce students to the Animal Kingdom by showing them pictures of a diversity of unusual animals, most of which are likely to be unfamiliar to them. The URL below has photos of 22 rare and little known animals that you can use as a slide show. Place the photos in context by telling the class that there are more than a million known animal species living today but many more have yet to be discovered. Add that, of the total number of living animal species, about 90 percent are insects. Tell students they will learn much more about the fascinating diversity of animals when they read this lesson. <http://www.boredpanda.com/strange-animals/>

## Demonstration

You can use the PowerPoint slide show at the following URL as a more detailed introduction to the Animal Kingdom. It introduces basic traits and functions of animals and animal phyla. [https://docs.google.com/presentation/d/1v7K6AyEqImWK1a8Nt\\_8AJH15HKET3Vh9fSymMIA7bbA/present?slide=id.i0](https://docs.google.com/presentation/d/1v7K6AyEqImWK1a8Nt_8AJH15HKET3Vh9fSymMIA7bbA/present?slide=id.i0)

## Discussion

Point out how animal cells differ from plant cells, and show students examples of each type of cell (see URLs below). Discuss how the traits of animal cells allow them to take on different shapes and functions. [http://commons.wikimedia.org/wiki/File:Plant\\_cell#mediaviewer/File:Plant\\_cell\\_structure.png](http://commons.wikimedia.org/wiki/File:Plant_cell#mediaviewer/File:Plant_cell_structure.png) (plant cell) [http://commons.wikimedia.org/wiki/File:Animal\\_cell\\_structure\\_en.svg](http://commons.wikimedia.org/wiki/File:Animal_cell_structure_en.svg) (animal cell)

## Activity

After students read about the classification of animals, have them complete the worksheet activity at the following URL. They will match organisms to phyla and their descriptions. [http://www.biologycorner.com/worksheets/animal\\_matching.html](http://www.biologycorner.com/worksheets/animal_matching.html)

## Differentiated Instruction

Have pairs of students create a Frayer model for the term animal. They should draw a large box and divide it into four parts labeled “Definition,” “Drawing,” “Example,” and “Non-example.” Then they should fill in each part of the box for the term.

## Enrichment

Ask a few creative students to write a song or rap about the Animal Kingdom in which they summarize the traits of animals and how they differ from other organisms. Give them a chance to perform their creation for the class.

## Science Inquiry

Have the class do the inquiry activity at the following URL. In the activity, they will observe the diversity of animal life around their home, school, or a local park, and then try to determine which phylum is most common. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/Zoo\\_p015.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/Zoo_p015.shtml)

## Overcoming Misconceptions

Students typically have a restricted view of organisms that constitute the Animal Kingdom. It is common for young people to think that only vertebrates are animals. Make sure students realize that the majority of animals are invertebrates and that insects are the most common and successful animal species on Earth.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 11.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 11.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are animals?
2. What can animals do that other eukaryotes cannot?
3. Describe a general animal life cycle.
4. Assume you must classify a mystery organism. What questions could you ask about the organism that would help you decide whether it is an animal?
5. Explain why animals can develop specialized cells.
6. Compare and contrast invertebrates and vertebrates.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 11.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The first animal trait to evolve was the presence of multiple cells.

- How do you think this trait might have evolved?
- Why do you think this trait was adaptive?

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## 11.2 How Animals Evolved

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### Key Concepts

- Major events in animal evolution
- Trends in invertebrate evolution
- Evolution of the first vertebrates
- Adaptations that helped animals colonize the land

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### Standards

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### Lesson Objectives

- State when major events in animal evolution occurred.
- Outline major trends in invertebrate evolution.
- Explain how the first vertebrates evolved.
- Identify adaptations that helped animals colonize the land.

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### Lesson Vocabulary

- amniote: animal such as a reptile or bird that produces eggs with waterproof membranes
- aquatic: of or relating to the water, such as an organism that lives in water rather than on land
- chordate: animal with a notochord, post-anal tail, dorsal hollow nerve cord, and pharyngeal slits; animal in Phylum Chordata
- coelom: fluid-filled body cavity found in many invertebrates and all vertebrates that is completely enclosed by mesoderm
- cranium: bony skull that encloses and protects the brain of a vertebrate
- exoskeleton: non-bony skeleton that forms on the outside of the body of many invertebrates including insects and other arthropods
- notochord: rigid rod that runs the length of the body and is a defining trait of animals in Phylum Chordata
- pseudocoelom: partial fluid-filled body cavity not enclosed by mesoderm that is found in some invertebrates such as roundworms
- segmentation: division of an animal's body into multiple parts, or segments
- symmetry: trait of an organism that can be divided into two identical halves; may be radial or bilateral
- terrestrial: of or relating to the land, such as an organism that lives on land rather than in water

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## Teaching Strategies

### Introducing the Lesson

You can introduce the lesson by showing students this short video about the evolution of animals: <http://www.youtube.com/watch?v=dsVWJ7Rm0pA>

### Building Science Skills

Use the worksheet at the following URL to introduce the concepts of radial and bilateral symmetry and give students practice identifying objects and organisms that exhibit each type of symmetry. After students complete the worksheet, lead the class in a discussion of the adaptive nature of symmetry in invertebrates. <http://www.shellysciencespot.com/Worksheets/Animals/Invertebrates/DiscoveringSymmetry.pdf>

### Differentiated Instruction

Pair English language learners and less proficient readers with other students, and ask partners to work together to create a flow chart of invertebrate evolution. Flow charts should include the main trends in invertebrate evolution in the correct sequence.

### Enrichment

Suggest that interested students learn more about how the first vertebrates may have colonized the land. The article and video at the following URL describe recent research on colonization of the land by air-breathing fish. <http://www.livescience.com/47582-unusual-fish-bichir-animal-evolution.html>

### Science Inquiry

The inquiry investigation at the URL below is an excellent chance for students to interface with research being conducted by scientists and design their own investigations using samples produced in a research laboratory. In the activity, students will examine the changes in leg bones of mice that have been artificially selected in the laboratory for high levels of wheel running. This will help students understand how animals may have been selected for life on land. Students will develop their own hypotheses and measurement protocols, collect data, and have the opportunity to compare their results with those published in the scientific literature by the original researchers. <http://www.indiana.edu/~ensiweb/lessons/BornToRun.html>

### Overcoming Misconceptions

This is a good point in the course for reviewing common misconceptions about evolution and explaining why they are false. This URL is a good source for relevant misconceptions and explanations: <http://evolution.berkeley.edu/evosite/misconcepts/VIQuiz.shtml>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 11.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 11.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. When did the first animals evolve?
2. List five important animal traits that evolved in invertebrates.
3. What are chordates?
4. How did vertebrates evolve?
5. Assume that animals remained aquatic organisms and never colonized the land. Which animal traits do you think might not have evolved?
6. Compare and contrast radial and bilateral symmetry.
7. Explain why having a segmented body is adaptive.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 11.2 Quiz in CK-12 MS Life Science Assessments.

### Points to Consider

Some of the earliest animals evolved multiple, specialized cells. However, they lacked other animal traits, such as tissues. These traits evolved later.

- What modern animals are like early animals, with specialized cells but not tissues?
- Where do these modern animals live?

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# CHAPTER 12 TE MS Other Invertebrates

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## Chapter Outline

- 12.1 SPONGES AND CNIDARIANS**
  - 12.2 FLATWORMS AND ROUNDWORMS**
  - 12.3 MOLLUSKS AND ANNELIDS**
  - 12.4 INSECTS AND OTHER ARTHROPODS**
  - 12.5 ECHINODERMS AND INVERTEBRATE CHORDATES**
- 

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## Chapter Overview

This chapter describes the structure, function, reproduction, and ecology of major invertebrate phyla, including sponges, cnidarians, flatworms, roundworms, mollusks, annelids, arthropods, echinoderms, and invertebrate chordates.

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## Online Resources

See the following Web sites for appropriate laboratory activities:

Use the lab at the URL below to give students opportunities to observe flatworms and roundworms under a microscope. [http://biologycorner.com/worksheets/simple\\_worms\\_lab.html](http://biologycorner.com/worksheets/simple_worms_lab.html)

Garden snails make excellent research subjects for classroom investigations of mollusks. You can find information for keeping and using snails in the classroom at the following URL. The Web page has suggestions for detailed observations of snails and ideas for developing and testing hypotheses about them. [http://www.accessexcellence.org/AE/AEC/AEF/1994/liu\\_snails.php](http://www.accessexcellence.org/AE/AEC/AEF/1994/liu_snails.php)

The URL below is a lab for the dissection of an earthworm. The document includes materials, procedure, questions, and space for students to record their observations. <http://www.shellysscience.com/Worksheets/Animals/Invertebrates/EarthwormDissectionLab.pdf>

The following URL is a mollusk lab in which students will investigate the main classes of mollusks. They will identify the unique characteristics of the classes; describe how they are adapted to meet their needs; use a taxonomic key to identify and classify different kinds of mollusks; and report on the behavior and anatomy of a representative mollusk specimen, the eastern mud snail. [http://mathinscience.info/public/meet\\_mollusks/meet\\_the\\_mollusks.htm](http://mathinscience.info/public/meet_mollusks/meet_the_mollusks.htm)

These Web sites may also be helpful:

Students can explore the world of sponges with the video at this URL: [http://www.youtube.com/watch?v=m8a0oNsDEx8&feature=player\\_embedded](http://www.youtube.com/watch?v=m8a0oNsDEx8&feature=player_embedded)

Go to this URL for a collection of useful entomological resources for middle school students: <http://www.uky.edu/A/g/CritterFiles/casefile/bugconnection/teaching/teaching.htm>

You and/or your students can read in greater detail about the different taxonomic groups of echinoderms at this URL: <http://animals.about.com/od/echinoderms/p/echinoderms.htm>

After students have studied all the invertebrate phyla in this chapter, you can use the invertebrate classification challenge activity at the following URL to reinforce their knowledge. A PowerPoint presentation is also provided to introduce the activity. In addition, there is a quiz to check their comprehension. <http://sciencespot.net/Pages/classbio.html#invert>

Use these award-winning videos in your classroom to give students a first-hand look at the invertebrate phyla covered in this chapter: <http://www.shapeoflife.org/video/sponges-origins> <http://www.shapeoflife.org/video/cnidarians-life-move> <http://www.shapeoflife.org/video/flatworms-first-hunter> <http://www.shapeoflife.org/video/annelids-powerful-and-capable-worms> <http://www.shapeoflife.org/video/marine-arthropods-successful-design> <http://www.shapeoflife.org/video/terrestrial-arthropods-conquerors> <http://www.shapeoflife.org/video/molluscs-survival-game> <http://www.shapeoflife.org/video/echinoderms-ultimate-animal>

You can find links to a large collection of student activities relating to corals and coral reefs at this URL: [http://coralreef.noaa.gov/education/educators/resourcecd/activities/resources/middle\\_school\\_sa.pdf](http://coralreef.noaa.gov/education/educators/resourcecd/activities/resources/middle_school_sa.pdf)

**TABLE 12.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
12.1 Sponges and Cnidarians	2.0
12.2 Flatworms and Roundworms	1.5
12.3 Mollusks and Annelids	1.5
12.4 Insects and Other Arthropods	2.5
12.5 Echinoderms and Invertebrate Chordates	1.0

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## 12.1 Sponges and Cnidarians

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### Key Concepts

- Structure and function of sponges
- Cnidarian adaptations, reproduction, and ecology

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### Standards

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### Lesson Objectives

- Describe the structure and function of sponges.
- Outline cnidarian adaptations, reproduction, and ecology.

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### Lesson Vocabulary

- bioluminescence: production of light by a living organism through biochemical means
- cnidarian: aquatic invertebrate such as a jellyfish or coral in Phylum Cnidaria
- coral: aquatic invertebrate in Phylum Cnidaria that lives in a large colony in shallow ocean water and may build a reef
- coral reef: hard, mineralized underwater structure that is built by coral animals as an exoskeleton and provides a habitat for many other ocean organisms
- endoskeleton: internal skeleton of cartilage and bone that supports and protects the body of vertebrates
- jellyfish: aquatic invertebrate in Phylum Cnidaria that lives virtually anywhere in the ocean and is typically a predator
- medusa (medusae, plural): one of two cnidarian body forms (the other is the polyp), in which the animal is bell shaped and typically able to move
- polyp: one of two cnidarian body forms (the other is the medusa), in which the animal is tubular and usually attached to a surface and unable to move
- sponge: simple aquatic invertebrate in Phylum Porifera, which lives attached to surfaces and filters food from the water

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## Teaching Strategies

### Introducing the Lesson

Bring a dried sea sponge to class, and have students pass it around and examine it. Call on volunteers to describe the sponge and explain what it is. If necessary, identify it as a marine sponge and say that it is the simplest type of animal. Challenge students identify any characteristics of the sponge that would lead them to classify it as an animal. Conclude by telling students will learn about the sponge phylum in this lesson.

### Demonstration

The URL below is a slide presentation on sponges and cnidarians. It includes basic information about each phylum and many colorful images of animals in each taxon. It is a good way to illustrate classroom discussions of these phyla. [https://docs.google.com/presentation/d/1bpD7zZZFipgFP3QI\\_2votVscUQ0-dvJSJbmV0JIZhQ8/present?slide=id.i0](https://docs.google.com/presentation/d/1bpD7zZZFipgFP3QI_2votVscUQ0-dvJSJbmV0JIZhQ8/present?slide=id.i0)

### Demonstration

Use the short video at the following URL to demonstrate to students how sponges filter water for food. <http://www.youtube.com/watch?v=T7E1rq7zHLc>

### Activity

Hand out copies of the sponge anatomy worksheet at the URL below, and have pairs of students work together to label the structures. <http://www.biologycorner.com/worksheets/sponge-anatomy.html>

### Differentiated Instruction

Assign less proficient readers the cnidarian article at the following URL. After they read the article, have them complete the questions at the end, which require them to locate pertinent information in the reading. From the assignment, they will learn about cnidarians and also improve their reading skills. <http://www.biologycorner.com/worksheets/articles/hydra.html>

### Enrichment

Challenge a few students to identify and explain to the class some of the many scientific inaccuracies about sponges in the cartoon show “SpongeBob SquarePants.” Suggest that they watch this short video for a few ideas: <http://www.youtube.com/watch?v=NFy3gHWF5oo>

### Science Inquiry

At the first URL below, you can access a hydra microscope activity, which allows students to observe preserved and living hydra. The second URL is a short video of a living hydra as viewed under a microscope that you can use instead of living hydra on a slide. In the activity, students will observe and interpret hydra behavior. <http://www.biologycorner.com/worksheets/hydra.html> <http://www.schooltube.com/video/8b4ca7db15144b83b7c6/Hydra>

## Overcoming Misconceptions

Misconceptions about jellyfish abound. One of the most common is that they are fish. Have students read the article below to learn more about jellies and some of the misunderstandings about them. <http://aquaviews.net/explore-the-blue/truth-misunderstood-jellyfish/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 12.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 12.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Describe the ability of sponges and cnidarians to move.
2. Identify specialized cells in sponges, and state their functions.
3. What is a nematocyst? What is its role?
4. Besides cnidarians, many other ocean organisms are bioluminescent. What is bioluminescence? Why do you think it is relatively common in ocean organisms such as cnidarians?
5. Compare and contrast the medusa and polyp forms of cnidarians, including how they reproduce.
6. Explain why coral reefs are found only in shallow water.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 12.1 Quiz in CK-12 MS Life Science Assessments.

---

## Points to Consider

Cnidarians such as jellyfish have radial symmetry. Flatworms and roundworms, which you will read about next, have bilateral symmetry.

- What did flatworms and roundworms need to evolve first in order to develop bilateral symmetry?
- Why is bilateral symmetry adaptive?

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## 12.2 Flatworms and Roundworms

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### Key Concepts

- Flatworm adaptations, reproduction, and ecology
  - Roundworm traits, reproduction, and ecology
- 

### Standards

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### Lesson Objectives

- Describe flatworm adaptations, reproduction, and ecology.
  - Outline roundworm traits, and explain how roundworms reproduce and “make a living.”
- 

### Lesson Vocabulary

- flatworm: invertebrate in Phylum Platyhelminthes, such as a tapeworm, which has three embryonic cell layers and bilateral symmetry but lacks a pseudocoelom
  - roundworm: invertebrate in Phylum Nematoda, such as a hookworm, which has a pseudocoelom and a complete digestive system
- 

### Teaching Strategies

#### Introducing the Lesson

The slide shows at the following URLs are good visual introductions to flatworms and roundworms. [http://docs.google.com/present/view?id=dfh23k67\\_1500grndh3c5](http://docs.google.com/present/view?id=dfh23k67_1500grndh3c5) [http://docs.google.com/present/view?id=dfh23k67\\_1520cfq8qrer](http://docs.google.com/present/view?id=dfh23k67_1520cfq8qrer)

#### Discussion

Discuss the trends in invertebrate evolution that are represented by flatworms and roundworms. Make a table on the board or an overhead to compare and contrast cnidarians, flatworms, and roundworms. Call on students to add items to the table and explain their evolutionary significance. For example, students might compare and contrast cell layers in the three taxa (cnidarians have just two cell layers, compared with three in flatworms and three in roundworms). They might explain that having a third cell layer (mesoderm) allows flatworms and roundworms to develop muscle tissues for movement.

### Differentiated Instruction

Have less proficient readers read the flatworm article at the URL below and then answer the questions at the end of the article. The reading exercise will increase their knowledge of flatworms and give them a chance to practice reading skills. <http://www.biologycorner.com/worksheets/articles/planarian.html>

### Enrichment

Students interested in history may enjoy reading about recently discovered evidence that King Richard III of England was riddled with parasitic roundworms when he was killed in battle in 1485. The articles below summarize the evidence and how it was gathered and interpreted. Ask students to share the information with the class and what it reveals about this important historical character and the times in which he lived. <http://www.livescience.com/39392-king-richard-iii-roundworm-infection.html> [http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(13\)61757-2/fulltext](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)61757-2/fulltext)

### Science Inquiry

With the flatworm inquiry activity at the following URL, students will observe and design an experiment about planarians. <http://www.biologycorner.com/worksheets/planarian.html>

### Science Inquiry

In the inquiry activity at the URL below, students will investigate how long it takes for planaria cut in different places to regenerate a head. <http://www.hhmi.org/biointeractive/classroom-activities-planaria-regeneration-activity>

### Health Connection

Parasitic flatworms and roundworms cause a great deal of human illness and suffering. The slides at the following URL show some of the worms that commonly parasitize human hosts. Show the slides to your class and use the accompanying text to explain how each type of worm causes disease and its significance as a public health threat. <http://www.scientificamerican.com/slideshow/worms-human-parasites/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 12.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 12.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Describe reproduction in flatworms.
2. Outline the life cycle of a parasitic tapeworm.
3. Identify the phylum of roundworms.

4. Explain why going barefoot outside might increase the risk of hookworm infection in people.
5. Explain why flatworms are flat and roundworms are round.
6. Explain the role of roundworms in the carbon cycle.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 12.2 Quiz in CK-12 MS Life Science Assessments.

### Points to Consider

In the next lesson, you'll read about worms called annelids. Mollusks such as snails are also described in the next lesson.

- How do you think annelids might be different from flatworms and roundworms?
- Why do you think annelids are placed in a lesson with mollusks instead of with flatworms and roundworms?

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## 12.3 Mollusks and Annelids

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### Key Concepts

- Mollusk traits, reproduction, and ecology
- Annelid adaptations, reproduction, and ecology

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### Standards

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### Lesson Objectives

- Outline the traits, reproduction, and ecology of mollusks.
- Describe annelid segmentation, organ systems, reproduction, and feeding strategies.

---

### Lesson Vocabulary

- annelid: segmented worm, such as an earthworm, in Phylum Annelida
- mollusk: invertebrate, such as a snail, in Phylum Mollusca that generally has a shell, head, and foot

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### Teaching Strategies

#### Introducing the Lesson

Show the class pictures of segmented worms and roundworms, such as the images below, and challenge students to identify how the two types of worms differ. Tell students they will learn about segmented worms such as these—and why segmentation is adaptive—when they read this lesson. Roundworms: [http://commons.wikimedia.org/wiki/File:Ascaris-suum.jpg?fastcgi\\_from=5138619](http://commons.wikimedia.org/wiki/File:Ascaris-suum.jpg?fastcgi_from=5138619) [http://commons.wikimedia.org/wiki/File:Ascaris\\_lumbricoides.jpeg?fastcgi\\_from=5138619](http://commons.wikimedia.org/wiki/File:Ascaris_lumbricoides.jpeg?fastcgi_from=5138619) Segmented worms: <http://commons.wikimedia.org/wiki/File:Regenwurm1.jpg> [http://commons.wikimedia.org/wiki/File:Eisenia\\_foetida\\_R.H.\\_\(11\).JPG](http://commons.wikimedia.org/wiki/File:Eisenia_foetida_R.H._(11).JPG)

#### Using Visuals

When you teach students about mollusks, you can use the colorful slide show at the following URL to illustrate the lesson. [https://docs.google.com/presentation/d/13SviYIYFS\\_wfJLEo7dCeQkbSYEeF1NuhGUAiLXmBxYM/present?slide=id.i0](https://docs.google.com/presentation/d/13SviYIYFS_wfJLEo7dCeQkbSYEeF1NuhGUAiLXmBxYM/present?slide=id.i0)

### Activity

The mollusk lesson plan at the URL below offers a variety of activities to introduce your class to mollusks and their characteristics. <http://www.oocities.org/sseagraves/mollusks.htm>

### Building Science Skills

Students can grow red worms in the classroom and use them to build observational and other science skills. Tips for growing the worms and ideas for classroom activities with them can be found at these URLs: <http://www.calrecycle.ca.gov/Education/curriculum/worms/98activities.pdf> <http://compost.css.cornell.edu/worms/basics.html> [http://www.dec.ny.gov/docs/materials\\_minerals\\_pdf/rw.pdf](http://www.dec.ny.gov/docs/materials_minerals_pdf/rw.pdf)

### Differentiated Instruction

Pair students of differing ability levels, and ask partners to make two cluster diagrams organizing lesson concepts. One cluster diagram should organize the information on mollusks and one should organize the information on annelids.

### Enrichment

Ask a few interested students to research and present to the class human uses of mollusks. Their presentation might take the form of a PowerPoint show, poster, or bulletin board display. Suggest that students start their research at the following URLs. [http://www.manandmollusc.net/advanced\\_uses/advanced\\_uses-print.html](http://www.manandmollusc.net/advanced_uses/advanced_uses-print.html) <http://www.molluskman.com/Malacology.html>

### Science Inquiry

With the inquiry activity at the following URLs, students will compare the external anatomy and locomotion of earthworms, mealworms, crickets and crayfish (all of which can be purchased at low cost from a pet store). The discussion questions provided will help students understand the evolutionary basis of observed similarities and differences. This activity can be used as an introduction to the annelids and arthropods in the next lesson and the important biological principle that form matches function. (teacher notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/InvertDiversityTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/InvertDiversityTeachPrep.pdf) (teacher notes) (student handout) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/InvertDiversityProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/InvertDiversityProtocol.pdf) (student handout)

### Overcoming Misconceptions

There are many common misconceptions about annelids. For example, because of their familiarity with earthworms, students may think that most or all segmented worms live in the soil. In fact, many annelids are aquatic. Some are marine organisms, some live in fresh water, and some live in sediments at the bottom of the water. Students may also think that annelids bite, which is impossible because they lack jaws and teeth, or that they carry diseases, which is also not true.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 12.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 12.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Give examples of mollusks.
2. What are some mollusk traits?
3. Describe how annelids feed.
4. Earthworms are often added to compost bins. Explain why.
5. Compare and contrast mollusks and annelids.
6. Explain why annelid segmentation is adaptive.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 12.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The majority of mollusks and annelids live in the water or inside hosts. Arthropods are invertebrates that include insects. The majority of arthropods live on land.

- What special challenges might arthropods face on land?
- What adaptations might they have evolved to meet these challenges?

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## 12.4 Insects and Other Arthropods

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### Key Concepts

- Arthropod characteristics and life cycles
- Insect traits and adaptations

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### Standards

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### Lesson Objectives

- Describe arthropod characteristics and life cycles.
- Identify special traits of insects, and explain why they have been so successful.

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### Lesson Vocabulary

- arthropod: invertebrate in Phylum Arthropoda, which includes insects, spiders, centipedes, and lobsters
- cocoon: special container built by an arthropod inside of which the pupa stage of the animal undergoes metamorphosis to change into the adult form
- incomplete metamorphosis: type of life cycle in arthropods in which newly hatched offspring look like small adults and do not go through distinct larval stages before adulthood
- insect: arthropod in Class Insecta that has three body segments, six jointed legs, and multiple head appendages
- metamorphosis: process in which arthropods and many other animals change from a distinct larval form into the adult form
- molting: process in which an animal such as an insect sheds its outgrown exoskeleton
- pupa: life stage of an arthropod when it is undergoing metamorphosis and changing from the larval to the adult form, often inside a cocoon

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### Teaching Strategies

#### Introducing the Lesson

Show students a collage of photos representing a diversity of arthropods. The URLs below are good examples. Call on volunteers to point out any similarities they observe in the different animals. Then tell students that all of the animals belong to the same phylum, Phylum Arthropoda, which they will learn about in this lesson. <http://upload.wikimedia.org/wikipedia/commons/8/80/Arthropoda.jpg> <https://classconnection.s3.amazonaws.com/994/flashcards/404994/jpg/arthropods1317485309807.jpg> <http://www.anonymousphilanthropist.com/jots/arthropods.jpg>

## Building Science Skills

Students can build science skills while learning about spiders with the “Great Spider Debate” at the following URL. In the activity, students will learn about the hunting and survival adaptations of several different types of spiders and learn how spiders are classified. They will also undertake a search for spiders indoors and out and record the numbers and types of spiders they find. <http://www.uky.edu/Ag/CritterFiles/casefile/bugconnection/teaching/Spider%20Debate%206-8.pdf>

## Differentiated Instruction

Download one or more of the insect worksheets at the URL below, and have students complete them. The worksheets include insect labeling activities and a reading comprehension exercise. <http://www.havefunteaching.com/worksheets/science-worksheets/insect-worksheets>

## Enrichment

Challenge a small group of creative students to invent an insect for a specific habitat and niche. Their insect should have the correct features for its class as well as specific adaptations for its habitat and niche. A sample activity is provided at the URL below. Give students a chance to share their creation in a class presentation. Encourage other students to ask the presenters questions about the insect. <http://www.slsc.org/blog-invent-an-insect>

## Science Inquiry

Students can investigate how temperature affects the development of insects with the inquiry activity at the URL below. Students will develop and test a hypothesis in order to answer the research question. <http://www.entfdn.org/documents/EffectsofTemperatureonRateofDevelopment.pdf>

## Science Inquiry

With the inquiry activity described at the following URL, groups of students will collect and examine insects to develop a better appreciation of the diversity and adaptations of living organisms. Students will take an overnight field trip to school in order to get a field experience. Using fluorescent lights and capture containers, they will attract and collect at least eight different specimens. They will examine the specimens to learn about their diversity and adaptations, and then they will try to classify them. [http://www.accessexcellence.org/AE/AEC/AEF/1996/habeeb\\_trip.php](http://www.accessexcellence.org/AE/AEC/AEF/1996/habeeb_trip.php)

## Overcoming Misconceptions

There are many common misconceptions about insects. You can find several at the following URL. For each misconception cited, a correct explanation is provided. Share the information to your students, or give them copies of the article to read as a homework assignment. [http://www.umass.edu/ent/BugNetMAP/r\\_misconcept.html](http://www.umass.edu/ent/BugNetMAP/r_misconcept.html)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 12.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 12.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. List five traits of arthropods.
2. Describe the arthropod exoskeleton and its functions.
3. Identify types of appendages you might see on an insect.
4. It might be said of insects that we can't live with them or without them. Do you agree or disagree? Apply lesson concepts to explain why.
5. Why are distinctive life stages and metamorphosis adaptive?
6. Explain the significance of flight in insects.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 12.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

One species in a mystery phylum is called a starfish, but it's not a fish. Another species in the same phylum is called a sea cucumber, but it's not a plant.

- Which phylum includes both starfish and sea cucumbers?
- What are some traits of organisms in this phylum?

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## 12.5 Echinoderms and Invertebrate Chordates

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### Key Concepts

- Echinoderm traits and reproduction
- Definition of chordates and chordate traits
- Traits of invertebrate chordates

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### Standards

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### Lesson Objectives

- Describe echinoderms, their traits, and their reproduction.
- Define chordates and list chordate traits.
- Identify invertebrate chordates and their traits.

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### Lesson Vocabulary

- echinoderm: ocean-dwelling invertebrate in Phylum Echinodermata, such as the sea star, sea urchin, or sand dollar
- lancelet: aquatic invertebrate in Phylum Chordata that retains the four defining traits of chordates into adulthood
- tunicate: aquatic invertebrate in Phylum Chordata that loses some of the four defining chordate traits by adulthood; commonly called a sea squirt

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### Teaching Strategies

#### Introducing the Lesson

Pique students' interest in learning about echinoderms by sharing fascinating facts about them, such as their ability to regenerate arms. For additional ideas, go to these URLs: [http://w3.shorecrest.org/~Lisa\\_Peck/MarineBio/syllabus/ch7invertebrates/Invertwp/2007/tj/cool.html](http://w3.shorecrest.org/~Lisa_Peck/MarineBio/syllabus/ch7invertebrates/Invertwp/2007/tj/cool.html) <http://aquaviews.net/explore-the-blue/5-cool-facts-echinoderms/>

#### Discussion

Use the interesting video at the first URL as the basis for a discussion of the perennially popular sea star, which you can use as a model echinoderm. The second URL is a study guide to use with the video. It includes pre- and

post-viewing discussion questions. <http://www.blueworldtv.com/webisodes/watch/sea-stars> [http://www.blueworldtv.com/images/uploads/study-guides/Blue\\_World\\_Study\\_Guide\\_S2\\_E14.pdf](http://www.blueworldtv.com/images/uploads/study-guides/Blue_World_Study_Guide_S2_E14.pdf)

### Cooperative Learning

Students can learn about the evolution of echinoderms with a cooperative learning activity. Have groups of students complete the worksheet at the first URL after they watch the amazing echinoderm video at the second URL. Encourage students within each group to discuss the worksheet questions and answer them as a group. <http://www.shapeoflife.org/sites/default/files/lesson-plans/Evolution-Echinoderms.pdf> <http://www.shapeoflife.org/video/echinoderms-ultimate-animal>

### Activity

Suggest that students use this interactive online quiz to test their knowledge of echinoderms: [http://www.biology4kids.com/extras/quiz\\_invertechino/index.html](http://www.biology4kids.com/extras/quiz_invertechino/index.html)

### Differentiated Instruction

Have students look at photos of echinoderms in the Flexbook lesson. Then have them do a KWL chart for this phylum of invertebrates. Students should fill in the K (Know) and W (Want to Know) columns of the chart before they read the lesson. Then they should complete the L (Learned) column of the chart after they read the lesson. Ask them if there is anything they wanted to know but didn't learn. If there is, help them find the information.

### Enrichment

Students can complete this echinoderm crossword puzzle for an extra challenge: [http://www.science-teachers.com/life/echinoderm\\_crossword.doc](http://www.science-teachers.com/life/echinoderm_crossword.doc)

### Enrichment

For students who want to learn more about tunicates, this beautifully illustrated article is highly recommended: <http://www.mesa.edu.au/tunicates/>

### Science Inquiry

Challenge students to learn about the traits that distinguish the major classes of echinoderms. The URL below is a good place to start. Then give each of several groups of students two unlabeled photos or preserved specimens of echinoderms from different taxa. Challenge the groups to correctly classify their assigned specimens. Have a representative of each group show the specimens to the class and explain how the group classified them. Call on other students to explain why any misclassifications are incorrect. <http://www.mbgnet.net/salt/coral/animals/echinod.htm>

### Real-World Connection

Introduce the problem of invasive species with the real-world example of invasive tunicates. The URLs below provide basic information about the problem for you and/or your students. The first URL includes links to videos that document the extent of the problem on both the East and West Coasts of the U.S. Discuss with the class the economic and ecological impact of the tunicate invasion and what can be done to help control it. <http://seagrant.oreg>

[onstate.edu/invasive-species/wise/news/tunicates](http://onstate.edu/invasive-species/wise/news/tunicates) <http://www.invasivespecies.wa.gov/priorities/tunicates.shtml> <http://wdfw.wa.gov/ais/tunicates.html>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 12.5 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 12.5 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are echinoderms?
2. List the four defining traits of chordates.
3. How do echinoderms use their tube feet?
4. Sea tulips and sea daisies are both invertebrates that live on the ocean floor. Sea tulips live along coasts at a maximum depth of about 80 meters. Sea daisies live in the deepest ocean. One of these two invertebrates is a tunicate and the other is an echinoderm. Which animal should be classified in each taxon? Explain your answer.
5. Echinoderm adults have radial symmetry. What evidence shows that they evolved from an ancestor with bilateral symmetry?
6. Explain what distinguishes vertebrate chordates from invertebrate chordates.
7. Compare and contrast tunicates and lancelets.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 12.5 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Other than tunicates and lancelets, all chordates are vertebrates.

- What are some examples of modern vertebrates?
- Besides having a backbone, how do you think vertebrates might differ from invertebrates?

# CHAPTER 13 THE MS Fishes, Amphibians, and Reptiles

## Chapter Outline

- 13.1 INTRODUCTION TO VERTEBRATES
- 13.2 FISH
- 13.3 AMPHIBIANS
- 13.4 REPTILES

## Chapter Overview

This chapter introduces vertebrates, including their reproduction, classification, and evolution. It also describes specific traits and ecology of fish, amphibians, and reptiles.

## Online Resources

See the following Web sites for appropriate laboratory activities:

In the fish diversity lab at the URL below, students will explore fish habitats, adaptations, and diversity. They will also investigate fish morphology, defense strategies, general characteristics, and ecosystems. <http://marinediscovery.arizona.edu/lessonsS01/andreas/2.html>

You can find a classic frog dissection lab at the first URL. For a virtual frog dissection, go to the second URL. <http://www.shellyssciencepot.com/Worksheets/Animals/Vertebrates/FrogDissection.pdf> <http://www.froguts.com/>

These Web sites may also be helpful:

This Web site includes a diversity of resources on fish, from virtual fish dissections to underwater movies of fish. <http://australianmuseum.net.au/fishes/>

At the following URL, you can find links to many Web sites and online videos about amphibians. <http://www.nhptv.org/kn/vs/scilab6fa4f.asp>

This URL has several links to videos on reptiles that are suitable for the middle school science classroom: <http://www.neok12.com/Reptiles.htm>

You can find wonderful National Geographic videos on fish, amphibians, and reptiles at these URLs: <http://video.nationalgeographic.com/video/animals/fish> <http://video.nationalgeographic.com/video/animals/amphibians> <http://video.nationalgeographic.com/video/animals/reptiles>

**TABLE 13.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
13.1 Introduction to Vertebrates	2.0
13.2 Fish	2.0

**TABLE 13.1:** (continued)

Lesson	Class Period(s) (60 min)
13.3 Amphibians	2.0
13.4 Reptiles	2.0

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## 13.1 Introduction to Vertebrates

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### Key Concepts

- Vertebrate traits
- Vertebrate reproductive strategies
- Classification of vertebrates
- Vertebrate evolution

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### Standards

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### Lesson Objectives

- Describe traits of vertebrates.
- Identify three reproductive strategies of vertebrates.
- Explain how vertebrates are classified.
- Outline the evolution of vertebrates.

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### Lesson Vocabulary

- bone: hard tissue consisting of the protein collagen and minerals such as calcium that generally makes up most of the vertebrate endoskeleton
- cartilage: tough, flexible tissue containing the protein collagen that makes up some or all of the endoskeleton of a vertebrate
- ectothermy: controlling body temperature to a limited extent from outside the body by changing behavior
- endothermy: controlling body temperature within a narrow range from inside the body through biological means
- ovipary: development of an embryo within an egg outside the mother's body
- ovovivipary: development of an embryo within an egg inside the mother's body but without the embryo receiving any nourishment from the mother
- vertebra (vertebrae, plural): one of the repeating units of bone that make up the vertebral column (backbone) of a vertebrate
- vivipary: development and nourishment of an embryo within the mother's body and not inside an egg

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## Teaching Strategies

### Introducing the Lesson

Show students the amusing video at the URL below to introduce the basic distinguishing features of the vertebrate classes. <http://www.youtube.com/watch?v=CBJLdVdAN9Y>

### Activity

When students study vertebrate classification, you can use the vertebrate classification challenge activity at the following URL to reinforce their knowledge. A PowerPoint presentation is also provided to introduce the activity. In addition, there is a quiz to check their comprehension. <http://sciencespot.net/Pages/classbio.html#invert>

### Activity

Students can play an animal classification game at the URL below. It will require them to apply the basic defining characteristics of living vertebrate classes. <http://www.sheppardsoftware.com/content/animals/kidscorner/games/animalclassgame.htm>

### Building Science Skills

The lesson plans in the National Park Service's "Hoofin' It!" unit will help students learn the basics of animal classification and wildlife ecology. Lesson three focuses on distinctions between types of vertebrates using a series of vertebrate mystery stories. After completing the lesson, students will be able to define vertebrate and describe characteristics of all five groups of vertebrates. <http://www.nps.gov/noat/forteachers/classrooms/hoof-3.htm>

### Activity

With the vertebrate Web quest at the following URL, students will undertake guided Internet research about vertebrates in general and about a specific vertebrate in particular in order to create a "wanted" poster for their vertebrate. <http://zunal.com/webquest.php?w=32145>

### Differentiated Instruction

Pair English language learners with other students and have partners work together to create a cluster diagram for vertebrates. In their diagram, they should include a definition of vertebrate, types and examples of vertebrates, traits of vertebrates, and vertebrate reproduction.

### Enrichment

Ask a few students to create a poster or PowerPoint show to illustrate the three reproductive strategies of vertebrates. They should include photos of animals that have each reproductive strategy and a detailed explanation of how each animal reproduces.

## Science Inquiry

In the exploration activity at the URL below, groups of students will select a vertebrate and research how the structure of its body parts influences the way those parts function. They will also research their vertebrate's habitat to discover the biotic and abiotic factors that might affect its ability to survive. Each group will share their findings in a presentation to the class. [http://www.ssec.si.edu/Media/SSEC/Science-How/Vertebrate\\_SG.pdf](http://www.ssec.si.edu/Media/SSEC/Science-How/Vertebrate_SG.pdf)

## Overcoming Misconceptions

Be aware of common vertebrate misconceptions that students may hold. For example, many studies have shown that students are likely to correctly identify mammals and birds as vertebrates but often fail to classify amphibians and reptiles as vertebrates or even as animals. They may think that vertebrates such as snakes and fish are invertebrates because they lack external segmentation and limbs. Certain invertebrates, such as grasshoppers, on the other hand, may be misclassified as vertebrates because they have segmentation and appendages. Students also frequently classify amphibians as reptiles and vice versa.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 13.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 13.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What traits set vertebrates apart from invertebrate chordates?
2. Describe how living vertebrates are classified.
3. Outline vertebrate evolution.
4. What can you do as an endotherm that you could not do if you were an ectotherm?
5. Compare and contrast the three reproductive strategies of vertebrates.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 13.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Fish were the first vertebrates to evolve. The earliest fish lived in the water, and modern fish are still aquatic.

- What are some examples of modern fish?
- What traits do you think fish have that adapt them for life in the water?

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## 13.2 Fish

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### Key Concepts

- Traits of fish
- Fish reproduction
- Classification of fish
- Fish ecology

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### Standards

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### Lesson Objectives

- Identify traits of fish.
- Explain how fish reproduce.
- Outline the classification of fish.
- Describe where fish live and what they eat.

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### Lesson Vocabulary

- fin: projection from the body of a fish that helps it swim by acting as a paddle or rudder
- fish: aquatic, ectothermic vertebrate that is covered with scales and has gills to absorb oxygen from water
- gill: organ in fish and some other aquatic organisms that absorbs oxygen from water
- spawning: gathering of adult fish in the same place at the same time to release gametes into the water for reproduction
- swim bladder: balloon-like organ in many fish that can be inflated or deflated so the fish can rise or sink in the water

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### Teaching Strategies

#### Introducing the Lesson

Share these amazing fish facts with students to engender interest in learning more about fish:

- The world's largest fish, the great whale shark, grows to more than 15 meters (65 feet) in length and 10 tons in weight. It is bigger than the average school bus!

- The world's smallest fish, *Paedocypris progenetica*, is only 7.9 millimeters (0.3 inches) in length and is transparent.
- The fish with the longest lifespan is the roughey rockfish, which may live to be more than 200 years old.
- The fastest fish in the world are sailfish and wahoo, which can swim faster than 90 kph (about 56 mph).
- Seahorses are the slowest fish in the world. The slowest species swims at a speed of just 0.0016 kph (0.001 mph).

### Building Science Skills

Students can build their observation and classification skills while learning more about fish with the fish classification activity at this URL: [http://www.pbs.org/wgbh/nova/education/activities/2215\\_reef.html](http://www.pbs.org/wgbh/nova/education/activities/2215_reef.html)

### Cooperative Learning

The activity at the URL below is a hands-on, team-oriented activity that uses scenarios for students to discover, through guided inquiry, the importance of sustainability of fish. [http://eir.ca/pdf/eir\\_activities-105%20GOFishSustainability.pdf](http://eir.ca/pdf/eir_activities-105%20GOFishSustainability.pdf)

### Differentiated Instruction

Activity 2-3 at the following URL is a good way for visual and English language learners to learn general fish anatomy. Students are provided with a worksheet and asked to label the main parts of a fish. An answer key and student fish anatomy fact sheet are also provided. The anatomy fact sheet will help students understand how variation in fish anatomy is correlated with where and how fish live. <http://www.marine.usf.edu/pjoc/packets/f99/f99u21e2.pdf>

### Enrichment

Challenge interested students to learn about careers in fish biology, marine biology, or fish and wildlife conservation. They can start with the URLs below. If possible, arrange for them to interview a professional in one of these fields. Contact a state conservation department or fishery for possible professionals to interview. Ask students to create a brochure or Web page to share what they learn with the rest of the class. [http://education-portal.com/articles/Become\\_a\\_Fish\\_Biologist\\_Education\\_and\\_Career\\_Roadmap.html](http://education-portal.com/articles/Become_a_Fish_Biologist_Education_and_Career_Roadmap.html) <http://oceanexplorer.noaa.gov/edu/oceanage/05auster/welcome.html>

### Science Inquiry

Students can design and conduct research to discover firsthand what types of fish is being sold in their community, where the fish come from, and whether the fish are overfished species. This lesson gives students a chance to do their own research, introduces fish as an important food source, and leads students to develop knowledge about using fish sustainably. [http://ocean.si.edu/sites/default/files/lesson\\_plans/admin/Know\\_the\\_Fish\\_WETA.pdf](http://ocean.si.edu/sites/default/files/lesson_plans/admin/Know_the_Fish_WETA.pdf)

### Science Inquiry

With the inquiry activity at the URL below, students will design a fish and justify why it has a particular body part or adaptation. In the activity, they will also write a paragraph explaining where their fish lives and how the fish is adapted to survive in its habitat. <http://www.wpcouncil.org/education/Design%20a%20Fish.pdf>

## Overcoming Misconceptions

Five common misconceptions about sharks are addressed in the short article at the following URL. You can share the information with your students or assign the article for them to read. <http://aquaviews.net/explore-the-blue/shark-myths-facts-infographic/>

## Language Arts Connection

Activities 2-1 and 2-2 at the URL below are writing exercises pertaining to fish and their adaptations. In the first activity, students will write a newspaper article based on an “interview” with a fish. In the second activity, they will create poetry about fish. The document also provides additional information about fish and their ecology. <http://www.marine.usf.edu/pjocean/packets/f99/f99u2le2.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 13.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 13.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Identify aquatic adaptations of fish.
2. Outline how fish are classified.
3. Describe how cartilaginous fish such as sharks feed.
4. An unknown fish lives in shallow fresh water and eats small invertebrates. In which class would you place the unknown fish?
5. Summarize how fish generally reproduce.
6. Compare and contrast lobe-finned and ray-finned fish.

### Lesson Quiz

Check students’ mastery of the lesson with Lesson 13.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Amphibians evolved from lobe-finned fish.

- What are some examples of modern amphibians?
- What traits of lobe-finned fish made them good candidates for amphibian ancestors?

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## 13.3 Amphibians

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### Key Concepts

- Amphibian traits
- Amphibian reproduction
- Classification of amphibians
- Amphibian ecology and extinction

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### Standards

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### Lesson Objectives

- Define amphibians and identify their traits.
- Describe how amphibians reproduce.
- Outline how amphibians are classified.
- Explain the roles of amphibians in ecosystem and why they are at risk of extinction.

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### Lesson Vocabulary

- amphibian: ectothermic vertebrate with smooth, moist skin that lives on land as an adult but lays eggs and spends the larval stage in water
- cloaca: body cavity in most vertebrates that has an external opening to pass wastes and gametes or fertilized eggs out of the body
- keratin: tough protein in the skin, scales, feather, fur, or hair of vertebrates
- tadpole: aquatic, legless larval stage of a frog

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### Teaching Strategies

#### Introducing the Lesson

Introduce amphibians with the worksheet at the URL below. Students will decide which of numerous animals are amphibians and then write an explanation for their choices. This activity will start students thinking about traits that identify the amphibian class. Teacher notes are provided for the activity. <http://cosmos.bgsu.edu/PiR2/pdf/Is%20It%20an%20amphibian.pdf>

## Activity

Students can learn about amphibian anatomy and physiology by making a “frog sandwich,” using instructions and materials at the following URLs. They will label and color the organs, bones, and major systems of a frog. Then they will cut out the parts and glue them together. <http://www.shellyssciencespot.com/Worksheets/Animals/Vertebrates/FrogSandwichInstructions.pdf> <http://www.shellyssciencespot.com/Worksheets/Animals/Vertebrates/FrogSandwichPictures.pdf>

## Cooperative Learning

Have teams of students do “The Vanishing Frog” activity at the URL below. Students will research an endangered or threatened amphibian species, identify strategies for saving it, and persuade others to take action as well. <http://www.amphibianark.org/pdf/Vanishing-Frogs-Middle-School.pdf>

## Differentiated Instruction

Have students create a Frayer model for the term amphibian. They should draw a large box and divide it into four parts. The parts should be labeled “Definition,” “Drawing,” “Example,” and “Nonexample.” Then students should fill in each part of the box for the term.

## Enrichment

Encourage interested students to learn more about amphibian malformations as evidence of environmental degradation. Suggest that they begin with the articles below. Ask them to present their findings to the class with a PowerPoint show. <https://www.fws.gov/contaminants/Documents/AbnormalAmphibsFinal.pdf> <http://cgee.hamline.edu/frogs/science/malform.html>

## Science Inquiry

If you can take a fieldtrip to a local pond, students can do an amphibian field investigation. In the project described at the following URL, students will determine the percentage of malformed frogs in a local pond and whether it is greater than what is expected for a healthy pond. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/EnvSci\\_p016.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p016.shtml)

## Science Inquiry

Have students solve the “Case of the Missing Anurans” at the URL below. After they complete the activity, students will be able to describe environmental changes that can affect anurans and state a hypothesis about the cause of a large change in anuran population size. <http://cgee.hamline.edu/frogs/teachers/activity/CaseofMA.pdf>

## Overcoming Misconceptions

A common student misconception is that all animals that live both on land and in water, such as marine turtles, are amphibians. Make sure students are aware of the actual defining characteristics of amphibians.

### Language Arts Connection

Use the research and writing activity at the URL below to help students develop basic research skills and learn about amphibians. <http://www.abcteach.com/documents/writing-basic-research-for-amphibians-uppermiddlehigh-44654>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 13.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 13.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are amphibians?
2. Describe the skin of amphibians.
3. State how amphibians reproduce and develop into adults.
4. Create a public service announcement to help raise awareness about the importance of amphibians, their risk of extinction, and what individuals can do to help.
5. Compare and contrast the three living orders of amphibians.
6. Explain the ecological roles of amphibians, including both larval and adult stages.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 13.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Amphibians were the dominant land vertebrates until they gave rise to reptiles.

- What are some examples of modern reptiles?
- How do you think reptiles differ from amphibians?

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## 13.4 Reptiles

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### Key Concepts

- Terrestrial adaptations of reptiles
- Reptile reproduction
- Classification of reptiles
- Reptile ecology

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### Standards

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### Lesson Objectives

- List terrestrial adaptations of reptiles.
- Describe how reptiles reproduce.
- Explain how reptiles are classified.
- Identify where reptiles live and what they eat.

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### Lesson Vocabulary

- carnivore: heterotroph that eats only or mainly animals
- crocodilian: reptile in the Crocodilia Order, such as a crocodile or an alligator
- diaphragm: large, flat muscle that lies below the lungs in reptiles and mammals and helps move air into and out of the lungs
- herbivore: heterotroph that eats only or mainly plants
- omnivore: heterotroph that eats a variety of foods, including both plants and animals
- reptile: four-limbed, ectothermic vertebrate that produces amniotic eggs and has scaly skin

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### Teaching Strategies

#### Introducing the Lesson

Show students several stunning images of colorful reptiles to pique their interest in learning more about this class of vertebrates. Some good examples can be found at these URLs: [http://www.redorbit.com/media/uploads/2013/02/Reptiles\\_021513-617x416.jpg](http://www.redorbit.com/media/uploads/2013/02/Reptiles_021513-617x416.jpg) [http://wallpoper.com/images/00/36/22/06/snakes-garter\\_00362206.jpg](http://wallpoper.com/images/00/36/22/06/snakes-garter_00362206.jpg) <http://whatdoanimaleat.com/wp-content/uploads/2013/08/Seaturtles-01.jpg>

### Using Visuals

Use the PowerPoint presentation at the following URL to provide visuals for your lesson when you teach students about reptiles. [https://docs.google.com/presentation/d/194dnqBbTv2jdvCcf2FF\\_w3O1Nab7e5EVdQ2QTHfcJKc/present?slide=id.i0](https://docs.google.com/presentation/d/194dnqBbTv2jdvCcf2FF_w3O1Nab7e5EVdQ2QTHfcJKc/present?slide=id.i0)

### Activity

With the activity at the following URL, students will read an article and do online research about box turtles. Then they will imagine that they are interviewing a real box turtle about its life. They will use information from the article and online sources to write the turtle's responses to the questions. <http://www.nwf.org/pdf/2011/Box-Turtle-Interview-3-8.pdf>

### Cooperative Learning

In the guided research activity at the URL below, the class will create a snake field guide, with each student contributing a section on one particular type of snake. By doing the activity, students will learn that snakes thrive in almost every region of the world and that different types of snakes have different physical characteristics that help them survive in their particular habitats. <http://www.discoveryeducation.com/teachers/free-lesson-plans/snakes.cfm>

### Differentiated Instruction

Work with students to create a Venn diagram comparing and contrasting reptiles and amphibians.

### Enrichment

Challenge two or more students to research and present a debate on the pros and cons of beach development versus protecting marine turtle egg-laying locations. Give the students an opportunity to present their debate in front of the rest of the class.

### Science Inquiry

With the activity at the URL below, groups of students will compare and contrast the physical characteristics of marine, freshwater, and land turtles. After creating compare-contrast charts, groups will share and discuss their charts. They will identify similarities and differences among turtle species and make inferences about habitat preferences based on turtle morphology. In closing, students will create sketches of turtles adapted to various types of environments. <http://www.seaturtleinc.org/education/lesson-plans/are-all-turtles-alike/>

### Overcoming Misconceptions

There are many negative myths and misconceptions about reptiles. One of the best ways to overcome them is to have students examine their own feelings about reptiles by completing a survey. Afterward, they can help educate others about reptiles by creating posters and displays. [http://smithsonianeducation.org/educators/lesson\\_plans/herps/lesson1.html](http://smithsonianeducation.org/educators/lesson_plans/herps/lesson1.html)

## Real-World Connection

With the real-world activity at the following URL, students will learn about the benefits of lizards in a garden and construct a shelter to attract lizards to a garden. By completing the activity, students will learn more about lizards and their ecology. <http://www.nwf.org/pdf/Schoolyard%20Habitats/lizardlair.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 13.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 13.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are reptiles?
2. Identify some of the terrestrial adaptations of reptiles.
3. Describe how reptiles reproduce.
4. In many parts of the world, beaches are being used for new homes and condominiums. Such beach developments may put aquatic turtle populations at risk. Explain why.
5. Compare and contrast the Crocodilia and Squamata Orders of reptiles.
6. Explain the ecosystem roles of carnivorous reptiles.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 13.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Birds evolved from a reptile ancestor, but modern birds and reptiles are very different. Birds are now the most numerous four-limbed vertebrates on Earth.

- How do modern birds differ from reptiles?
- Why do you think birds have been so successful?

# CHAPTER 14 THE MS Birds and Mammals

## Chapter Outline

- 14.1 BIRDS
- 14.2 MAMMALS
- 14.3 PRIMATES

## Chapter Overview

This chapter describes the traits, reproduction, ecology, and classification of birds and mammals. It also introduces the mammalian order of primates, to which human beings belong.

## Online Resources

See the following Web sites for appropriate laboratory activities:

In the lab at the following URL, students will create beach models and use them to simulate how oil spills affect shorebirds. Students will measure the depths of a variety of oil spills in their model beaches and match the lengths of bird beaks to oil spill depths. They will create a report and presentation based on the findings of the simulation. [http://psgs.usf.edu/images/uploads/Bird\\_Beaks.pdf](http://psgs.usf.edu/images/uploads/Bird_Beaks.pdf)

With the online project at the following URL, students will track the movements of aquatic mammals (harbor porpoises) using satellite data. They will determine whether there is a pattern to the movements and, if there is, whether the pattern correlates with ocean currents, ocean temperatures, or other environmental factors. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/OceanSci\\_p004.shtml#summary](http://www.sciencebuddies.org/science-fair-projects/project_ideas/OceanSci_p004.shtml#summary)

The lab at the URL below allows students to investigate the importance of the primate trait of opposable thumbs. Students will compare their performance of a series of tasks with and without using their thumbs. In the class discussion that follows the activity, students will discuss fine and gross motor skills and speculate on the role of an opposable thumb in primate evolution. <http://www.accessexcellence.org/AE/AEPC/WWC/1995/thumbs.php>

These Web sites may also be helpful:

A wide diversity of bird information and resources are available from the world-famous Cornell Lab of Ornithology. You can access it at this URL: <http://www.allaboutbirds.org/Page.aspx?pid=1189>

This URL has links to Web sites on birds for teachers: <http://www.cumbavac.org/birds.htm>

This searchable index of endangered mammals provides a variety of information about such topics as history, habitat, and the world's rarest mammals. There are photos of the featured animals as well. <http://apps.exploratorium.edu/10cool/click-through.php?id=618>

This URL has an excellent collection of primate photos, a long list of FAQs about primates, and a detailed primate classification chart: <http://www.primates.com/welcome.htm>

For more information, photos, and links about primates, you and/or your students can go to this URL: [http://tolweb.org/treehouses/?treehouse\\_id=3029](http://tolweb.org/treehouses/?treehouse_id=3029)

**TABLE 14.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
14.1 Birds	3.0
14.2 Mammals	3.0
14.3 Primates	1.0

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## 14.1 Birds

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### Key Concepts

- Definition of bird
- Adaptations of birds for flight
- Reproduction and parental care in birds
- Bird specialists and generalists

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### Standards

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### Lesson Objectives

- Define the bird class.
- Identify adaptations of birds for flight.
- Describe how birds reproduce and care for their young.
- Compare and contrast birds that are specialists and birds that are generalists.

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### Lesson Vocabulary

- bipedal: of or relating to an animal that walks on two legs
- bird: four-limbed, endothermic vertebrate that lays amniotic eggs and has wings and feathers
- courtship: special behavior, such as a unique song or visual display, performed by an animal to attract a mate
- generalist: organism that has general (nonspecialized) traits for exploiting a variety of foods or other resources in the environment
- incubation: keeping eggs warm until they hatch
- specialist: organism that has specialized traits for exploiting a specific food or other resource in the environment

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### Teaching Strategies

#### Introducing the Lesson

Begin the study of birds with a challenge to the class. Play bird songs of local birds that students are likely to have heard. You can choose from a wide variety of bird songs at the following URLs. Ask students to identify the birds from the songs. Tell the class they will learn about birds, including songbirds, in this lesson. <http://www.birdjam.com/learn.php> <http://www.mbr-pwrc.usgs.gov/id/songlist.html>

### Building Science Skills

Students can build skills relating form and function, as well as learn about the diversity of foods eaten by birds, with the bird beak activity at these URLs: <http://www.shellyssciencepot.com/Worksheets/Animals/Vertebrates/BirdBeakAdaptations.pdf> <http://www.shellyssciencepot.com/Worksheets/Animals/Vertebrates/BirdBeakAdaptationsSlides.pdf>

### Building Science Skills

Use the birds of prey teaching strategy at the following URL to help students build research skills and learn about predator-prey relationships. Students will research several birds of prey and examine their relationships with their prey. The strategy includes a student worksheet and ideas for assessment and extension. <http://scienetlinks.com/lessons/birds-of-prey/>

### Differentiated Instruction

Pair less proficient readers with other students, and ask partners to make an outline of lesson content. If necessary, show them how to use the lesson headings and subheadings to structure their outline. They should add important details below each subheading.

### Enrichment

Encourage interested students to join the international Albatross Project at the URL below. After students are registered (for free), they will receive daily batches of real albatross data, which they can use to test hypotheses in their own investigations. <http://www.wfu.edu/biology/albatross/>

### Science Inquiry

Students can investigate the relationship between temperature and bird migration with the inquiry project at the URL below. They will choose a bird species to investigate and then access and evaluate real data collected by scientists. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/Zoo\\_p062.shtml#summary](http://www.sciencebuddies.org/science-fair-projects/project_ideas/Zoo_p062.shtml#summary)

### Science Inquiry

The PDF document below from the Cornell Lab of Ornithology contains three science inquiry lessons featuring stunning and exotic birds-of-paradise. In the first lesson, “Science in Paradise,” the focus is on the scientific process and the nature of science. The second lesson, “Sexual Selection,” focuses on evolution by natural selection, specifically sexual selection. The third lesson, “Heritable Behaviors,” focuses on behavioral adaptations and heritability. <http://info.allaboutbirds.org/Portals/95627/docs/BoP%20curriculum%20Final.pdf>

### Overcoming Misconceptions

At the following URL, you can find a list of many common student misconceptions about birds, as well as strategies for revealing and correcting them. <http://beyondpenguins.ehe.osu.edu/issue/arctic-and-anarctic-birds/common-misconceptions-about-birds>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 14.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 14.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a bird?
2. Describe adaptations of birds for flight.
3. Define courtship in birds. Give an example.
4. How do most bird parents take care of their eggs and hatchlings?
5. Describe the order of flying birds that contains the largest number of species.
6. Look at the bird in the photo below. Do you think this bird is a generalist or a specialist? Explain your answer.
7. Discuss bird intelligence.
8. Explain why birds have been so successful.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 14.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Birds aren't the only endothermic vertebrates. Mammals are also endotherms.

- What are some examples of mammals?
- Besides endothermy, what other traits do mammals have?

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## 14.2 Mammals

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### Key Concepts

- Traits of mammals
- Regulation of body temperature in mammals
- Mammalian diets
- Monotreme, marsupial, and placental mammals
- Classification of mammals

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### Standards

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### Lesson Objectives

- Identify traits of mammals.
- Explain how mammals keep their body temperature stable.
- Describe variation in mammalian diets.
- Compare and contrast monotreme, marsupial, and placental mammals.
- Outline the classification of mammals.

---

### Lesson Vocabulary

- alveolus (alveoli, plural): one of millions of tiny sacs in the lungs of mammals where gas exchange takes place
- frugivore: heterotrophic animal that eats only or mainly fruit
- insectivore: heterotrophic animal that eats only or mainly insects
- lactation: production of milk from mammary glands by a female mammal to feed her offspring
- mammal: four-limbed, endothermic vertebrate that has hair or fur and mammary glands in females
- mammary gland: gland in female mammals that produces milk to feed offspring
- marsupial: member of the subclass of mammals that give birth to an embryo, which continues to grow and develop in a pouch on its mother's body
- monotreme: member of the subclass of mammals that lay eggs, such as the platypus or echidna
- placenta: temporary, spongy organ that develops from both fetal and maternal tissues to nourish the fetus of a placental mammal
- placental mammal: member of the largest subclass of mammals that give birth to a relatively large fetus after a long pregnancy during which a placenta develops to sustain the fetus
- sweat: salty fluid produced by glands in the skin of mammals that helps cool down the body when it evaporates

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## Teaching Strategies

### Introducing the Lesson

Introduce mammals with the short Discovery Channel video at the URL below. It shows the diversity of mammals, while also focusing on their shared traits and uniqueness. <http://www.neok12.com/video/Mammals/zX6d6165767b617e5b075273.htm>

### Using Visuals

You can use the slides at the following URL when you teach your students about mammals. The slides include comprehensive notes and photos to illustrate them. <http://www.slideshare.net/seamonr/mammal-notes>

### Activity

A number of different mammals, including bats and dolphins, use echolocation to find objects in the dark. With the hands-on cooperative activity described at the URL below, pairs of students can simulate using echolocation to determine the shape of an unknown object. Students will experience how dolphins and other echolocating mammals locate and identify objects without using their sense of sight. [http://www.accessexcellence.org/AE/AEC/AEF/1995/mills\\_echo.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/mills_echo.php)

### Building Science Skills

Students can learn more about mammals while honing their classification skills. First have them view the well-illustrated mammalian orders presentation at the first URL below. Then have them apply what they learn by completing the classification chart at the second URL. <https://docs.google.com/presentation/d/1vm9jIMvDPdEBYvk1nITqgYwe4Zr7FNgXsuOw3ipZPso/present?slide=id.i0> <http://www.biologycorner.com/worksheets/mammalchart.htm>

### Differentiated Instruction

Have students make a main ideas/details chart for the lesson. Tell them to divide a sheet of paper in half and on the left side write the main ideas from the lesson. They should skip several lines between each main idea so they can fill in the right side with important details about each main idea as they read.

### Enrichment

Ask one or more students to make a word puzzle incorporating all of the lesson vocabulary terms. They can make their puzzle by hand or use the free online puzzle maker at the following URL. Make copies of the puzzle and have other students complete it as a review of lesson terms. <http://www.discoveryeducation.com/free-puzzlemaker/>

### Science Inquiry

You can find an inquiry curriculum on marine mammals at URL below. The materials include PowerPoint lectures, teacher notes, media files, and student activities with worksheets and answer keys. Students will learn how marine mammals are surveyed and why they are being studied. In the activities, students will step into the scientific role by planning a survey. <https://swfsc.noaa.gov/textblock.aspx?id=15821>

## Overcoming Misconceptions

Students commonly hold these misconceptions about mammals:

- All mammals give birth to live young.
- Whales and other marine mammals are fish.
- Bats are birds.

Make sure that your students are not confused by these misconceptions.

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 14.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 14.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Describe two traits that define the mammal class.
2. Outline variation in the foods that mammals eat.
3. Identify three orders of placental mammals.
4. When working out in the heat, you need to drink extra fluids to avoid dehydration. Explain why.
5. Which type of mammalian diet do you eat?
6. Explain how shivering helps to keep you warm on a cold day.
7. Contrast pros and cons to mother and offspring of the reproductive methods of placental, marsupial, and monotreme mammals.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 14.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Human beings are mammals. Like other mammals, we have hair and mammary glands. The subclass in which the human species is classified is the placental mammals.

- In which placental mammal order is the human species placed?
- What are some unique traits of this order of mammals?

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## 14.3 Primates

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### Key Concepts

- Definition of primates
- Primate traits
- Primate habitats and diets

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### Standards

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### Lesson Objectives

- Define primates, and identify primate traits.
- Describe primate habitats and diets.

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### Lesson Vocabulary

- brachiation: moving through trees by using the arms and hands to swing from branch to branch
- opposable thumb: thumb that can be brought into opposition with the other fingers of the same hand so the hand can grasp and hold things
- primate: placental mammal in the Primate Order, which has five digits on each hand or foot and opposable thumbs
- prosimian: small primate such as a lemur or loris that is similar to the earliest primates

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### Teaching Strategies

#### Introducing the Lesson

You can introduce your class to the Primate Order by sharing the 12 fascinating primate facts and beautiful accompanying photos at this URL: <http://www.mnn.com/earth-matters/animals/stories/12-fascinating-facts-about-apes-and-monkeys>

#### Cooperative Learning

Divide the class into groups and assign each group a different primate species. Students in each group should work cooperatively to gather information from many resources on their primate species. They should then present your

findings in a poster or other visual display. Information might include the common and scientific names of the species and its family, habitat, diet, special adaptation(s), social organization, reproduction, methods of communication, physical size and description, life span, and/or conservation status.

### Building Science Skills

Have pairs of students do one or both of the activities in the lesson plan at the following URL. In the activities, students will investigate the value of stereoscopic vision and opposable thumbs, two important primate traits. After pairs complete the activities, use the “Think About It!” questions at the end of the lesson plan for a class discussion. [http://www.pbs.org/safarchive/4\\_class/45\\_pguides/pguide\\_504/4554\\_monkey.html#think](http://www.pbs.org/safarchive/4_class/45_pguides/pguide_504/4554_monkey.html#think)

### Activity

Use the activity “Can Chimps Talk?” at the URL below to involve students in a debate about the humane use of primates in scientific research. [http://www.pbs.org/wgbh/nova/education/activities/2105\\_chimps.html](http://www.pbs.org/wgbh/nova/education/activities/2105_chimps.html)

### Differentiated Instruction

Assign individual students questions such as those listed below to think about as they read the lesson. After they read, pair students of differing abilities and have partners work together to answer the questions.

1. What are primates?
2. What are some unique traits of primates?
3. Where do primates live and what do they eat?

### Enrichment

Suggest that students read, and write a book review of, *Primates: The Fearless Science of Jane Goodall, Dian Fossey, and Biruté Galdikas* by Jim Ottaviani (First Second/Roaring Brook, 2013). The slim volume is a lightly fictionalized and lively account of the lives and work of the three ground-breaking primatologists. The book is recommended for middle and high school students.

### Science Inquiry

With the inquiry lesson at the following URL, students will research, and then design an experiment to investigate, great ape intelligence. The lesson plan includes discussion questions, assessment, extensions, and suggested readings. <http://school.discoveryeducation.com/lessonplans/programs/greatapes/index.html>

### Overcoming Misconceptions

A very common misconception is that humans evolved from apes. Make sure that students understand that modern apes and humans share a common ancestor but that both groups of primates have evolved in many ways during the millions of years since they diverged from that ancestor.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 14.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 14.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are primates?
2. Identify three primate traits.
3. Describe the distribution and diet of primates.
4. Why do you think stereoscopic vision is important to an animal that brachiates? What activities do you do for which stereoscopic vision is important?
5. Compare and contrast prosimian and non-prosimian primates.
6. Relate the rate of primate development to the importance of learning in primates.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 14.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Mammals in general and primates in particular are noted for their ability to learn.

- Are mammals the only animals that can learn?
- How do animals learn new behaviors?

# CHAPTER 15 TE MS Animal Behavior

## Chapter Outline

### 15.1 UNDERSTANDING ANIMAL BEHAVIOR

### 15.2 TYPES OF ANIMAL BEHAVIOR

## Chapter Overview

This chapter explains how animal behaviors evolve through natural selection, and it distinguishes between innate and learned behaviors. The chapter also describes different ways in which animals learn and different types of animal behaviors, including reproductive behaviors and cooperation.

## Online Resources

See the following Web sites for appropriate laboratory activities:

Students can investigate learning in cockroaches with the lab activity at the following URL. They will provide a positive stimulus and then try to detect learning in the insects. By doing the lab, students will get practice developing an experimental design and also gain an appreciation of the complexities of animal behavior. [http://www.accessexcellence.org/AE/AEC/AEF/1995/colvard\\_cockroach.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/colvard_cockroach.php)

Have students do the first experiment at the URL below. In the experiment, they will monitor their own circadian rhythm of body temperature and then plot it in a graph. As an extension of the basic temperature experiment, they can measure their reaction time and see whether it correlates with changes in body temperature. <http://faculty.washington.edu/chudler/clock.html>

These Web sites may also be helpful:

You and/or your students may enjoy this witty, fast-paced video “Crash Course” on animal behavior: <https://www.youtube.com/watch?v=EyyDq19Mi3A>

Careers in animal behavior (e.g., animal training, wildlife rehabilitation, veterinary technology, zoo keeping) may be popular with students. Information on animal behavior careers is available here: <http://www.animaledu.com/Landingpages/AnimalBehavior.aspx?gclid=COLMsKKAnsICFcxQ7AodwjcAWw>

This excellent bower bird video by David Attenborough provides an excellent visual example of animal behavior: <https://www.youtube.com/watch?v=GPbWJPSPdA>

**TABLE 15.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
15.1 Understanding Animal Behavior	3.0
15.2 Types of Animal Behavior	3.0

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## 15.1 Understanding Animal Behavior

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### Key Concepts

- Natural selection and evolution of animal behaviors
- Innate animal behaviors
- Learned animal behaviors

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### Standards

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### Lesson Objectives

- Describe how animal behaviors can increase fitness and evolve through natural selection.
- Define innate behavior, and give examples of innate behaviors in humans and other animals.
- Define learned behavior, and explain different ways that animals can learn new behaviors.

---

### Lesson Vocabulary

- animal behavior: any way that an animal interacts with other animals or the environment
- conditioning: way of learning that involves a reward or punishment, such as teaching a dog commands by giving it food treats
- habituation: way of learning that occurs when an animal is exposed repeatedly to a stimulus that is annoying or frightening but not harmful, such as a crow learning to ignore a scarecrow
- innate behavior: instinctive behavior that does not need to be learned, or any behavior that occurs naturally and in exactly the same way in all the individuals of a given species
- insight learning: way of learning that is based on past experiences and reasoning and that generally involves coming up with a new way to solve a problem
- instinct: innate behavior that does not need to be learned but that occurs naturally and in exactly the same way in all the individuals of a given species
- learned behavior: any behavior that occurs only after experience or practice
- observational learning: way of learning by watching and copying the behavior of another individual
- reflex behavior: simple response that always occurs when a certain stimulus is present, such as the grasp reflex in human infants

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## Teaching Strategies

### Introducing the Lesson

Introduce play behaviors in a diversity of animal species with the short video at the following URL. The cute antics of young animals at play, ranging from meerkats to lion cubs, will be sure to get students' attention. Tell students they will learn more about play and other animal behaviors in this lesson. <https://www.youtube.com/watch?v=DhTi9zvGYp8>

### Building Science Skills

Students can build science skills while studying evidence of animal behavior with the lesson plan at the URL below. Students will use a variety of methods to observe, collect, document, classify, and summarize data on animal tracks. They will also use a field guide and related references to identify and interpret the tracks. In addition, they will analyze their data and use it to try to explain animal behavior, traits, and needs. <http://nationalzoo.si.edu/Education/ClassroomScience/AnimalTracks/Teacher/default.cfm>

### Activity

A fun way for students to learn about animal learning through conditioning is to play the interactive online game called "Pavlov's Dog" at this URL: <http://www.nobelprize.org/educational/medicine/pavlov/index.html>

### Differentiated Instruction

Create a gallery walk for the different ways in which animals learn. Post a large sheet of paper in four different places in the classroom, and on each sheet write one of the following ways of learning: habituation, observational learning, conditioning, or insight learning. Divide the class into groups and have the groups walk around the room from one poster to another. Each group (using a different color of ink) should write a definition, description, and/or example of the particular way of learning on each poster. The group should also read and respond to the writings of other groups. Following the gallery walk, hold a class discussion of the responses. Emphasize the best definitions, descriptions and examples; and point out any errors.

### Enrichment

Ask one or more interested students to find additional examples of innate reflex behaviors in human infants. Several examples are described in the articles at the following URLs. Have the students make a poster to illustrate the reflexes, show when they typically occur, and explain why they might be adaptive. <http://www.healthychildren.org/English/Pages/default.aspx> <http://www.todayparent.com/baby/baby-development/reflexes-5-instincts-your-baby-is-born-with/>

### Science Inquiry

The inquiry activity at the first URL below allows students to use ethology. They will observe and quantify animal behavior using crickets as subjects. The second URL is a link to the video (Trial of Life: Talking to Strangers) that is referenced in the lesson plan for the activity. In the activity, students will collect detailed observations of animal behavior; develop an ethogram of animal behavior; measure various animal behaviors by collecting quantitative data; identify various modes of animal communication; develop simple investigations of animal behavior

(in small student groups); and analyze, interpret and report on their data. [http://gk12.asu.edu/Lessons/Life\\_Science/AnimalBehavior/Lesson\\_Plan\\_Draft4.pdf](http://gk12.asu.edu/Lessons/Life_Science/AnimalBehavior/Lesson_Plan_Draft4.pdf) [http://www.dailymotion.com/video/x1cv4t6\\_bbc-david-attenborough-s-trials-of-life-10-of-12-talking-to-strangers-1990\\_tv](http://www.dailymotion.com/video/x1cv4t6_bbc-david-attenborough-s-trials-of-life-10-of-12-talking-to-strangers-1990_tv)

### Language Arts Connection

With the lesson plan at the following URL, students can practice writing and observation skills by keeping nature journals. They will observe animals on the National Zoo's Web cam, write about the behaviors they see, and then make hypotheses based on their observations. [http://www.smithsonianeducation.org/educators/lesson\\_plans/journals/index.html](http://www.smithsonianeducation.org/educators/lesson_plans/journals/index.html)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 15.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 15.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Define animal behavior.
2. Identify three examples of innate behavior, including one in humans.
3. Describe three different ways that an animal might learn a new behavior.
4. Explain how you could use conditioning to teach a dog to lie down on command.
5. Compare and contrast innate and learned behaviors.
6. Explain how innate behaviors evolve through natural selection.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 15.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Some animal behaviors have the purpose of sharing information with other animals. This is called communication.

- What are some ways animals communicate?
- Why do animals communicate? What purposes might it serve?

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## 15.2 Types of Animal Behavior

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### Key Concepts

- Animal communication
- Social animals and cooperation
- Reproductive behaviors of animals
- Defensive behaviors of animals
- Cyclical behaviors

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### Standards

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### Lesson Objectives

- Describe ways that animals may communicate, and explain why communication is essential for social animals.
- Give examples of social animals and how they cooperate.
- Identify animal behaviors involved in reproduction.
- Describe defensive behaviors, and explain why they occur.
- Give an overview of behaviors that occur in annual or daily cycles.

---

### Lesson Vocabulary

- biological clock: tiny structure in the brain of many animal species that controls behaviors occurring in daily cycles
- circadian rhythm: daily cycle of behavior that occurs in an animal, such as the daily sleep-wake cycle
- communication: any way in which animals share information
- cooperation: working together with others toward the same overall goal, such as bees working together to feed and protect the colony
- diurnal: of or relating to being active during the day, such as a diurnal animal
- hibernation: state in which an animal's body processes slow down and its body temperature falls so it can sleep deeply through a time of year when food is scarce
- language: use of symbols such as words to communicate
- mating: pairing of an adult male and an adult female for the purpose of reproduction
- migration: movement of animals from one place to another to find more plentiful resources, or the movement of individuals into or out of a population
- nocturnal: of or relating to being active during the night, such as a nocturnal animal
- social animal: any species of animal in which individuals live together in groups and different animals within a group have different jobs so group members must work together for the good of all

- territorial: of or relating to an animal that defends a given area, or territory, typically including its nest and enough space to feed itself and its young

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## Teaching Strategies

### Introducing the Lesson

Introduce specific types of animal behaviors with the amazing video at the following URL. It shows social insects (honeybees and ants) communicating in various ways and demonstrating many other behaviors needed to maintain the colony. <http://www.cosmeo.com/videotitle.cfm?guidassetid=9F2B08C6-99F1-438D-823D-C21128CA6AA5>

### Cooperative Learning

With the activity at the URL below, students will work in groups to research and analyze the migration patterns of different animal species. <http://www.pbslearningmedia.org/resource/kqed07.sci.life.lpladybug/signs-of-migration/>

### Differentiated Instruction

Create a list of cloze prompts for students to fill in as they read the lesson. Good cloze prompts summarize important ideas in the lesson, require multiples words to complete, and present lesson concepts in the same sequence as they appear in the text (e.g., “Communication is any way that animals [share information.]”). Filling in the cloze prompts will help students focus on the main ideas in the lesson.

### Enrichment

Ask a few interested students to learn about circadian rhythms in human teens. Specifically, have them investigate the sleep-wake cycle in teens, how it changes during puberty, how it conflicts with early school start times, and the effects of sleep deprivation on school and athletic performance. Students can start their research with the URLs below. Have them summarize their research in an oral report to the class. Then ask them to lead a class discussion of whether schools should start later in the day to correspond with the teen sleep-wake cycle. <http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/from/sleep.html> [http://msue.anr.msu.edu/news/teen\\_sleep\\_cycles\\_affect\\_school\\_success\\_habits\\_that\\_help](http://msue.anr.msu.edu/news/teen_sleep_cycles_affect_school_success_habits_that_help) <http://www.rosecrance.org/tag/sleep-cycles/>

### Science Inquiry

You can use the Smithsonian lesson plan at the following URL to have students observe and analyze animal behavior. Specific objectives of the lesson plan include identifying and investigating behaviors that animals perform in their environments, explaining different types of animal behavior, and drawing conclusions based on careful documentation and analysis. <http://nationalzoo.si.edu/Education/ClassroomScience/Behavior/Teacher/default.cfm>

### Overcoming Misconceptions

Listed below are two common student misconceptions about migration in birds. The true conceptions are given in brackets. Read each misconception to the class. Then call on volunteers to explain why it is false.

- All birds fly south in the winter.

[Birds that migrate do so to move to an area where the resources they need can be found, not necessarily to the south. They may migrate to the tropics, a coast, or even a different elevation. Some species do not migrate at all.]

- Birds migrate because it is too cold (to avoid freezing).

[Birds migrate toward areas of increasing or higher resources (nesting sites, food). Both environmental (temperature, daylight) and genetic factors are involved in bird migration.]

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 15.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 15.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is communication? Give an example of communication in nonhuman animals.
2. What is the purpose of courtship behaviors in animals?
3. Why do animals such as male gorillas put on defensive displays?
4. What are two different ways you could communicate an emotion such as fear to another person.
5. Explain how honeybees in a colony work together to promote the survival of all colony members.
6. Why does providing care for offspring increase the fitness of adult animals?
7. Compare and contrast behaviors with annual cycles and behaviors with daily cycles.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 15.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Human beings have the biggest brain for their body size and are the most intelligent animals. As a result, they depend more than other animals on learned behaviors.

- Besides their big brain and intelligence, how else might human beings differ from other animals?
- What organ systems do you think make up the human body?

## CHAPTER

## 16

## TE MS Skin, Bones, and Muscles

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Chapter Outline

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- 16.1 INTRODUCTION TO THE HUMAN BODY
  - 16.2 THE INTEGUMENTARY SYSTEM
  - 16.3 THE SKELETAL SYSTEM
  - 16.4 THE MUSCULAR SYSTEM
- 

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Chapter Overview

This chapter introduces the levels of organization of the human body and explains how human organ systems work together to maintain homeostasis. It also describes the integumentary, skeletal, and muscular systems.

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Online Resources

See the following Web sites for appropriate laboratory activities:

Students can develop an understanding of homeostasis by experiencing it themselves with three simple activities, as described in the learning lab at the URL below. The PDF document includes background for teachers, teaching notes, differentiated instruction, and extensions. [http://www.msichicago.org/fileadmin/Education/learninglabs/lab\\_downloads/Homeostasis.pdf](http://www.msichicago.org/fileadmin/Education/learninglabs/lab_downloads/Homeostasis.pdf)

In the measurement lab at this URL, students will estimate the area of the skin covering a middle school student's body: [https://teacher.ocps.net/brian.boylan/2\\_files/Measuring\\_Skin\\_Surface\\_Area.pdf](https://teacher.ocps.net/brian.boylan/2_files/Measuring_Skin_Surface_Area.pdf)

The “Awesome Arm” lab at the URL below allows students to research how muscles and bones work together like levers. In the lab, they will form and investigate a hypothesis to answer the question: How does the location of a muscle's attachment to a bone affect the muscle's ability to do work (move a mass a certain distance)? [http://www.myscience8.com/human\\_biology/module\\_3/the\\_awesome\\_arm\\_lab\\_form.pdf](http://www.myscience8.com/human_biology/module_3/the_awesome_arm_lab_form.pdf)

With the simple lab at the following URL, students will repeat several activities involving different muscles until they experience muscle fatigue. They will record how long it takes for muscle fatigue to set in when different muscles are used and draw conclusions from their observations about muscle fatigue and its cause. [http://www.myscience8.com/human\\_biology/module\\_3/muscle\\_fatigue\\_labs\\_form.pdf](http://www.myscience8.com/human_biology/module_3/muscle_fatigue_labs_form.pdf)

These Web sites may also be helpful:

The URL below has links to student-friendly reference articles about all the human body systems. <http://www.livescience.com/37009-human-body.html>

Students can explore human organs with this kid-friendly Web site, which has both English and Spanish versions: [http://kidshealth.org/kid/htbw/htbw\\_main\\_page.html](http://kidshealth.org/kid/htbw/htbw_main_page.html)

At the following URL, you will find links to several excellent video clips for students about the human body. From the videos, students can learn more about human anatomy, organs, and organ systems. <http://www.sciencekids.co.nz/videos/humanbody.html>

The interactive Web site at the following URL has detailed images and descriptions that allow students to learn about the anatomy and physiology of organs and organ systems. Students are provided with many navigation options for exploring the systems and organs. A wealth of textual information is also provided. <http://www.innerbody.com/>

With the activity at the URL below, students will use internet resources to research an organ and learn how it works with other organs and organ systems to keep the body healthy. The information gathered will be used to create a poster (or other type of display) to share what they learn with their classmates. Have students begin the activity as they start learning about human organ systems. Then they can share their work as the class focuses on each relevant organ system. The URL includes teacher and student pages and a grading rubric. <http://sciencespot.net/Media/org-antrail.pdf>

At the URL below, you can find links to several lesson plans and interactives relating to the integumentary system. <http://sciencenetlinks.com/collections/skin-deep-project/>

You can find a crossword puzzle for middle school students on the skeletal and muscular systems at the following URL. Assign it so students can review what they learn about these two organ systems after they complete this chapter. <http://sciencespot.net/Media/hlthskelmuscuzz.pdf>

**TABLE 16.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
16.1 Introduction to the Human Body	1.5
16.2 The Integumentary Systems	2.0
16.3 The Skeletal System	2.0
16.4 The Muscular System	2.5

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## 16.1 Introduction to the Human Body

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### Key Concepts

- Levels of organization of the human body
- Human organ systems
- Homeostasis

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### Standards

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### Lesson Objectives

- Describe the levels of organization of the human body.
- Explain how human organ systems work together to maintain homeostasis.

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### Lesson Vocabulary

- connective tissue: type of tissue that forms the body's structure; includes bone, cartilage, and blood
- epithelial tissue: type of tissue that covers inner and outer body surfaces and secretes and absorbs substances; includes skin and linings of internal organs
- muscle tissue: type of tissue that consists of cells that can contract; includes skeletal, cardiac, and smooth muscle tissues
- nervous tissue: type of tissue that consists of cells that can send and receive electrical messages; includes the tissues of the brain, spinal cord, and nerves that run throughout the body

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### Teaching Strategies

#### Introducing the Lesson

Engender student interest in the human body and organ systems by sharing some or all of these fascinating facts with your class:

- The average adult human being is made up of 100 trillion cells.
- A newborn baby has 350 bones, but a fully-grown adult has only 206 bones.
- More than half the bones in the human body are in the hands and feet.
- The heart beats about 3 billion times in the average person's lifetime.
- Blood is a liquid tissue.

- The surface area of the lungs is about the same size as a tennis court.
- Food can travel to your stomach even if you're standing on your head.

### Cooperative Learning

The activity described at the following URL requires groups of students to investigate different organ systems of the human body. Each group should be assigned a different organ system and produce a fact sheet and a 3-D model of all or part of their assigned system. They will also create a “grabber” to attract attention to their exhibit, which they will set up as part of the class’s overall “fantastic voyage.” Individual members of the groups will have specific roles to fill, but each group member must participate in all aspects of the project. [http://www.accessexcellence.org/AE/AEC/AEF/1995/allard\\_voyage.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/allard_voyage.php)

### Activity

With the activity at the URL below, students will explore how the human body maintains homeostasis. The Web site guides you through a variety of different activities that develop knowledge of the process in your students. The activities include hands-on data collection activities, structured class discussions, video clips, and interactive Web activities. [http://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.lp\\_humanreg/human-body-regulation/](http://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.lp_humanreg/human-body-regulation/)

### Cooperative Learning

Divide the class into pairs and ask each student to trace an outline of his or her partner’s body on a large piece of butcher paper. Then have each student draw (or create using construction paper) as many body organs as possible within the outline. Encourage students to label their drawings.

### Differentiated Instruction

Pair any English language learners and less proficient readers with other students, and have partners work together on the human body systems word search puzzle at the URL below. The puzzle will reinforce basic terminology and the main functions of the organ systems. <http://sciencespot.net/Media/hlthhumbdypuzz.pdf>

### Enrichment

Assign the body system challenge game at the following URL for an enrichment activity. Thirty-one terms relating to the human body systems are hidden in the puzzle. Students have to find each term and then link it with its correct system. <http://sciencespot.net/Media/hlthhumbdychall.pdf>

### Science Inquiry

With the exploration activity at the URL below, students will investigate how the human body maintains homeostasis during exercise. Students will carry out an experimental design, collect and graph data, analyze data and draw conclusions, share data and conclusions with their peers, and revise initial ideas and hypotheses. [http://7th-grade.mcdowell.ejh.groupfusion.net/modules/locker/files/get\\_group\\_file.phtml?gid=92844&fid=1111977](http://7th-grade.mcdowell.ejh.groupfusion.net/modules/locker/files/get_group_file.phtml?gid=92844&fid=1111977)

====Health Connection===== Briefly discuss with students the major body systems and how they function. Brainstorm a list of things young people can do to keep their bodies functioning smoothly. Ask each student to write and illustrate one health or safety rule they can follow. Display the rules on a classroom bulletin board.

## Overcoming Misconceptions

Students often think that the human organ systems operate in isolation from one another. Be sure to give them several examples of ways the organ systems interact. For example, explain how the digestive system and circulatory systems are connected.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 16.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Outline how the human body is organized.
2. List three examples of specialized human cells.
3. What are the four types of human tissues?
4. Identify and state the functions of three human organ systems.
5. Describe an example of two or more organ systems working together to maintain homeostasis.
6. Compare and contrast muscle tissue and epithelial tissue.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 16.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The skin is a familiar organ made of epithelial tissue.

- How do you choose healthy foods? To which organ system does the skin belong?
- What other organs are in this organ system?

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## 16.2 The Integumentary System

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### Key Concepts

- Structure and functions of the skin
- Keeping the skin healthy
- Structure and functions of hair and nails

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### Standards

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### Lesson Objectives

- List organs of the integumentary system
- Describe the two layers of the skin.
- Identify functions of the skin.
- Explain what you can do to help keep your skin healthy.
- Outline the structure and functions of hair and nails.

---

### Lesson Vocabulary

- acne: common skin disorder characterized by the formation of pimples on the skin, which are caused by a bacterial infection
- dermis: inner layer of skin that is made of tough connective tissue and contains blood vessels, nerve endings, hair follicles, and sweat and sebaceous glands
- epidermis: outer layer of skin that consists almost entirely of epithelial cells and contains no skin structures except melanocytes
- hair follicle: structure in the dermis, or lower layer of the skin, where a hair originates
- integumentary system: human body system that includes the skin, hair, and nails
- melanin: brown pigment produced by melanocytes in the epidermis that gives skin much of its color and helps protect the dermis from exposure to ultraviolet light
- melanocyte: special cell in the epidermis of the skin that produces the brown pigment called melanin
- sebaceous gland: gland in the dermis of the skin that produces an oily substance called sebum, which it secretes into a hair follicle
- sebum: oily substance produced in the dermis by a sebaceous gland that waterproofs the hair and skin
- sweat gland: gland in the dermis of the skin that produces the salty fluid called sweat

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## Teaching Strategies

### Introducing the Lesson

Introduce skin and the integumentary system by challenging the class with a question.

- Ask: What is the largest organ in the human body?
- Answer: The correct answer is the skin, but students may be more likely to say an internal organ such as the stomach or large intestine.

Tell students that the body of an adult (of normal size) is covered with about 1.8 m<sup>2</sup> (about 19.4 ft<sup>2</sup>) of skin. You might want to measure and mark an area of this size on a wall or the floor to impress students with how much area the skin covers. Tell students they will learn more about the skin in this lesson.

### Cooperative Learning

Have one or more teams of students complete the “Human Body Quest” activity for the integumentary system at the following URL. Each team will prepare a PowerPoint presentation to share what they learn with the rest of the class. They will also create a worksheet for other students to fill in. The presentation must include the major parts and functions of the integumentary system and how it works with other body systems. It also must include fun facts about the integumentary system or its parts. Teams may use their textbook, print reference materials, and online resources for their research. <http://sciencespot.net/Media/hlthhumbdyquest.pdf>

### Activity

Use the lesson plan at the URL below so students can examine the skin and how it functions both as an organ and as part of a body system. The lesson includes class activities, discussions, online readings, and assessment questions. <http://sciencenetlinks.com/lessons/skin-as-an-organ/>

### Demonstration

You can demonstrate to students how the hair and nails grow with the kid-friendly animated videos at these URLs: <http://kidshealth.org/kid/htbw/hair-movie.html> <http://kidshealth.org/kid/htbw/nails-movie.html>

### Differentiated Instruction

Print and have students label the diagram of the human skin at the URL below. This is a good way for kinesthetic, visual, and English language learners to review the structures and layers of the skin. [http://kidshealth.org/kid/htbw/\\_bfs\\_SKINactivity.html](http://kidshealth.org/kid/htbw/_bfs_SKINactivity.html)

### Enrichment

Students who want to learn more about the skin can read the excellent AAAS monograph, *The Science Inside Skin*, available online at the following URL. The book is recommended for ages 14 to adult. Encourage the students to write a short book report to share with the class. [http://sciencenetlinks.com/media/filer/2011/10/25/si\\_skin\\_book.pdf](http://sciencenetlinks.com/media/filer/2011/10/25/si_skin_book.pdf)

## Science Inquiry

In the inquiry activity at the URL below, students will formulate a hypothesis about which area of their skin is likely to have the most or least amounts or types of bacteria. To test their hypothesis, students will collect and culture bacteria from their skin. They will observe and record changes in their bacterial cultures in a journal and compare and contrast the bacteria found on different areas of skin. Students will use the information collected to confirm or reevaluate their hypothesis. <http://www.pbslearningmedia.org/resource/sf10.sci.lv.ls.orgenv.lplifeon/whats-on-my-skin/>

## Real-World Connection

Assign the following interactive activity so students can appreciate how knowledge of the skin is relevant to the real world. In the activity, they will review skin anatomy, learn about three types of skin cancer, and then apply the knowledge by simulating working in a dermatology clinic. <http://sciencenetlinks.com/interactives/skindeep/interactive/base.html>

## Health Connection

Both lesson plans at the following URLs relate knowledge of the skin to health concerns that are relevant to young teens. In the first lesson, students will explore how personal behaviors can affect the health of the skin. In the second lesson, students will learn about the importance of proper protection from common skin conditions when they engage in sports-related activities. In the third lesson, students will learn about the underlying causes, prevention, and treatment of acne. <http://sciencenetlinks.com/lessons/skin-the-behavior-and-health-connection/> <http://sciencenetlinks.com/lessons/skin-and-sports/> <http://sciencenetlinks.com/lessons/skin-care-acne/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 16.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is the integumentary system?
2. Outline how the epidermis is constantly being renewed.
3. Identify three functions of the skin.
4. How do sebaceous glands and sweat glands help maintain homeostasis?
5. Why does it usually hurt to cut the skin but not the hair or nails?
6. Compare and contrast the epidermis and dermis.
7. Explain the role of melanocytes in the skin.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 16.2 Quiz in CK-12 MS Life Science Assessments.

---

## Points to Consider

You can see all the organs of your integumentary system because they cover the outside surface of your body. Most of the organs of your other body systems are hidden inside your body. For example, your skeletal system is completely hidden by your skin and other tissues.

- What organs do you think make up the skeletal system?
- What are some of the functions of the skeletal system?

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## 16.3 The Skeletal System

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### Key Concepts

- Structure and functions of the skeletal system
- Composition and growth of bone
- Types of joints
- Skeletal system problems

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### Standards

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### Lesson Objectives

- Identify components of the skeletal system.
- List functions of the skeletal system.
- Describe the structure of bone, and explain how bones grow and develop.
- Describe different types of joints, and explain how they function.
- Identify skeletal system problems and ways to prevent them.

---

### Lesson Vocabulary

- bone fracture: crack or break in bone
- bone marrow: soft connective tissue inside pores and cavities in spongy bone tissue at the center of a bone
- compact bone: very dense, hard bone tissue that lies between periosteum and spongy bone and that gives bone its strength
- joint: place where two or more bones of the skeleton meet
- ligament: band of fibrous connective tissue that connects bones and holds them together
- ossification: process in which mineral deposits replace cartilage in bone
- osteoporosis: disease in which bones become porous and weak because they do not contain enough calcium
- periosteum: tough, fibrous membrane that covers and protects the outer surface of bone
- skeletal system: human body system that includes bones, cartilage, and ligaments
- spongy bone: type of bone tissue that lies below compact bone at the center of bone and contains many pores for blood vessels and bone marrow
- sprain: strain or tear in a ligament that has been twisted or stretched too far

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## Teaching Strategies

### Introducing the Lesson

Pique students' interest in the skeletal system by showing them a human skeleton. If possible, bring an articulated human skeleton or model skeleton to class for students to examine. Encourage students to handle the bones and see how they move. Another option is to display images of articulated human skeletons (see first URL below) and of individual human bones (see links at second URL below). Tell students they will learn about the human skeleton and its bones in this lesson. [http://th08.deviantart.net/fs71/PRE/f/2012/144/4/2/human\\_skeleton\\_study\\_by\\_meletis-d50zbp1.jpg](http://th08.deviantart.net/fs71/PRE/f/2012/144/4/2/human_skeleton_study_by_meletis-d50zbp1.jpg) <https://homes.bio.psu.edu/faculty/strauss/anatomy/skel/skeletal.htm>

### Introducing the Lesson

Another way to introduce the skeletal system is with the lesson at the following URL. Student will examine the bones of animals and record what they already know about bones and also what they wonder about bones. Examining the bones of other animals should give students ideas about the characteristics and functions of human bones and also raise questions about them. <http://www.canteach.ca/elementary/life7.html>

### Demonstration

You can demonstrate the bones and joints of the skeletal system by showing students this video: <http://www.neok12.com/video/Skeletal-System/zX7d5e056d641f5f630d5351.htm> You can demonstrate the structure and types of bones and bone cells with this video: <http://www.neok12.com/video/Skeletal-System/zX4b7e7c015e414f645c4206.htm>

### Activity

At the URL below, students can take an interactive tour of the human skeleton, using X-ray images of actual human bones. <http://www.accessexcellence.org/RC/VL/xrays/index.php>

### Activity

There are four activities on the skeletal system at the following URL. After completing the activities, students will be able to identify the functions of bones in the human body, describe the makeup of bone, understand that loss of calcium weakens bones, and describe the structure of the vertebral column. <http://www.iit.edu/~smile/bi9711.html>

### Differentiated Instruction

Print the human skeleton diagram at the URL below, and have students label it. This is a good activity for kinesthetic, visual, and English language learners. [http://kidshealth.org/kid/htbw/\\_bfs\\_SSactivity.html](http://kidshealth.org/kid/htbw/_bfs_SSactivity.html)

### Enrichment

Students interested in mysteries and forensics can find out what can be learned from bones by watching some or all of the following forensic anthropology videos. Ask students to share what they learn with the class in an oral report. Suggest that they create sketches to demonstrate important points in their talk. <http://www.youtube.com/w>

[atch?v=H-Iso0JL3Z8 http://www.history.com/videos/written-in-bone-forensic-anthropology-tools-and-techniques](http://www.history.com/videos/written-in-bone-forensic-anthropology-tools-and-techniques)  
<http://www.youtube.com/watch?v=kGriERmU8Dc&feature=related>

### Science Inquiry

Use the inquiry lesson “Bone up on Bones” at the URL below. Students will learn more about bones and form hypotheses about the potential effects of space travel on human bones. <http://virtualastronaut.tietronix.com/textonly/act16/text-skeletonact.html>

### Overcoming Misconceptions

Many students hold the misconception that bones are not living structures. Make sure they realize that bones consist of living tissues. Point out how they are supplied with nerves and blood, and explain that they exhibit characteristics of living things, such as needing nutrients and growing and developing. Another common misconception is that the only function of the skeletal system is to support the body. Be sure to discuss the homeostatic roles of bones and how bones protect soft tissues and organs.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 16.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. List components of the skeletal system.
2. What are three functions of the skeletal system?
3. Outline how human bones grow and develop, from the fetus to the adult.
4. Identify three types of joints based on the degree of movement they allow, and give examples of each type.
5. Regular weight-bearing exercise can reduce the risk of osteoporosis. Apply lesson concepts to explain why.
6. Make a table comparing and contrasting the four types of tissues in bones.
7. Contrast fractures with sprains.

### Lesson Quiz

Check students’ mastery of the lesson with Lesson 16.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The skeletal system allows the body to move, but the muscular system is also needed.

- How do muscles and bones work together to move the body?
- Not all muscles work with bones to move the body. Some muscles have other jobs. What are some other jobs of muscles?

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## 16.4 The Muscular System

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### Key Concepts

- How muscles contract
- Types of muscle tissue
- Structure and function of skeletal muscles
- Keeping the muscular system healthy

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### Standards

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### Lesson Objectives

- Define muscle.
- Explain how muscles contract.
- Identify three types of muscle tissue.
- Describe the structure and function of skeletal muscles.
- List ways to keep the muscular system healthy.

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### Lesson Vocabulary

- cardiac muscle: type of striated muscle tissue that is found only in the walls of the heart, causes the heart to beat, and is not under voluntary control
- muscle: organ of the muscular system that is composed primarily of cells called muscle fibers, which have the ability to contract
- muscle fiber: long, thin cell in muscle tissue that contains multiple nuclei, mitochondria, and organelles called myofibrils that allow the cell to contract
- muscular system: human body system that includes muscles and tendons
- myofibril: organelle in muscles fibers that allows muscles to contract
- skeletal muscle: type of striated muscle tissue that is attached to bone and is under voluntary control
- smooth muscle: type of nonstriated muscle tissue that is found in the walls of internal organs and is not under voluntary control
- tendon: tough connective tissue that anchors a skeletal muscle to a bone

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## Teaching Strategies

### Introducing the Lesson

Pique students' interest in learning about the muscular system by sharing some or all of the following fascinating facts about muscles.

- The smallest muscles in the body are found in the middle ear.
- The largest muscles in the body are found in the back near the spine. They hold the body upright.
- The strongest muscles in the body, for their mass, are the muscles that you chew with.
- Humans are born with all of the muscle cells they will ever have. They don't grow new muscle cells; the cells just increase in size.
- If all the muscles in the body could pull in the same direction at once, it would create a force of 25 tons.
- Smiling requires 17 facial muscles, whereas frowning requires 43 facial muscles.
- Muscles are even found inside the eyes, where they help keep the eyes focused and help control the amount of light that enters the eyes.

### Building Science Skills

In the quick activity at the following URL, students will place a tiny piece of shaved beef on a microscope slide, observe the striations under high power, and infer which type of muscle tissue they are observing. [http://www.myscience8.com/human\\_biology/module\\_3/dead\\_meat\\_lab\\_form.pdf](http://www.myscience8.com/human_biology/module_3/dead_meat_lab_form.pdf)

### Activity

Have students do the online interactive muscular system activity at the URL below. They will put mystery muscles into the right places in the human body and also learn important facts about the muscles. [http://www.bbc.co.uk/science/humanbody/body/interactives/3djigsaw\\_02/index.shtml?muscles](http://www.bbc.co.uk/science/humanbody/body/interactives/3djigsaw_02/index.shtml?muscles)

### Demonstration

Demonstrate to students how muscles work by showing them the kid-friendly cartoon at this URL: <http://kidshealth.org/kid/closet/movies/MSmovie.html>

### Differentiated Instruction

Visual learners and less proficient readers may have a better understanding of lesson content by viewing the three short animations at the following URLs. The first animation identifies the different types of muscles and their functions. The second animation focuses in detail on the structure of skeletal muscles and how they contract. The third animation explains the differences between aerobic and anaerobic exercise. [http://www.pennmedicine.org/encyclopedia/em\\_DisplayAnimation.aspx?gcid=000088&ptid=17](http://www.pennmedicine.org/encyclopedia/em_DisplayAnimation.aspx?gcid=000088&ptid=17) [http://www.pennmedicine.org/encyclopedia/em\\_DisplayAnimation.aspx?gcid=000113&ptid=17](http://www.pennmedicine.org/encyclopedia/em_DisplayAnimation.aspx?gcid=000113&ptid=17) [http://www.pennmedicine.org/encyclopedia/em\\_DisplayAnimation.aspx?gcid=000052&ptid=17](http://www.pennmedicine.org/encyclopedia/em_DisplayAnimation.aspx?gcid=000052&ptid=17)

### Enrichment

At the following URL, students can play a game in which they try to correctly identify the location of different muscles in the body. In the process, they will learn the names of many of the body's muscles. <http://www.bbc.co.uk>

[/science/humanbody/body/interactives/3djigsaw\\_02/index.shtml?muscles](/science/humanbody/body/interactives/3djigsaw_02/index.shtml?muscles)

## Science Inquiry

In the inquiry activity at the following URL, students will work in pairs to investigate how muscles work against gravity to maintain balance. Using themselves as test subjects, they will perform simple maneuvers to investigate factors involved in maintaining balance. In the activity, students will make predictions and observations, gather and record data, and draw conclusions. [http://www.pennmedicine.org/encyclopedia/em\\_DisplayAnimation.aspx?gcid=000113&ptid=17](http://www.pennmedicine.org/encyclopedia/em_DisplayAnimation.aspx?gcid=000113&ptid=17)

## Overcoming Misconceptions

Discuss the following common misconceptions with your class. The correct information is given in brackets following each misconception.

- Muscles are used only for voluntary physical actions like walking or throwing.

[Skeletal muscles, which are under voluntary control, are likely to be most familiar to students, but other types of muscles are essential for life functions. For example, heart muscle is composed of cardiac muscle cells and pumps blood throughout the body. Smooth muscle cells line blood vessels and the intestinal tract to help move blood or food through those passages. Neither heart nor smooth muscle is under voluntary control.]

- Muscles turn to fat if you quit exercising.

[This common misconception reflects a basic misunderstanding about these two types of body tissues. If a person stops exercising, the muscle cells may decrease in volume and become smaller. At the same time, there may be an increase in the volume of fat cells in the body. These changes may give the impression that muscle is turning to fat, but this is not the case.]

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 16.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are muscles?
2. What role do tendons play in the muscular system?
3. Create a public service announcement to convey the importance of regular exercise for healthy muscles.
4. Explain how muscles contract.
5. Compare and contrast the three types of muscle tissues.
6. Explain why skeletal muscles must work in pairs to move bones back and forth at joints.

## Lesson Quiz

Check students' mastery of the lesson with Lesson 16.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

You may have heard that eating certain foods causes acne. This may or may not be true. But there's no question that what you eat is important for the health of your skin, bones, and muscles.

- Do you know how to eat for good health?
- How do you choose healthy foods?

# CHAPTER 17

## TE MS Food and the Digestive System

### Chapter Outline

- 17.1 FOOD AND NUTRIENTS**
- 17.2 CHOOSING HEALTHY FOODS**
- 17.3 THE DIGESTIVE SYSTEM**

### Chapter Overview

This chapter identifies major types of nutrients and distinguishes between macronutrients and micronutrients. It also explains how to choose healthy foods using food labels and MyPlate, and it outlines the organs and functions of the digestive system.

### Online Resources

See the following Web sites for appropriate laboratory activities:

With the investigation “What Types of Foods Contain Starch and Protein?” at the following URLs, students will design and carry out experiments to evaluate indicator solutions to test for starch and/or protein, form hypotheses about which types of food contain each nutrient, and then design and carry out experiments to test their hypotheses. Finally, using their results, they will evaluate, and if necessary revise, their hypotheses. (teacher notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/StarchProteinTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/StarchProteinTeachPrep.pdf) (teacher notes) (student handout) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/StarchProteinProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/StarchProteinProtocol.pdf) (student handout)

In the lab “Mix It Up and Squeeze” at the URL below, students will make a model of the digestive system that demonstrates mechanical and chemical digestion. <http://medibotics.njit.edu/DG11.pdf>

These Web sites may also be helpful:

At the following URL, you can find several physical activities that will help students learn about nutrients and healthy eating while increasing their physical activity levels. <http://www.nyrr.org/youth-and-schools/running-start/nutrition-activities/middle-school>

You and/or your students can find the nutrient content of thousands of foods at these URLs: <http://www.nutrition.gov/whats-food> <http://ndb.nal.usda.gov/ndb/>

You can access the 2010 edition of the Dietary Guidelines for Americans at the URL below. The next edition of the guidelines may be accessed from the www.health.gov Web site in 2015. <http://www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf>

For more information on MyPlate, go to this URL: <http://www.choosemyplate.gov/dietary-guidelines.html>

Good resources on the digestive system and how it works can be found at these URLs: <http://www.niddk.nih.gov/health-information/health-topics/Anatomy/your-digestive-system/Pages/anatomy.aspx> <http://www.acm.uiuc.edu/sigbio/project/digestive/>

**TABLE 17.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
17.1 Food and Nutrients	2.5
17.2 Choosing Healthy Foods	2.0
17.3 The Digestive System	3.0

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## 17.1 Food and Nutrients

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### Key Concepts

- Definition of nutrient and types of nutrients
- Macronutrients and the foods that contain them
- Micronutrients and the foods that contain them

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### Standards

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### Lesson Objectives

- List three reasons why your body needs food.
- Define nutrient, and identify the six major types of nutrients.
- Describe macronutrients, their functions, and the foods in which they are found.
- Describe micronutrients, their functions, and the foods in which they are found.

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### Lesson Vocabulary

- Calorie: unit used to measure the energy in food
- dehydration: condition in which the water content of the body is too low
- fiber: complex carbohydrate that consists mainly of cellulose, comes only from plants, and is needed for good health although it cannot be digested
- macronutrient: type of nutrient the body needs in relatively large amounts; carbohydrate, protein, lipid, or water
- micronutrient: type of nutrient the body needs in relatively small amounts; vitamin or mineral
- mineral: inorganic chemical element, such as calcium, that is needed in the diet in small amounts for normal body functioning
- nutrient: any substance in food that the body needs
- starch: large, complex carbohydrate found in foods such as grains and vegetables that the body uses for energy
- trans fat: harmful, artificial lipid that is added to some processed foods to preserve freshness
- vitamin: organic compound, such as vitamin C, that the body needs in small amounts to function properly

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## Teaching Strategies

### Introducing the Lesson

Students may be familiar with the term nutrient from popular media. Make sure they have a correct understanding of the term.

- Ask: What is a nutrient?

Answer: A nutrient is substance in food that the body needs. Help students recall what they know about nutrient molecules from the lesson “Chemistry of Living Things.”

- Ask: What are the four main classes of biochemical compounds?

Answer: Carbohydrates, proteins, lipids, and nucleic acids Tell students that carbohydrates, proteins, and lipids are three of the six major types of nutrients. The other three are water, vitamins, and minerals. Tell the class they will learn more about nutrients in this lesson.

### Activity

Students can have fun while learning more about food and nutrition by playing games at the “Nutrition Cafe” at this URL: [http://exhibits.pacsci.org/nutrition/nutrition\\_cafe.html](http://exhibits.pacsci.org/nutrition/nutrition_cafe.html)

### Discussion

The discussion and worksheet activity described at the following URL gives students insights into scientific research and why experts may disagree, using the health effects of vitamin E as a case study. Students will learn useful approaches for evaluating and synthesizing conflicting research results, identify the strengths and weaknesses of different types of studies, and learn why the results of any single study should be interpreted with caution. Links are provided to a student handout and teacher notes. <http://serendip.brynmawr.edu/exchange/bioactivities/vitamins>

### Activity

The interactive online activity at the URL below will allow students to explore the health effects of different nutrients, including specific vitamins and minerals. Students can learn why each nutrient is needed, health effects of a deficiency of the nutrient, good food sources of the nutrient, and how much of the nutrient is needed. <http://www-tc.pbs.org/wgbh/nova/assets/swf/1/nutrients-body-needs/nutrients-body-needs.swf>

### Differentiated Instruction

On an overhead transparency or the board, guide students in creating a Venn diagram or table to compare and contrast micronutrients and macronutrients. Venn diagrams/tables should give a definition of each category of nutrients and list specific types of nutrients in each category.

### Enrichment

We can’t live long without water, but too much water can be dangerous. Drinking too much water may cause hyponatremia, a disease in which the blood becomes too dilute. The disease can be fatal. It’s actually fairly common

in athletes, who may go overboard in an attempt to stay hydrated. Ask a few students to investigate the health effects of drinking too much water. The URL below is a good place to start. Have the students share what they learn with the rest of the class. The information might even save the life of a student athlete. <http://www.scientificamerican.com/article/strange-but-true-drinking-too-much-water-can-kill/>

### Science Inquiry

With the inquiry activity at the following URL, students will explore nutrients, Calories, and the nutrients in fruits and vegetables. Specifically, they will use investigative questions to examine their own eating habits and explore why fruits and vegetables are integral to good health. Then, they'll brainstorm ways to eat more fruits and vegetables, and take part in a challenge to increase their fruit and vegetable intake. By the end of the lesson, students will understand why fruits and vegetables are good for them, have set personal nutrition goals, and have taken the first steps toward a lifetime of better health by eating more fruits and vegetables. [http://www.fns.usda.gov/sites/default/files/nutvoyage7\\_trek1.pdf](http://www.fns.usda.gov/sites/default/files/nutvoyage7_trek1.pdf)

### Overcoming Misconceptions

A common misconception is that all fats in the diet are bad and should be avoided. Explain to your students that everyone needs to eat some fat. Fat is needed for several reasons. For example, it aids in nutrient absorption, nerve transmission, and the maintenance of cell membranes. However, not all fats are created equal. Some fats promote good health while others may increase the risk for heart disease. Tell students that saturated fats should be restricted in a healthy diet and trans fats should be avoided completely. These fats should be replaced with polyunsaturated and monounsaturated fats. Also point out that the total amount of fat in the diet should be limited. Explain that consuming too much fat may contribute to weight gain, cardiovascular disease, and some types of cancer.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 17.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 17.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are three general purposes for which the body needs food?
2. Define nutrient, and list types of nutrients that can provide the body with energy.
3. Identify three functions of protein in the diet.
4. An apple contains about 20 grams of carbohydrates. How much energy does it provide?
5. Compare and contrast macronutrients and micronutrients.
6. Explain why you need fiber in your diet even though you can't digest it.
7. Why is water considered a nutrient?

## Lesson Quiz

Check students' mastery of the lesson with Lesson 17.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Now you know what nutrients you need and some of the foods that contain them.

- How can you combine the foods for a healthy diet?
- What rules or guidelines should you follow?

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## 17.2 Choosing Healthy Foods

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### Key Concepts

- How to use my MyPlate
- How to read food labels
- Balancing food with exercise to avoid obesity

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### Standards

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### Lesson Objectives

- Describe how to use MyPlate to make nutritious food choices.
- Outline how to use food labels to choose healthy foods.
- Explain why you must balance food with exercise to maintain a healthy weight and avoid obesity.

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### Lesson Vocabulary

- ingredient: specific item that a food contains
- main ingredient: item a food contains in the greatest amount; item listed first on a food's ingredient list
- MyPlate: diagram that shows the relative amounts of five food groups you should eat at each meal for balanced eating
- nutrition facts label: label on packaged food that shows the size, Calories, and major nutrients per serving
- obesity: disorder in which a person has a high percentage of body fat, which increases the risk of diabetes, high blood pressure, and other health problems

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### Teaching Strategies

#### Introducing the Lesson

Place 28 raw baby carrots on a plate. On an identical plate, place 10 fried potato chips. Show both plates to the class and ask students which food has more Calories. (Students may think that the carrots have more Calories because there are so many more of them.) Explain that both foods have 100 Calories but the chips have few nutrients except fat and sodium whereas the carrots are rich in vitamins and fiber. Make the point that the carrots are more nutrient dense and would also be more filling. Ask students to think about this comparison when they read about healthy eating this lesson.

### Activity

Use the curriculum supplement at the following URL when you teach students about energy balance and avoiding obesity. The module includes several interactive student activities and a teacher's guide. <http://science.education.nih.gov/supplements/nih4/energy/default.htm>

### Discussion

The discussion/worksheet activity at the following URL allows students to apply the scientific process to test a hypothesis about the relationship between carbohydrate consumption and athletic performance. A student handout and teacher notes are provided. <http://serendip.brynmawr.edu/exchange/bioactivities/sciproc>

### Activity

At the URL below, you can find links to a nutrition jeopardy game in which students will identify and describe principles from MyPlate and the 2010 Dietary Guidelines by answering nutrition questions. [http://www.drexel.edu/nutritioneducation/ms\\_lesson\\_plans\\_fy15.html](http://www.drexel.edu/nutritioneducation/ms_lesson_plans_fy15.html)

### Activity

Use the “Fast Food Frenzy” lesson plan at the following URL to help students learn how to eat wisely when they eat at fast food restaurants. Objectives of the activity include explaining why excessive fat intake is not healthful, describing ways to limit fat when eating fast food, identifying the difference between healthful and less healthful fats, and making lower-fat choices from fast food restaurant menus. [http://www.drexel.edu/nutritioneducation/ms\\_lesson\\_plans\\_fy15.html](http://www.drexel.edu/nutritioneducation/ms_lesson_plans_fy15.html)

### Differentiated Instruction

Give each kinesthetic or English language learner a paper plate. Then ask the students to cut out or sketch pictures of foods and arrange the pictures on the plate to model MyPlate.

### Enrichment

Ask any students who are interested in a teaching career to prepare a lesson for an elementary grade on how to use MyPlate to choose foods for a well-balanced diet. If possible, arrange for the students to present their lesson to an elementary class in your school district.

### Science Inquiry

The inquiry activity described at the URL below is an investigation that is carried out at the local grocery store. Students will visit a local supermarket and gather information on various food items. Working with a partner, they will fill in information in a worksheet that requires them to read product labels; compare fat, sodium, and sugar contents of various food items; and make judgments regarding the relative healthfulness of the items. Back in the classroom, students will use their data to develop sample healthy diets. [http://www.accessexcellence.org/AE/AEC/AEF/1996/drake\\_supermarket.php](http://www.accessexcellence.org/AE/AEC/AEF/1996/drake_supermarket.php)

## Science Inquiry

In the inquiry-based activity at the following URL, students will learn that there are many fun ways to be physically active in addition to playing sports. They will also learn about physical activity guidelines for their age group, analyze their own physical activity levels, and take part in a challenge to increase their time spent in physical activity. [http://www.fns.usda.gov/sites/default/files/nutvoyage8\\_trek1.pdf](http://www.fns.usda.gov/sites/default/files/nutvoyage8_trek1.pdf)

## Real-World Connection

With the activity at the following URL, students can be real-world food detectives. They will search for answers to specific questions about actual prepared food products, including what a food is made from, the source of its ingredients, and how the ingredients were grown. The activity includes options for homework. <http://forces.si.edu/ltop/pdfs/6-8-BeAFoodDetective.pdf>

## Math Connection

In the math-based activity at the URL below, students will use math to evaluate the snack options available at their school, based on nutrition facts labels and dietary guidelines. They will also think critically about how the school could offer healthier snacking choices. By the end of the activity, students will better understand what constitutes a healthy snack and may have made a direct impact on their school environment. [http://www.fns.usda.gov/sites/default/files/nutvoyage8\\_trek2.pdf](http://www.fns.usda.gov/sites/default/files/nutvoyage8_trek2.pdf)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 17.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 17.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is MyPlate?
2. List four guidelines for using MyPlate.
3. Identify information included in a nutrition facts label.
4. Define obesity. What causes it and what health problems are associated with it?
5. Look at the nutrition facts label in Figure 17.8. Which, if any, nutrients are present at high levels in the food? Which are present at low levels?
6. Describe a weekly plan that would allow you to fit adequate physical activity into your schedule.
7. Explain how you can use a food label to identify the main ingredient in a food.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 17.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The food you eat provides your body with nutrients. But first, the food must be broken down by the digestive system.

- What are some of the organs that make up the digestive system?
- What processes break down food into nutrients?

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## 17.3 The Digestive System

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### Key Concepts

- Organs of the digestive system
- Role of enzymes in digestion
- Processes of digestion, absorption, and elimination
- Intestinal bacteria
- Digestive system problems

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### Standards

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### Lesson Objectives

- Identify the major organs and general functions of the digestive system.
- Explain the role of enzymes and other secretions in digestion.
- Outline the digestive functions of the mouth, esophagus, and stomach.
- Explain how digestion and absorption occur in the small intestine.
- State functions of the large intestine and roles of intestinal bacteria.
- Describe two digestive system problems and how to prevent them.

---

### Lesson Vocabulary

- absorption: process in which nutrients or other molecules are taken up by the blood
- chemical digestion: chemical process in which large food molecules are broken down into smaller nutrient molecules in the digestive system
- digestion: process of breaking down food into nutrients that takes place in the digestive system; includes mechanical digestion and chemical digestion
- digestive system: body system that breaks down food, absorbs nutrients, and eliminates any remaining solid food waste
- elimination: process in which feces pass out of the body through the anus
- esophagus: tube-like organ of the digestive system that carries food from the pharynx in the throat to the stomach
- food allergy: reaction that occurs when the immune system responds to substances in food as though they were pathogens
- foodborne illness: illness that occurs when harmful bacteria enter the digestive system in food; commonly called food poisoning
- gall bladder: sac-like organ of the digestive system that stores and concentrates liver bile before releasing it into the small intestine

- gastrointestinal (GI) tract: long tube that connects the mouth to the anus and through which food passes as it is digested, its nutrients are absorbed, and food waste is eliminated; consists of the mouth, esophagus, stomach, small intestine, and large intestine
- large intestine: wide, tube-like organ of the digestive system that connects the small intestine and anus, eliminates feces from food wastes, and provides a home for helpful bacteria
- liver: organ of digestion and elimination that makes and secretes bile acids into the small intestine and gall bladder to help digest fats
- mechanical digestion: physical process in which large chunks of food are broken down into smaller pieces in the digestive system
- pancreas: gland in the digestive and endocrine systems that secretes digestive enzymes into the small intestine and secretes the hormone insulin into the blood
- peristalsis: waves of muscle contractions in the organs of the gastrointestinal tract that keep food moving through the tract
- small intestine: long, narrow, tube-like organ of the digestive system between the stomach and large intestine that carries out most chemical digestion and nutrient absorption
- stomach: sac-like organ of the digestive system between the esophagus and small intestine that carries out both mechanical and chemical digestion
- villi (villus, singular): tiny projections covering the inner surface of the jejunum and ileum of the small intestine that greatly increase the surface area for absorption of nutrients

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## Teaching Strategies

### Introducing the Lesson

Introduce the digestive system with the classic saltine cracker activity. Give each student a piece of saltine cracker. Tell students to put the cracker in their mouth and let it slowly soften from their saliva. They should keep the cracker in their mouth without swallowing it for several minutes. Have students observe how the cracker tastes when they first place it in their mouth and then again after a few minutes have passed. Students are likely to notice that the cracker starts to taste sweet even though the original cracker contained almost no sugar and did not taste sweet. Explain that the starch in the cracker starts to break down to sugars by digestion in the mouth. Tell students they will learn how this happens when they read the lesson.

### Demonstration

Show students videos to help them learn about the digestive system. The entertaining animated movie at the first URL demonstrates how the digestive system works. In the amazing movie at the second URL, students will watch a tiny camera's journey through an actual human digestive tract. <http://kidshealth.org/kid/htbw/DSmovie.html>  
<http://www.pbslearningmedia.org/resource/68fa248f-397a-4a6d-b7cf-f3073dcb7475/guts-the-small-intestines-and-digestion/>

### Activity

Students can simulate the work of digestive organs with the hands-on class activity described at the URL below. The digestive tract is assembled using two parallel strips of tape on the floor 3-4 feet apart and the width of the classroom. A large filled bag represents the food particle. Students standing on both lines act out digestive functions of the organs in the GI tract as the food particle comes to them. [http://www.accessexcellence.org/AE/AEC/AEF/1995/cave\\_digest.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/cave_digest.php)

## Building Science Skills

With the activity at the following URL, teams of students will reinforce their knowledge of the human digestive system while exploring simulation and technological design. Each team will develop a pill coating that can withstand the churning actions and acidic environment of the stomach. Teams will test the coating's durability by using a clear soda to simulate stomach acid. <http://teachers.egfi-k12.org/digest-this/>

## Activity

The lesson at the following URL contains six hands-on activities on digestion and the digestive system that are appropriate for middle school students. <http://mypages.iit.edu/~smile/bi9706.html>

## Differentiated Instruction

Kinesthetic English language learners can “walk” through the digestive system with the activity at the following URL. This simulation will help students understand what happens to food as it passes through the digestive system. Each student will be given a 3x5 index card representing food, which he/she carries to stations around the room. Each station creatively represents one of the organs of the digestive system and gives the student a specific instruction to “digest” the index card. At the end of the simulation, students will form cooperative learning groups to discuss the results of the simulation and how it applies to the real digestive system. The groups should combine differential learners with other students in the class. [http://www.accessexcellence.org/AE/AEC/AEF/1994/ward\\_walk.php](http://www.accessexcellence.org/AE/AEC/AEF/1994/ward_walk.php)

## Differentiated Instruction

Print the human digestive system diagram at the following URL, and have students label it. This is another good activity for kinesthetic and English language learners. [http://kidshealth.org/kid/htbw/\\_bfs\\_DSactivity.html](http://kidshealth.org/kid/htbw/_bfs_DSactivity.html)

## Enrichment

Have one or more students create a crossword puzzle using at least 12 of the lesson vocabulary terms. They can make the puzzle by hand or use the free online puzzle maker at the following URL. Distribute copies of the puzzle to other students and have them complete it as a review of lesson vocabulary. <http://www.discoveryeducation.com/free-puzzlemaker/>

## Science Inquiry

The inquiry activity provided at the URL below is an excellent way for students to investigate the role of enzymes in digestion. In the activity, students will work with models of substrates and enzymes, test the digestion of lactose with the enzyme lactase, and determine whether digestion of lactose has occurred. The activity can be extended with related activities to illustrate that enzymes are specific and reusable. [http://www.accessexcellence.org/AE/AEC/AEF/1996/crumlish\\_enzyme.php](http://www.accessexcellence.org/AE/AEC/AEF/1996/crumlish_enzyme.php)

## Overcoming Misconceptions

AAAS research has found that more than a third of middle school students think that simple sugars, fatty acids, and amino acids have to be broken down into smaller, simpler molecules before they can enter the cells of the body. Made sure students realize that these are the end products of digestion that are circulated in the blood and carried to cells.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 17.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 17.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is the GI tract? What organs does it include?
2. Describe the roles of the mouth, esophagus, and stomach in digestion.
3. Identify two functions of the large intestine.
4. List three foods that commonly cause food allergies.
5. How could you reduce the risk of foodborne illness on a picnic? What materials and methods could you use?
6. Explain the role of enzymes in digestion, and give two examples.
7. Explain the structure and function of villi in the small intestine.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 17.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

In the digestive system, food is digested and its nutrients are absorbed by the blood for transport around the body. The blood is part of the cardiovascular system.

- What organs make up the cardiovascular system?
- Besides nutrients, what other substances are transported by the blood?

## CHAPTER

## 18

## TE MS Cardiovascular System

## Chapter Outline

- 18.1 OVERVIEW OF THE CARDIOVASCULAR SYSTEM
- 18.2 HEART AND BLOOD VESSELS
- 18.3 BLOOD

## Chapter Overview

This chapter focuses on the cardiovascular system. It distinguishes between the pulmonary and systemic circulations, describes the heart and blood vessels, and identifies cardiovascular and blood diseases. The chapter also outlines components and functions of the blood and explains blood type and its significance.

## Online Resources

See the following Web sites for appropriate laboratory activities:

With the lab described at the following URL, students will work in small groups to identify parts of the heart and their functions, using a bisected beef heart and a heart diagram. The Web page includes a materials list, student procedure, and background for the teacher. [http://learn.fi.edu/learn/heart/enrichment/activity\\_healthy-heart.html](http://learn.fi.edu/learn/heart/enrichment/activity_healthy-heart.html)

In the lab at the URLs below, students will design and carry out an experiment to investigate factors that affect heart rate. (Student handout) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/HeartRateProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/HeartRateProtocol.pdf) (Student handout) (Teacher prep notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/HeartRateTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/HeartRateTeachPrep.pdf) (Teacher prep notes)

Students will have a better understanding of the composition of blood by doing the 30-minute “Healthy Hematocrit” lab at the URL below. In the lab, students will measure the hematocrit (percentage of blood that is red blood cells) of a mystery sample of “blood,” which they will simulate with vegetable oil (plasma) and red sugar crystals (red blood cells). [http://www.americasblood.org/media/43213/mbyb\\_hs\\_tg.pdf](http://www.americasblood.org/media/43213/mbyb_hs_tg.pdf)

These Web sites may also be helpful:

The following URL contains a complete lesson plan for teaching the cardiovascular system. It includes class discussions and activities, Web activities and games, and a culminating word search puzzle. [http://www.pbslearnmedia.org/resource/tdc02.sci.life.stru.lp\\_circula/the-circulatory-system/](http://www.pbslearnmedia.org/resource/tdc02.sci.life.stru.lp_circula/the-circulatory-system/)

The Web sites at the URLs below provide a plethora of information, links, activities, and other resources on the human heart and cardiovascular health. <http://learn.fi.edu/learn/heart/index.html> [http://www.heart.org/HEARTORG/Educator/FortheClassroom/MiddleSchoolLessonPlans/Middle-School-Lesson-Plans\\_UCM\\_304280\\_Article.jsp](http://www.heart.org/HEARTORG/Educator/FortheClassroom/MiddleSchoolLessonPlans/Middle-School-Lesson-Plans_UCM_304280_Article.jsp)

TABLE 18.1: Lesson Pacing

Lesson	Class Period(s) (60 min)
18.1 Overview of the Cardiovascular System	1.0

**TABLE 18.1:** (continued)

Lesson	Class Period(s) (60 min)
18.2 Heart and Blood Vessels	1.5
18.3 Blood	1.5

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## 18.1 Overview of the Cardiovascular System

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### Key Concepts

- Organs and functions of the cardiovascular system
- Pulmonary and systemic circulations

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### Standards

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### Lesson Objectives

- Identify parts of the cardiovascular system.
- State functions of the cardiovascular system.
- Compare and contrast the two circulations of the cardiovascular system.

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### Lesson Vocabulary

- cardiovascular system: human body system that consists of the heart, blood vessels, and blood and transports materials throughout the body
- pulmonary circulation: shorter of two loops of the cardiovascular system that carries blood between the heart and lungs
- systemic circulation: longer of two loops of the cardiovascular system that carries blood between the heart and rest of the body except the lungs

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### Teaching Strategies

#### Introducing the Lesson

Introduce the cardiovascular system by explaining that all of the body's trillions of living cells need nutrients and oxygen to stay alive. Whether a person is exercising or sleeping, the cardiovascular must keep supplying all of the cells with nutrients and oxygen. Emphasize that the cardiovascular system must keep working non-stop from before birth until death. Point out that if a cell is deprived of oxygen for even a few minutes, it will start to die. Add that the cardiovascular system also must collect carbon dioxide and other waste products from cells so these substances can be eliminated from the body. Tell students they will learn more about the functions of the cardiovascular system in this lesson.

## Discussion

After students read about the functions of the cardiovascular system in the Flexbook lesson, discuss how the system works with other organ systems to deliver food and oxygen to all the body's cells and remove waste products from the cells.

## Cooperative Learning

Let teams of students educate the rest of the class about the cardiovascular system by having them do the “Human Body Quest” activity for the cardiovascular system at the URL below. Each team will create a presentation and worksheet for the system using their textbook, online resources, and other references materials for their research. <http://sciencespot.net/Media/hlthhumbdyquest.pdf>

## Differentiated Instruction

Work with students to create a Venn diagram, compare-contrast table, or other visual display to summarize the differences between the pulmonary and systemic circulations. Post the finished display in the classroom. It will be useful for students to refer to when they learn about the two sides of the heart in the next lesson (“Heart and Blood Vessels”).

## Enrichment

Arrange for any students interested in a medical career to interview a physician, nurse, or technician in the cardiology department of a nearby hospital, clinic, or medical school. Suggest that the students prepare a list of questions or discussion topics in advance. Have them share what impressed or interested them most in the interview in an oral report to the class.

## Science Inquiry

With the inquiry activity at the URL below, students will use simple materials to design and build a model circulatory system. The model will simulate the pumping action of the heart to circulate blood to body cells. With their models, students will be able to observe directly how a pump moves liquid through a closed system of vessels. <http://www.igreatschools.org/science/5275-iridescent-science-experiment-circulatory-system.gs>

## Overcoming Misconceptions

The following cardiovascular system misconceptions have been identified in middle school students. Some of the misconceptions are opposite but equally erroneous concepts. Discuss with your class why each misconception is false.

1. Oxygen and molecules from food go directly from the lungs or mouth to the rest of the body.
2. Oxygen and molecules from food are distributed through the body by special tubes, not by the bloodstream.
3. Blood flows freely through the walls of blood vessels.
4. Carbon dioxide, oxygen, water, and molecules from food pass directly through the walls of arteries and veins to and from body cells (rather than only through the walls of capillaries).
5. Capillaries are found only in internal organs, such as the lungs and the intestines.
6. Capillaries are found only in the extremities, such as the hands and feet.
7. Anything can pass through the walls of capillaries.
8. Nothing can pass through the walls of capillaries.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 18.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 18.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. List the parts of the cardiovascular system.
2. State two general functions of the cardiovascular system.
3. The cardiovascular system has been called the highway system of the body. Do you think this is a good analogy for the cardiovascular system? Why or why not?
4. Compare and contrast the pulmonary and systemic circulation loops of the cardiovascular system.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 18.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The main organs of the cardiovascular system are the heart and blood vessels. Both organs contain valves. Valves also are found in plumbing systems. They can be turned on or off to control the flow of water.

- What is the function of valves in the cardiovascular system?
- Why are valves needed in the cardiovascular system?

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## 18.2 Heart and Blood Vessels

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### Key Concepts

- Structure and function of the heart
- Types of blood vessels
- Blood vessels and homeostasis
- Cardiovascular diseases
- Cardiovascular system health

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### Standards

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### Lesson Objectives

- Describe the structure and function of the heart.
- Identify types of blood vessels, and explain how blood vessels help maintain homeostasis.
- Describe cardiovascular diseases and ways to keep the cardiovascular system healthy.

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### Lesson Vocabulary

- artery: thick-walled blood vessel that generally carries oxygen-rich blood away from the heart
- atherosclerosis: condition in which plaques build up inside arteries, reduce blood flow, and often lead to cardiovascular disease
- atrium (atria, plural): either of two upper chambers of the heart; right atrium or left atrium
- blood vessel: long, tube-like organ that forms part of the complex network of vessels that run through the body and transport blood to all the body's cells
- capillary: smallest type of blood vessel that connects an arteriole and venule and exchanges substances between cells and the blood
- cardiovascular disease: disease of the heart or blood vessels, such as coronary heart disease
- coronary heart disease: cardiovascular disease in which there is poor blood flow to the heart because plaques block coronary arteries that normally supply blood to the heart
- heart: muscular organ in the chest that pumps blood through blood vessels in the cardiovascular system
- heart attack: death of cardiac muscle cells that occurs when the blood supply to part of the heart muscle is blocked
- valve: flap in the heart or a blood vessel that opens to allow blood to flow through in one direction and then closes to prevent blood from flowing back in the opposite direction
- vein: thin-walled blood vessel that generally carries oxygen-poor blood toward the heart
- ventricle: either of the two lower chambers of the heart; right ventricle or left ventricle

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## Teaching Strategies

### Introducing the Lesson

Instruct students to lay their hand (palm side up) on their desk and have them open and close their hand to make a fist repeatedly for at least one minute. Their hand should start getting tired before the time is up. Tell students that a similar action occurs inside their body day in and day out and never stops until the end of life. Explain that the action is the pumping of their heart muscle. The heart, which is approximately fist sized, beats about 70 times a minute throughout life. In an average lifetime, it beats more than two and a half billion times, without ever pausing to rest. Tell students they will learn more about this amazing organ when they read the lesson.

### Demonstration

Show students the kid-friendly video at the following URL to demonstrate how the heart works. <http://kidshealth.org/kid/htbw/CSmovie.html>

### Activity

Students can learn more about the heart and heart beat by doing the hands-on activity described at the URL below. Pairs of students will create a simple stethoscope and listen to their partner's heartbeat. They will count heart beats and use it to calculate heart rate. [http://learn.fi.edu/learn/heart/enrichment/activity\\_heartbeat.html](http://learn.fi.edu/learn/heart/enrichment/activity_heartbeat.html)

### Cooperative Learning

In the activity at the URL below, teams of students will become “biomedical engineers.” They will learn about the engineering design process and how a one-way valve works by creating heart valves from tape, plastic tubing and a variety of other materials. The exercise will reinforce their understanding of how heart valves work and show them how engineering can contribute to solving medical problems. <http://teachers.egfi-k12.org/no-valve-in-vain/>

### Differentiated Instruction

Have students use the drag-and-drop activities at the following URLs to label the parts of the human heart (first URL) and match definitions to basic cardiovascular system terminology (second URL). These are good activities for visual, kinesthetic, and English language learners. <http://www.freezeray.com/flashFiles/heart.htm> [http://www.softschools.com/matching\\_games/science/the\\_circulatory\\_system/1413/](http://www.softschools.com/matching_games/science/the_circulatory_system/1413/)

### Enrichment

The blood pressure project at the following URL can be used as a science fair project or for enrichment. In the project, students will collect blood pressure data from children of different ages to determine whether blood pressure is age related. Ask students to share the results of their investigation with the rest of the class. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/HumBio\\_p030.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/HumBio_p030.shtml)

### Science Inquiry

With the inquiry activity at the URLs below, students will model what happens to the flow of blood when atherosclerosis narrows a person's arteries. They will create their model using straws, disposable cups, and colored water.

(teacher guide) [http://www.sciencebuddies.org/science-fair-projects/Classroom\\_Activity\\_Teacher\\_Modeling\\_Blood\\_Flow.shtml](http://www.sciencebuddies.org/science-fair-projects/Classroom_Activity_Teacher_Modeling_Blood_Flow.shtml) (teacher guide) (student guide) [http://www.sciencebuddies.org/science-fair-projects/Classroom\\_Activity\\_Student\\_Modeling\\_Blood\\_Flow.shtml](http://www.sciencebuddies.org/science-fair-projects/Classroom_Activity_Student_Modeling_Blood_Flow.shtml) (student guide)

### Health Connection

Tell students that the heart, like any muscle, needs exercise to stay strong and healthy. Doing an exercise such as running in place increases the rate at which the heart beats and gives the heart muscle a workout. Students can observe how their own heart rate responds to exercise with the simple activity at the following URL. After students complete the activity and plot their data, have them compare their results with those of other students. Then discuss as a class good ways for students to incorporate regular exercise into their daily lives. <http://www.gscdn.org/library/cms/55/14755.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 18.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 18.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Describe the structure of the heart.
2. Give an example of homeostasis involving blood vessels.
3. Define cardiovascular diseases.
4. Create a poster showing ways to keep the cardiovascular system healthy.
5. Explain how the heart pumps blood.
6. Compare and contrast the three major types of blood vessels.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 18.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Transporting blood is the main job of the heart and blood vessels.

- What is blood? What is it made of?
- What substances are transported around the body in blood?

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## 18.3 Blood

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### Key Concepts

- Components and functions of the blood
- Blood types
- Diseases of the blood

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### Standards

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### Lesson Objectives

- Describe blood components, and list functions of the blood.
- Define blood type, and explain its medical significance.
- Identify some diseases of the blood.

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### Lesson Vocabulary

- anemia: disease that occurs when there is not enough hemoglobin (or iron) in the blood to transport adequate oxygen to the cells
- antigen: protein that may be recognized by the immune system as self or nonself, such as a red blood cell antigen that determines blood type (self) or an antigen on a bacterial cell (nonself)
- blood: liquid connective tissue that circulates throughout the body via blood vessels due to the pumping action of the heart
- blood clot: solid mass of platelets and other substances that plugs a leak in a damaged blood vessel and stops bleeding
- blood type: classification of an individual's blood based on the particular antigens found on the individual's red blood cells, such as blood type A in the ABO antigen system, in which the red blood cells carry A antigens
- hemoglobin: protein containing iron that is found in red blood cells and that binds with oxygen so it can be carried by the blood to cells throughout the body
- hemophilia: genetic disorder controlled by a gene on the X chromosome in which blood fails to clot properly, leading to excessive bleeding
- leukemia: type of cancer in which bone marrow produces abnormal white blood cells that cannot fight infections
- plasma: golden-yellow liquid part of the blood that contains dissolved substances such as glucose, proteins, and gases
- platelet: small, sticky cell fragment in blood that helps blood clot
- red blood cell: type of blood cell that carries oxygen in the blood

- sickle-cell disease: genetic disorder of the blood in which abnormal hemoglobin causes red blood cells to take on a characteristic sickle shape under certain conditions
- white blood cell: type of blood cell that helps defend the body

## Teaching Strategies

### Introducing the Lesson

Introduce the lesson by asking students to define or describe blood. For example, ask: What is blood made of? Why is blood red? Accept all reasonable responses at this point. Tell students they will learn answers to the questions in this lesson.

### Building Science Skills

Students can build observational skills while playing a game. In the “Cell Hunt” lab at the following URL, students will use a simulation game to observe the shapes, sizes, and relative abundance of the different cellular components of blood (red blood cells, white blood cells, and platelets). [http://www.americasblood.org/media/43213/mbyb\\_hs\\_tg.pdf](http://www.americasblood.org/media/43213/mbyb_hs_tg.pdf)

### Demonstration

Do a simple demonstration to show how form is related to function in red blood cells. Inflate a red balloon, and tell students you will use the balloon to model the shape of a red blood cell. After the balloon is inflated and tied off, place your fists on opposite sides of the balloon and press inward, so the balloon takes on the concave disk shape of a red blood cell. Explain that a real red blood cell is like a bag of hemoglobin, and hemoglobin needs to be near the cell surface to accept or give up oxygen. Point out, using the balloon, how a disk shape would allow more hemoglobin molecules to be close to the surface of the cell. Release the balloon so it goes back to a spherical shape. Point out how a spherical shape would mean that many hemoglobin molecules are in the center, far from the surface.

### Differentiated Instruction

Guide students in creating a compare-contrast table for ABO blood types. Include the genotype(s) for each blood type. Also include the antigens and antibodies found in each type of blood, as well as blood types that can safely be transfused into patients of each blood type. A sample table is shown below. After completing the table, ask students to explain why type AB is called the universal recipient and type O is called the universal donor.

**TABLE 18.2:** Different Blood Types

Blood Type	Genotype(s) of This Blood Type	Antigens in Blood of This Type	Antibodies in Blood of This Type	Blood Types This Type Can Safely Receive in a Transfusion
A	AA, AO	A	anti-B	A, O
B	BB, BO	B	anti-A	B, O
AB	AB	A, B	none	A, B, AB, O
O	OO	none	anti-A, anti-B	O

## Enrichment

Have advanced students read the excellent article at the URL below on sickle-cell trait and malaria resistance. This trait is widely used as a classic example of natural selection in human beings. Students will learn why sickle-cell trait is selected for in populations where malaria is endemic and the long-accepted theory about why people with the trait are resistant to malaria. Then they will read about recent research that supports a very different explanation for why the trait confers resistance. This example will show students how scientific knowledge typically advances. Ask them to summarize what they learn in an oral report to the class. <http://www.sciencedaily.com/releases/2011/04/110428123931.htm>

## Science Inquiry

Have students do the minds-on activity, “Using Blood Tests to Identify Babies and Criminals,” at the following URLs. In the activity, students will apply the genetics and immunobiology of the ABO blood type system. They will use simple chemicals and logical reasoning to solve a murder mystery and to determine whether two babies were switched in the hospital. (Student worksheet) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/BloodTypeGeneticsProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/BloodTypeGeneticsProtocol.pdf) (Student worksheet) (Teacher notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/BloodTypeGeneticsTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/BloodTypeGeneticsTeachPrep.pdf) (Teacher notes)

## Real-World Connection

Connect blood types to their real-world applications by having students play the award-winning educational game at the following URL. The challenge is to save patients in urgent need of blood transfusions by deciding which blood type they have and which blood type(s) they can safely receive. <http://www.nobelprize.org/educational/medicine/bloodtypinggame/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 18.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 18.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is blood?
2. Identify the main function of blood.
3. Describe two diseases of the blood and their causes.
4. Why might it be necessary to determine your ABO blood type?
5. If you have type O blood, which type(s) of blood can you safely receive?
6. Compare and contrast red blood cells and white blood cells.
7. Relate antigens to blood types.

## Lesson Quiz

Check students' mastery of the lesson with Lesson 18.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The blood picks up oxygen in the lungs and carries it to cells throughout the body.

- How does oxygen enter the lungs?
- How does oxygen get from the lungs into the blood?

## CHAPTER

## 19

# TE MS Respiratory and Excretory Systems

## Chapter Outline

**19.1 THE RESPIRATORY SYSTEM**

**19.2 THE EXCRETORY SYSTEM**

## Chapter Overview

This chapter identifies structures of the respiratory system; explains how breathing, gas exchange, and gas transport occur; and describes diseases of the respiratory system. The chapter also identifies organs and functions of the excretory system; explains how the kidneys filter blood, produce urine, and maintain homeostasis; and describes kidney diseases.

## Online Resources

See the following Web sites for appropriate laboratory activities:

In the investigation at the following URLs, students will carry out an experiment to test whether changing levels of oxygen and carbon dioxide influence how long they can hold their breath. Several background activities are also provided. (student handout) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/BreathingLabProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/BreathingLabProtocol.pdf) (student handout) (teacher notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/BreathingLabTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/BreathingLabTeachPrep.pdf) (teacher notes)

Use the dialysis lab at the following URL to teach students how the kidneys function, as well as the basic processes of osmosis and diffusion, which are needed for all cells to function normally. The document includes extensive background material for the teacher. <http://www.yale.edu/ynhti/nationalcurriculum/units/2011/7/11.07.07.x.html>

These Web sites may also be helpful:

Use the inquiry-based learning cycle unit at the URL below after students read about the respiratory system. The unit covers aspects of cardiovascular and respiratory physiology that are important in exercise and fitness. It is designed to provide middle school students with a basic understanding of how the heart and the lungs work together when someone exercises. The unit can be used as an integrative review of these topics, or selected activities from the unit could be used to introduce some of the topics. The unit assumes a basic knowledge of the cardiovascular and respiratory systems. <http://www.lifescitrc.org/download.cfm?submissionID=4270>

The following URL has links to many urinary system teaching resources, including games, quizzes, and videos: <http://www.neok12.com/Urinary-System.htm>

You can find concise, student-friendly articles on the excretory system at these URLs: [http://www.kidsbiology.com/human\\_biology/excretory-system.php](http://www.kidsbiology.com/human_biology/excretory-system.php) [http://www.biology4kids.com/files/systems\\_excretory.html](http://www.biology4kids.com/files/systems_excretory.html) <http://www.mcwden.org/body/excretory.html>

**TABLE 19.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
19.1 The Respiratory System	2.0
19.2 The Excretory System	1.5

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## 19.1 The Respiratory System

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### Key Concepts

- Process of respiration
  - Structures of the respiratory system
  - Breathing, gas exchange, and gas transport
  - Diseases of the respiratory system
  - Health of the respiratory system
- 

### Standards

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### Lesson Objectives

- Define respiration and distinguish it from cellular respiration.
  - Identify structures of the respiratory system.
  - Explain how breathing, gas exchange, and gas transport occur.
  - Describe respiratory system diseases and how to keep the respiratory system healthy.
- 

### Lesson Vocabulary

- asthma: respiratory system disease in which bronchioles in the lungs periodically swell and fill with mucus, making breathing difficult
- emphysema: respiratory system disease in which the walls of alveoli break down, reducing gas exchange in the lungs and causing shortness of breath
- lung: one of a pair of organs in the respiratory system where gas exchange between the air and blood takes place
- pneumonia: respiratory disease in which some of the alveoli in the lungs fill with fluid so they can no longer exchange gas, causing coughing and other symptoms
- respiration: exchange of oxygen and carbon dioxide between the body and the outside air
- respiratory system: organ system that exchanges gases with the outside air and includes the nose, trachea, and lungs
- trachea: respiratory system organ that consists of a long tube through which air passes from the throat to the lungs; commonly called the wind pipe

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## Teaching Strategies

### Introducing the Lesson

Introduce the respiratory system with a simple activity. Ask students to take a deep breath and hold it for as long as they can. (After a minute or two, everyone will be gasping for breath.) Ask students why they couldn't go longer without air when they can go for several days without water and even longer without food. Accept all reasonable responses at this point, and tell students they will learn the answer to this question when they read the lesson.

### Demonstration

Use the kid-friendly cartoon video at the following URL to explain the structures and functions of the organs of the respiratory system. [http://kidshealth.org/PageManager.jsp?lic=1&article\\_set=59300&cat\\_id=20607](http://kidshealth.org/PageManager.jsp?lic=1&article_set=59300&cat_id=20607)

### Cooperative Learning

Have groups of students undertake the “Human Body Quest” activity for the respiratory system at the URL below. Each group will prepare a PowerPoint presentation and worksheet to share the information with their classmates. In the presentation, they will describe the major parts and functions of the respiratory system and explain how the respiratory system works with other body systems. <http://sciencespot.net/Media/hlthhumbdyquest.pdf>

### Activity

With the activity “Lung Capacity” at the following URL, students will carry out a simple procedure to measure lung capacity, or the volume of exhaled air. Using readily available materials, they will make a spirometer, which is a device used to measure lung capacity. Its applications include measuring the lung capacity of people with asthma or other respiratory system diseases. Discuss medical uses of a spirometer with the class, and then challenge students to think of possible research applications. Ask students to think of possible reasons that a life scientist would want to measure lung capacity. [http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs\\_respiratory\\_system\\_tg.pdf](http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs_respiratory_system_tg.pdf)

### Differentiated Instruction

Ask students to draw a diagram of the respiratory system and label the parts and functions. They can refer to the diagram in the Flexbook lesson and the descriptions in the text if they need help.

### Differentiated Instruction

Help kinesthetic and English language learners understand the role of the diaphragm in breathing by placing their hand over their diaphragm when they breathe. Tell them to observe how the diaphragm moves when they inhale and exhale. Ask them to describe the movement in words.

### Enrichment

Encourage interested students to learn about and make a poster for one of the following lesson-related topics. Suggested URLs are provided. Posters should relate the topic to the respiratory system as well as provide practical tips. Display students' posters in the classroom.

- How to save a life with the Heimlich maneuver

<http://www.nlm.nih.gov/medlineplus/ency/article/000047.htm>

- How to get enough oxygen to your brain (including the brain's need for oxygen)

<http://bebrainfit.com/lifestyle/nutrition/brain-nutrition-basics-3-nutrients-you-cant-live-without/>

- How to take care of yourself when you have asthma

<http://www.pamf.org/asthma/selfcare/>

## Science Inquiry

Students can create a model lung to learn how the lung and diaphragm work together to enable breathing, using the activity at the URL below. The activity also features a demonstration of how incomplete combustion of fossil fuels releases particles into the air that can negatively affect human health and how we can protect ourselves from these effects. <http://teachers.egfi-k12.org/pollution-and-lung-health/>

## Overcoming Misconceptions

AAAS research shows that middle school students commonly misunderstand the role of the lungs in respiration. More than one third of students surveyed thought that air and blood mix in the heart rather than in the lungs. Make sure your students understand that alveoli in the lungs are where gas is exchanged with the blood.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 19.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 19.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is the function of the respiratory system?
2. Define respiration and relate it to cellular respiration.
3. List steps in the process of respiration.
4. Describe asthma, including its symptoms and possible triggers.
5. Make a poster warning teens of the respiratory system dangers of smoking.
6. Explain how the diaphragm controls breathing.
7. Relate the structure of alveoli to the function of the lungs.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 19.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The lungs release carbon dioxide into the air. Carbon dioxide is a gaseous waste product of the cells. Wastes are excreted from the body by the excretory system. Therefore, the lungs are organs of the excretory system as well as the respiratory system.

- What are some other organs of the excretory system?
- What types of waste products do these organs excrete?

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## 19.2 The Excretory System

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### Key Concepts

- Definition of excretion
- Organs of the excretory system
- Functions of the kidneys
- Kidney diseases

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### Standards

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### Lesson Objectives

- Define excretion, and identify organs of the excretory system.
- Outline the structures and functions of the urinary system.
- Explain how the kidneys filter blood and produce urine.
- Describe how the kidneys help maintain homeostasis.
- Identify kidney diseases and how they are treated.

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### Lesson Vocabulary

- excretion: process in which excess water or waste is removed from the body
- excretory system: organ system that removes excess water and waste from the body; includes the large intestine, liver, skin, lungs, and kidneys
- kidney: one of a pair of urinary system organs that filter blood, form urine, and help maintain homeostasis
- kidney failure: condition in which the kidneys can no longer filter blood and maintain homeostasis
- kidney stone: mineral crystal that forms in urine inside a kidney, often causing pain and possibly blocking the ureter
- nephron: one of the millions of identical functional units of the kidneys that filter blood and form urine
- ureter: one of a pair of muscular tubes in the urinary system that carries urine between a kidney and the urinary bladder
- urethra: muscular tube in the urinary system that carries urine from the urinary bladder out of the body
- urinary bladder: sac-like organ in the urinary system that stores urine from the kidneys until it exits the body
- urinary system: organ system that filters blood, forms urine, and excretes urine from the body; includes the kidneys, ureters, urinary bladder, and urethra
- urinary tract infection: infection in the urinary system, most commonly in the urinary bladder
- urination: process of urine leaving the body through the urethra
- urine: liquid containing excess water and waste that forms in the kidneys and is excreted from the body

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## Teaching Strategies

### Introducing the Lesson

Ask students to imagine what would happen if garbage trucks stopped running in their community for a while. Garbage would quickly pile up at homes and other buildings. Clearly, removing wastes is important to our communities. Point out that this holds true for our body as well. Our cells produce wastes that must be removed before they damage the cells and cause illness or even death. The process of removing wastes from the body is called excretion, and it is the focus of this lesson.

### Demonstration

Demonstrate how the structures of the urinary system work with this kid-friendly animated video: [http://kidshealthis.org/kid/closet/movies/USmovie.html?tracking=59983\\_E](http://kidshealthis.org/kid/closet/movies/USmovie.html?tracking=59983_E)

### Discussion

The focus of the Flexbook lesson is on the kidney as the main organ of the excretory system. You may want to add additional information on the liver as an excretory organ. Discuss the following roles of the liver in excretion:

- The liver changes excess nitrogen from the breakdown of proteins into urea, which is carried to the kidneys by the blood and excreted by the kidneys in urine.
- The liver removes toxins from the blood, such as mercury in fish, poisonous fumes from paint, and chemicals sprayed on food. The liver is our body's main defense against such poisons.
- The liver changes hemoglobin from dead red blood cells into bile, which is used in the small intestine to digest fats.

### Differentiated Instruction

See page 17 in the following PDF document for a diagram of the urinary system with blanks for students to label the parts of the system. A word bank is included. This is a good activity for English language learners. [http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs\\_excretory\\_system\\_tg.pdf](http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs_excretory_system_tg.pdf)

### Enrichment

Ask a small group of students to carry out the following simple experiment in the classroom to demonstrate how the kidneys function. [http://www.ehow.com/how\\_8034005\\_experiment-filters-explain-kidney-works.html](http://www.ehow.com/how_8034005_experiment-filters-explain-kidney-works.html)

### Science Inquiry

Challenge small groups of students to create a 3-D model of the urinary system using a collection of common items, including such as dried beans and drinking straws. The activity at the following URL provides guidelines and a list of materials. Give groups a chance to share their models by explaining what each part of the model represents and how all the parts function together. <http://www.teachnet.com/lesson/science/excretory002007.html>

## Overcoming Misconceptions

Make sure students don't have the misconception that all liquid waste is excreted by the kidney. Point out that the lungs excrete water (as water vapor) and the skin excretes water and dissolved substances in sweat, so the lungs and skin are both organs of liquid excretion as well.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 19.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 19.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Define excretion.
2. What are the organs of the excretory system?
3. Describe the urinary system.
4. Why does a person with kidney failure need hemodialysis?
5. Explain how the kidneys filter blood and form urine.
6. Explain two ways that the kidneys maintain homeostasis.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 19.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Although the process of urination is under conscious control, the other processes of the urinary system are not. You can't control the work of your kidneys, for example, but this doesn't mean that they operate without any control.

- What organ system controls the kidneys?
- What organs make up this system?

# CHAPTER 20 THE MS Controlling the Body

## Chapter Outline

- 20.1 THE NERVOUS SYSTEM
- 20.2 THE SENSES
- 20.3 THE ENDOCRINE SYSTEM

## Chapter Overview

This chapter introduces the nervous system and its functions, explains how nerve impulses travel, outlines divisions of the nervous system, and describes nervous system diseases and injuries. The chapter also explains the structure and functions of sensory organs, including the eyes and ears. In addition, the chapter describes the glands and hormones of the endocrine system and how they regulate other organ systems.

## Online Resources

See the following Web sites for appropriate laboratory activities:

Students can create 3-D models of neurons with the instructions at the URL below. Several sets of instructions are provided for making neuron models out of a variety of different materials. Students can also model a neural circuit by using several of their neuron models. If they use food items to make their neuron model, they can eat the model when they are done! <http://faculty.washington.edu/chudler/chmodel.html>

For a dramatic experiment, have students do the lab at the following URL. It demonstrates the blind spot, which is the area on the retina where the optic nerve exits the eye. This area lacks light receptors, so if an image falls on it, the image will not be visible. The lab will help students understand the anatomy and functioning of the eye. Links to several other experiments relating to the eye and vision are also provided at the Web site. <http://faculty.washington.edu/chudler/chvision.html>

Several experiments involving the senses of hearing, taste, smell, and touch are described at the following URLs. Many of the experiments are suitable for middle school students and will extend their knowledge of these human senses. <http://faculty.washington.edu/chudler/chhearing.html> <http://faculty.washington.edu/chudler/chtaste.html> <http://faculty.washington.edu/chudler/chsmell.html> <http://faculty.washington.edu/chudler/chtouch.html>

These Web sites may also be helpful:

At the following URL, you can find links to a wide variety of games for students to play to learn about the brain and nervous system. Most are suitable for middle school students. <http://faculty.washington.edu/chudler/chgames.html>

This URL has links to numerous printable worksheets relating to the brain and nervous system. They range from Sudoku and word search puzzles to complete lessons. <http://faculty.washington.edu/chudler/works.html>

Additional nervous system teaching resources, including videos, are available at the following URL. <http://www.ck12.com/Nervous-System.htm>

Go to this URL for many “Neuroscience for Kids” resources: <http://faculty.washington.edu/chudler/introb.html>

The URL below links to an extensive timeline summarizing the history of the human quest to understand the brain.

<http://www.pbs.org/wnet/brain/history/index.html>

You can find excellent teaching suggestions for the endocrine system at this URL: <http://justcallmemsfrizzle.wordpress.com/2010/04/21/great-intro-to-endocrine-system/>

Links to a dozen free endocrine system videos are available at the following URL: <http://www.watchknowlearn.org/Category.aspx?CategoryID=1841>

**TABLE 20.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
20.1 The Nervous System	3.5
20.2 The Senses	2.5
20.3 The Endocrine System	1.0

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## 20.1 The Nervous System

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### Key Concepts

- Functions of the nervous system
- Neurons and nerve impulses
- Central nervous system
- Peripheral nervous system
- Nervous system diseases and injuries
- Nervous system and drugs

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### Standards

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### Lesson Objectives

- Define the nervous system, and state its functions.
- Describe neurons, and explain how nerve impulses travel.
- Give an overview of the central nervous system.
- Outline the divisions of the peripheral nervous system.
- Describe nervous system diseases and injuries.
- Identify how drugs may affect the nervous system.

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### Lesson Vocabulary

- brain: main organ of the central nervous system that serves as the control center of the nervous system and of the body as a whole
- brain stem: smallest part of the human brain that controls unconscious body functions and carries nerve impulses between the rest of the brain and the spinal cord
- central nervous system: one of two main parts of the human nervous system that includes the brain and spinal cord
- cerebellum: second largest part of the human brain that is located beneath the cerebrum and controls body position, coordination, and balance
- cerebrum: largest part of the human brain that controls conscious functions such as thinking, sensing, speaking, and voluntary muscle movements
- concussion: bruise on the surface of the brain that is caused by an injury to the head and that may cause temporary symptoms such as headache and confusion
- drug abuse: use of a drug, either legal or illegal, without the advice of a medical professional and for reasons not originally intended
- drug addiction: condition in which a drug user is unable to stop using a psychoactive drug

- nerve: bundle of nerve cells through which electrical impulses travel in the nervous system
- nerve impulse: electrical message that is carried by neurons and nerves of the nervous system
- nervous system: organ system that consists of the brain, spinal cord, and a complex network of nerves running throughout the body and that functions as the control system of the body
- neuron: cell that transmits electrical impulses in the nervous system; commonly called nerve cell
- paralysis: inability to feel or move certain parts of the body, usually due to a stroke or spinal cord injury
- peripheral nervous system: one or two main parts of the human nervous system that includes nerves that run throughout the body and consists of all the body's nervous tissue except for the brain and spinal cord
- spinal cord: long, tube-shaped bundle of neurons that runs from the brain stem to the lower back and has the main function of carrying nerve impulses back and forth between the body and brain
- synapse: tiny gap between two adjacent neurons across which electrical messages are carried by chemicals called neurotransmitters

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## Teaching Strategies

### Introducing the Lesson

Stimulate student interest in the nervous system by showing them the fascinating TED animation “What If We Could Look Inside the Human Brain?” The animation summarizes the structure and function of the brain by showing how scientists and doctors study the brain and some of the amazing abilities of this “most beautiful organ.” At the conclusion of the video, tell students they will learn more about the brain and the rest of the nervous system in this lesson. <http://www.neok12.com/video/Nervous-System/zX415d415d555f5006707455.htm>

### Activity

The interactive online game at the following URL is a fun way for students to learn how the central nervous system controls the rest of the body. Students can work alone or in pairs on the activity. It could also be assigned as homework if all students have Internet access. Make sure students read the fact files about the nervous control of each organ or structure as they place it in the body and connect it to the central nervous system. Hints are provided if students get stuck on placing or connecting a particular organ or structure. [http://www.bbc.co.uk/science/humanbody/body/interactives/3djigsaw\\_02/index.shtml?nervous](http://www.bbc.co.uk/science/humanbody/body/interactives/3djigsaw_02/index.shtml?nervous)

### Activity

Another fun way for students to learn about and assess their knowledge of the nervous system is to play “Neuro-Jeopardy.” Modeled after the popular TV show, the game is played with a PowerPoint game board, which is available in both English and Spanish. The second URL describes several active outdoor (or gym) games the class can play to learn more about the nervous system, including “Synaptic Tag.” Complete lesson plans are provided for most of the games. <http://faculty.washington.edu/chudler/jeopardy.html> <http://faculty.washington.edu/chudler/outside.html>

### Differentiated Instruction

Print and distribute to any Spanish-speaking students the nervous system coloring book at the URL below. It includes 10 different full-page pictures to color, labeled in both English and Spanish. Pictures include a neuron, synapse, and the central nervous system. Tell students to color the pictures and label what each color represents. <http://faculty.washington.edu/chudler/pdf/colorbooksp.pdf>

## Differentiated Instruction

Print the human brain diagram at the following URL, and have students label it, using the word bank provided. This is a good activity for kinesthetic and English language learners. [http://kidshealth.org/kid/htbw/\\_bfs\\_NSactivity.html](http://kidshealth.org/kid/htbw/_bfs_NSactivity.html)

## Enrichment

Assign the nervous system crossword puzzle at the URL below for enrichment. Completing the puzzle will require students to learn concepts that extend lesson content. <http://sciencespot.net/Media/hlthnervsyspuzz.pdf>

## Enrichment

Students who want to learn more about the brain can explore its structures and functions with the interactive activity at the first URL. The second URL allows them to explore virtual brain surgery. [http://www.learner.org/series/discoveringpsychology/brain/brain\\_flash.html](http://www.learner.org/series/discoveringpsychology/brain/brain_flash.html) [http://www.edheads.org/activities/brain\\_stimulation/](http://www.edheads.org/activities/brain_stimulation/)

## Science Inquiry

Use the NIH curriculum supplement “The Brain: Our Sense of Self” at the following URL when students learn about the brain. It introduces students to the idea that our sense of identity is contained within the brain. It also provides inquiry-based interactive activities that students can engage in to investigate brain function and the various roles of the brain in the nervous system. The URL includes a link to the student activities and also to the teacher’s guide. <http://science.education.nih.gov/supplements/nih4/self/default.htm>

## Language Arts Connection

Students can further explore the nervous system by doing a creative writing project. Several writing projects are described at this URL, including limericks, poems, newspaper articles, and comics: <http://faculty.washington.edu/charudler/writing.html>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 20.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 20.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is the nervous system?
2. List three functions of the nervous system.
3. Describe neurons and nerve impulses.
4. Describe two nervous system diseases, including causes and symptoms.

5. A brain injury has affected a patient's ability to see. Explain which part of the brain was most likely injured.
6. Explain the role of synapses and neurotransmitters in the transmission of nerve impulses.
7. Compare and contrast the central nervous system and peripheral nervous system. How are the two systems related?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 20.1 Quiz in CK-12 MS Life Science Assessments.

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### Points to Consider

The peripheral nervous system includes several sense organs that gather information from the external environment.

- Name two sense organs.
- What information do these two sense organs monitor?

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## 20.2 The Senses

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### Key Concepts

- Vision and the eyes
- Hearing, balance, and the ears
- Touch, taste, and smell

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### Standards

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### Lesson Objectives

- Describe human vision, explain how the eye works, and identify vision problems.
- Describe other human senses and sensory organs, including hearing and the ears.

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### Lesson Vocabulary

- cochlea: fluid-filled, spiral-shaped structure in the inner ear, lined with tiny hair cells that translate sound waves to nerve impulses
- eardrum: membrane between the outer and middle ear that vibrates when sound waves strike it and passes the vibrations to the middle ear
- hearing: ability to sense sound
- hyperopia: vision problem in which distant objects can be seen clearly but nearby objects appear blurry; commonly called farsightedness
- lens: clear, curved structure near the front of the eye that helps focus light and form images on the retina
- myopia: vision problem in which nearby objects can be seen clearly but distant objects appear blurry; commonly called nearsightedness
- retina: thin layer of light-sensing cells that covers the back of the human eye, where images normally form
- semicircular canal: fluid-filled, curved structure in the inner ear that senses head position and helps maintain balance
- taste bud: bundle of sensory neurons on the tongue that sense the taste of chemicals in food
- touch: ability to sense pain, pressure, or temperature
- vision: ability to sense light, form images, and see

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## Teaching Strategies

### Introducing the Lesson

Engage the class in learning about the senses with a simple activity. Saturate several cotton balls with different scents by dipping them in nontoxic juices, oils, or flavorings such as lemon, orange, mint, or vanilla. Divide the class into groups, give each group a different cotton ball, and ask students to identify their scent. After all the scents have been identified, ask students what organs and other structures are involved in the sense of smell. Tell them they will learn about the sense of smell and other senses in this lesson.

### Activity

The interactive animation at the following URL will walk students through a more detailed anatomy and physiology of the eye than are presented in the Flexbook lesson. <http://www.lensshopper.com/eye-anatomy.asp>

### Demonstration

You can demonstrate how the eyes and ears work and how and why we feel pain with these animated videos: <http://kidshealth.org/kid/htbw/eyes-movie.html> <http://kidshealth.org/kid/htbw/ears-movie.html> <http://www.neok12.com/video/Nervous-System/zX7b0b5563055e0f417d7573.htm>

### Building Science Skills

In the research project at the URLs below, students will investigate how a person identifies different flavors of jellybeans, including the contribution of smell to taste. They will also explore the surprising ways the brain interprets the patterns of light and dark that reach our eyes, using visual illusions to illustrate general principles of sensory processing. (student handout) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/SensesProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/SensesProtocol.pdf) (student handout) (teacher notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/SensesTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/SensesTeachPrep.pdf) (teacher notes)

### Activity

Use the NIH curriculum supplement “How Your Brain Understands What Your Ear hears” at the URL below. The Web site provides several interactive animations and activities for students to learn more about the ears and sense of hearing. A teacher’s guide is also provided. <http://science.education.nih.gov/supplements/nih3/hearing/default.htm>

### Activity

Go to the following URL for a variety of activities in which students can explore the senses of taste, touch, and vision. [http://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.lp\\_senses/taste-touch-and-vision/](http://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.lp_senses/taste-touch-and-vision/)

### Differentiated Instruction

Students can use the interactive eye and ear at the URLs below to label the major parts of the human eye and ear. These are good activities for visual and English language learners. <http://www.freezeray.com/flashFiles/eye.htm> <http://www.freezeray.com/flashFiles/ear.htm>

## Enrichment

Interested students can explore visual illusions, which demonstrate tricks the eyes can play on the brain, by going to the following URLs. Ask the students to share their favorite visual illusion with the class and explain why they think it occurs. <http://kids.niehs.nih.gov/games/illusions/> <http://faculty.washington.edu/chudler/flash/nill.html> <http://www.michaelbach.de/ot/mot-feetLin/index.html>

## Science Inquiry

Have students do the peripheral vision inquiry activity at the following URL. Students will measure their central and peripheral visual fields under different circumstances and learn which areas of the retina carry these types of information to the brain. Then students will design their own experiment related to visual field. <http://faculty.washington.edu/chudler/eyetr.html>

## Health Connection

Use the infographic at the URL below to teach students about eye injury facts, myths, and prevention tips. <http://www.buymorecontacts.com/eye-injury-infographic.htm>

## Overcoming Misconceptions

Use the following list of five student misconceptions about the eye and vision as a true-false quiz to identify the misconceptions in your students. For any misconceptions students think are true, call on other students to explain why they are false.

1. The pupil of the eye is a black object or spot on the surface of the eye.
2. The eye forms upright images.
3. The lens is the only part of the eye responsible for focusing light.
4. The brain looks at the image on the retina, and this is how we see.
5. The eye is the only organ needed for sight; the brain is needed only for thinking.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 20.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 20.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Identify five human senses.
2. Summarize how the eye works.
3. Outline how sound waves travel through the ear.
4. Why does food taste bland when your nose is stuffy from a cold?

5. Explain 3-D vision in human beings.
6. Compare and contrast the human senses of taste and smell.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 20.2 Quiz in CK-12 MS Life Science Assessments.

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### Points to Consider

Sensory organs such as the eyes and ears are part of the nervous system. The nervous system controls all other body systems. However, the nervous system doesn't work alone. The endocrine system also helps to regulate the body and its functions.

- What are the organs of the endocrine system?
- The nervous system sends electrical messages. What type of messages does the endocrine system send?

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## 20.3 The Endocrine System

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### Key Concepts

- Endocrine system
- Endocrine glands
- Endocrine hormones
- Endocrine system diseases

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### Standards

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### Lesson Objectives

- Describe the endocrine system and its hormones.
- Identify several glands of the endocrine system.
- Explain how endocrine hormones work.
- Describe two endocrine system diseases.

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### Lesson Vocabulary

- adrenal gland: one of a pair of endocrine system glands located just above the kidneys that secrete hormones such as adrenaline into the blood
- endocrine gland: organ of the endocrine system that secretes hormones into the bloodstream for transport around the body
- endocrine system: system of glands that secrete chemical messenger molecules called hormones into the blood
- gonad: one of a pair of glands in the endocrine system that secretes sex hormones; ovary in females or testis in males
- hormone: chemical messenger molecule
- hypothalamus: structure in the brain that secretes hormones and provides a link between the nervous and endocrine systems
- pituitary gland: pea-sized structure at the base of the brain that is called the master gland of the endocrine system because it secretes hormones that control most other endocrine glands
- target cell: type of cell on which a given hormone has an effect because it has surface proteins to which the hormone can bind
- thyroid gland: relatively large endocrine gland in the neck that secretes hormones such as thyroxine, which increases the rate of metabolism in cells throughout the body

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## Teaching Strategies

### Introducing the Lesson

Introduce the endocrine system and its glands by showing students the amusing cartoon at the URL below. In the cartoon, a comic superhero named “Glandman” gives a good overview of lesson content. <http://kidshealth.org/kid/htbw/ESmovie.html>

### Cooperative Learning

Assign one or more groups of students to complete the “Human Body Quest” activity for the endocrine system. All necessary instructions, links, and materials can be found in the following PDF document. Students in each group will create a presentation to teach the rest of the class about the endocrine system. They will also create a worksheet for other students to fill in. Group members should use a variety of resources for their research. <http://sciencespot.net/Media/hlthhumbdyquest.pdf>

### Differentiated Instruction

Print the diagram of the human endocrine system at the following URL, and have students label it. This is a good activity for kinesthetic and English language learners. [http://kidshealth.org/kid/htbw/\\_bfs\\_ESactivity.html](http://kidshealth.org/kid/htbw/_bfs_ESactivity.html)

### Enrichment

Have a small group of students create a detailed PowerPoint presentation on the mechanism of negative feedback in the endocrine system. They should include a model for the mechanism, such as the control of a home furnace by a thermostat. Tell other students in the class to take notes on the presentation. Note-taking will help students focus on the information as well as give them practice with a useful skill.

### Science Inquiry

Divide the class into groups and give each group a fictitious patient’s “medical chart” listing signs and symptoms of a particular endocrine disorder (e.g., hypothyroidism, diabetes, acromegaly). Challenge groups to try to diagnose which gland is not functioning properly, based on the chart for their patient.

### Real-World Connection

Discuss the real-world problem of endocrine disruptors. These are environmental chemicals that disrupt the endocrine system (often because they mimic endocrine hormones) and produce adverse effects. They are found in many everyday products, such as plastics and pesticides. You can find good background information about endocrine disruptors at these URLs: <http://www.niehs.nih.gov/health/topics/agents/endocrine/> <http://www.epa.gov/endo/pubs/edspoverview/whatare.htm> <http://www.americanchemistry.com/Policy/Chemical-Safety/Endocrine-Disruption/Chemicals-and-Endocrine-Disruption.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 20.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 20.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is the endocrine system? How do endocrine hormones differ from the secretions of other glands, such as sweat glands?
2. How are the nervous and endocrine systems connected?
3. Define target cell.
4. Hypothyroidism is an endocrine system disease in which the thyroid gland doesn't secrete enough of its hormones. How do you think this disease might be treated?
5. Explain why the pituitary gland is considered the master gland of the endocrine system.
6. Use an example to show how negative feedback controls the secretion of endocrine hormones.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 20.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Type 1 diabetes occurs when the immune system attacks and damages insulin-producing cells of the pancreas.

- What is the immune system? What is its function?
- What are some of the parts of the immune system?

## CHAPTER

## 21

## TE MS Diseases and the Body's Defenses

## Chapter Outline

- 21.1 INFECTIOUS DISEASES
- 21.2 NONINFECTIOUS DISEASES
- 21.3 FIRST TWO LINES OF DEFENSE
- 21.4 IMMUNE SYSTEM DEFENSES

## Chapter Overview

This chapter explains the causes of infectious diseases and how they spread. It also identifies types of noninfectious diseases and why they occur. In addition, the chapter describes how general barriers and processes prevent most pathogens from causing disease and how the immune system launches attacks against specific pathogens.

## Online Resources

See the following Web sites for appropriate laboratory activities:

With the lab at the URL below, students can investigate viral infectious diseases. Students will learn how viruses can infect the human body, compromise the immune system, and interfere with normal body functions. <http://scienetlinks.com/lessons/virusesinfectious-diseases-whats-really-bugging-you/>

Have students do the lab “The Skin as a Barrier” at the following URL to investigate how the skin acts as a barrier to most pathogens. [https://www.aai.org/Education/Summer\\_Teachers/Docs/Archive/2007\\_DPaul\\_Final.pdf](https://www.aai.org/Education/Summer_Teachers/Docs/Archive/2007_DPaul_Final.pdf)

Two labs on the body's defenses can be found in the document at the following URL. The labs were created for 10th grade students but could easily be adapted for middle school students. In the first lab, students culture bacteria collected from their mouth. In the second lab, they create a model of the immune system. [http://pulse.pharmacy.arizona.edu/10th\\_grade/disease\\_epidemics/science/handouts/defensive.pdf](http://pulse.pharmacy.arizona.edu/10th_grade/disease_epidemics/science/handouts/defensive.pdf)

These Web sites may also be helpful:

Help students make the connection between their lives, their health, and global health by using the PBS video program, Rx for Survival. You can show the videos to your class and then use some or all of the activities presented in the teacher's guide. Topics include vaccines, vector-borne diseases, antibiotic resistance, delivery of health aid, links between diet and disease, and role of public health in containing disease. <http://www.pbs.org/wgbh/rxforsurvival/series/teachers/index.html>

Go to the URLs below for links to background information, teaching strategies, and student activities on infectious diseases. [http://msp.ehe.osu.edu/wiki/index.php/MSP:MiddleSchoolPortal/Whats\\_Making\\_You\\_Sick](http://msp.ehe.osu.edu/wiki/index.php/MSP:MiddleSchoolPortal/Whats_Making_You_Sick) <http://www.diseasedetectives.org/links>

You can find three middle school teaching activities on infectious disease prevention at the following URL: [http://spw.dpi.wi.gov/sites/default/files/imce/sspw/pdf/k\\_12communicable.pdf](http://spw.dpi.wi.gov/sites/default/files/imce/sspw/pdf/k_12communicable.pdf)

Go to this URL for an entire unit with several lessons on the epidemiology (spread and control) of infectious diseases: <http://www.cdc.gov/bam/teachers/epi.html>

Several articles written for students about noninfectious diseases and other health problems in children and teens can be accessed at this URL: [http://kidshealth.org/kid/health\\_problems/](http://kidshealth.org/kid/health_problems/)

The following URL has links to many resources, from games to videos, to teach your students about allergies. <http://www.neok12.com/Allergies.htm>

Several activities relating to human diseases and the immune system are available here: <http://sciencelearn.org.nz/Contexts/Fighting-Infection/Teaching-and-Learning-Approaches>

You can find immune system lessons, activities, and worksheets at this URL: <http://www.teacherplanet.com/resource/immune.php>

**TABLE 21.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
21.1 Infectious Diseases	1.0
21.2 Noninfectious Diseases	2.5
21.3 First Two Lines of Defense	1.0
21.4 Immune System Defenses	2.0

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## 21.1 Infectious Diseases

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### Key Concepts

- Infectious diseases
- Pathogens
- Preventing the spread of infectious diseases

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### Standards

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### Lesson Objectives

- Identify pathogens that cause infectious diseases, and explain how pathogens spread.
- List ways to prevent the spread of infectious diseases.

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### Lesson Vocabulary

- infectious disease: disease that is contagious because it is caused by a pathogen

---

### Teaching Strategies

#### Introducing the Lesson

Introduce infectious diseases with the following facts and figures that show how important they are:

- Nearly 22 million school days are lost in the U.S. each year due to the common cold.
- About 38 million school days are lost in the U.S. each year due to flu. More than 200,000 people are hospitalized as a result of flu complications each year, and about 36,000 people die annually from flu.
- At least 76 million cases of foodborne illness occur in the U.S. each year. They result in 325,000 hospitalizations and 5,000 deaths per year, on average.

#### Activity

At the following URL, students can apply lesson concepts by playing online games in which they help fight infectious disease outbreaks. <http://webadventures.rice.edu/stu/Games/MedMyst/>

## Building Science Skills

With the lesson plan at the following URL, students will investigate cholera in Native American populations. Then they will apply what they learn from that example to the case of Ebola today. [http://www.pbs.org/weta/thewest/lesson\\_plans/lesson09.htm](http://www.pbs.org/weta/thewest/lesson_plans/lesson09.htm)

## Differentiated Instruction

Tell students to make a KWL chart for infectious diseases. They should fill in the Know and Want-to-Know columns before they read the lesson and the Learned column after they read. Discuss anything the students wanted to know but didn't learn when they read the lesson.

## Enrichment

Have a few students make a public service announcement video about how to reduce the risk of contracting and spreading infectious diseases. The video should include practical tips and demonstrations, such as the proper way to cover a sneeze and how to effectively wash the hands. Suggest that the students go to the URL below for ideas and information. If possible, arrange to show their video to the class or even the entire student body. <http://www.cdc.gov/healthyyouth/infectious/>

## Science Inquiry

In the activity “Exploring the Environment: Rift Valley Fever” (see URL below), students will investigate the nature and transmission of the Rift Valley (Kenya) fever virus to determine ways to prevent an outbreak. This is an interdisciplinary, problem-based learning module that addresses a real-world problem. Teacher pages include module notes; ideas for use; and ideas for planning, facilitating, and assessing information. <http://www.cotf.edu/ete/modules/rift/rift.html>

## Overcoming Misconceptions

It may be important for students' health to overcome any misconceptions they have about diseases such as the common cold. You can find seven common myths (and why they are false) about colds at the URL below. Use the list as an informal true-false quiz for students. Ask for a show of hands from those who think each myth is true, and then discuss the correct facts. Also discuss how believing the myths might make a person more likely to pick up cold viruses or spread them to others. <http://www.commoncold.org/special1.htm>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 21.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 21.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is an infectious disease?
2. List four types of human pathogens, and give an example of a disease caused by each type.
3. What is a vector? Name a human disease spread by a vector.
4. Create a poster that shows young children ways to reduce their risk of catching a cold.
5. Explain how you could catch the flu by touching a doorknob.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 21.1 Quiz in CK-12 MS Life Science Assessments.

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### Points to Consider

Some diseases are not infectious. Noninfectious diseases are not contagious because they are not caused by pathogens.

- What are some examples of noninfectious diseases?
- What causes these diseases?

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## 21.2 Noninfectious Diseases

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### Key Concepts

- Noninfectious diseases
- Cancer
- Type 1 and type 2 diabetes
- Autoimmune diseases
- Allergies

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### Standards

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### Lesson Objectives

- Define noninfectious disease.
- List causes and common types of cancer, and state how cancer can be treated and prevented.
- Describe diabetes, and distinguish between type 1 and type 2 diabetes.
- Identify autoimmune diseases, and explain why allergies occur.

---

### Lesson Vocabulary

- allergen: any substance that causes an allergy
- allergy: disorder in which the immune system responds to a harmless substance as though it was a pathogen
- autoimmune disease: disease caused by the immune system attacking the body's own cells as though they were pathogens
- cancer: disease in which cells grow out of control, usually because of mutations in genes that control the cell cycle
- carcinogen: anything in the environment that can cause cancer, such as nicotine in tobacco or \*ultraviolet: radiation in sunlight
- diabetes: noninfectious disease that occurs when the pancreas does not make enough insulin or \*body cells are resistant to insulin so there is too much sugar in the blood
- noninfectious disease: disease that is not contagious because it is not caused by pathogens
- tumor: mass of abnormal tissue that may form when cancerous cells divide out of control
- type 1 diabetes: type of diabetes that usually develops in childhood or adolescence and is caused by the immune system attacking insulin-producing cells of the pancreas
- type 2 diabetes: type of diabetes that usually develops in adulthood and is caused by body cells no longer responding normally to insulin

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## Teaching Strategies

### Introducing the Lesson

Introduce noninfectious diseases to your class by sharing the following facts and figures, which will show students how important these diseases are worldwide.

- Five types of noninfectious diseases are the world's leading causes of death: cardiovascular diseases, cancers, diabetes, obesity, and chronic respiratory diseases.
- These five types of diseases kill an estimated 35 million people each year. They are responsible for 60 percent of all deaths.
- The World Health Organization estimates that total deaths from noninfectious will increase even more in future years.
- Noninfectious diseases are caused by the interaction of genetic, environmental, and especially lifestyle factors, including smoking, alcohol abuse, unhealthy diets, and physical inactivity.

Tell students they will learn more about noninfectious diseases in this lesson.

### Discussion

The analysis and discussion activity at the following URL introduces students to the molecular and cellular biology of cancer, including the important contributions of mutations in genes that code for proteins involved in regulating the rate of cell division. The questions in the activity challenge students to interpret information presented in prose, tables and diagrams and to apply their knowledge of basic molecular and cellular biology. The Web page has links to a student handout and teacher notes. <http://serendip.brynmawr.edu/exchange/bioactivities/cancer>

### Activity

Students will learn more about type 1 diabetes with the card game at the following URL. The objective of the game is for students to gain an understanding of the cause-and-effect relationships of type 1 diabetes, as well as how the disease can be treated. Also included at the URL are background information, vocabulary, and additional classroom activities. <http://www.reachoutmichigan.org/funexperiments/agesubject/lessons/newton/diabetes.html>

### Cooperative Learning

The purpose of the cooperative learning lesson at the URL below is for students to explore how the immune system functions in a variety of allergic reactions. Students will work in groups to identify, research, and write and present an article about a specific allergic reaction that interests them. Students will assume the role of health writers preparing a special section for the school newspaper on allergies. The lesson includes motivation, development, links, assessment, and extension ideas. <http://sciencenetlinks.com/lessons/the-allergy-chronicles/>

### Differentiated Instruction

Work with students to create a cluster diagram to summarize the information in the Flexbook lesson about cancer. The center circle should be labeled "Cancer." This circle should be surrounded by circles labeled "Definition," "Causes," "Types," "Diagnosis and Treatment," and "Prevention." Have students fill in a few important details in each of the labeled surrounding circles.

## Enrichment

Ask interested students to identify and learn about a common autoimmune disease that interests them. They should choose a disease that is not described in the Flexbook lesson. Some possibilities include Addison's disease, celiac disease (sprue), Graves' disease, myasthenia gravis, lupus, and Sjogren syndrome. Have the students create a poster or Web page to share what they find out, and encourage other students in the class to learn from it.

## Science Inquiry

With the inquiry activity at the following URLs, students can model the chances of developing an autoimmune disease. [projects/Classroom\\_Activity\\_Student\\_AutoimmuneDiseaseChance.shtml](http://www.sciencebuddies.org/science-fair-projects/Classroom_Activity_Student_AutoimmuneDiseaseChance.shtml) (student handout) [http://www.sciencebuddies.org/science-fair-projects/Classroom\\_Activity\\_Educator\\_AutoimmuneDiseaseChance.shtml](http://www.sciencebuddies.org/science-fair-projects/Classroom_Activity_Educator_AutoimmuneDiseaseChance.shtml) (teacher notes)

## Overcoming Misconceptions

Commonly held misconceptions about cancer may make sense, especially if they are based on prior scientific theories that have since been proven wrong. The misconceptions may interfere with proper prevention and treatment decisions, so it is important to debunk them. The following URL lists several common cancer misconceptions and explains why they are incorrect in terms of recent scientific information. Share the misconceptions with your students and explain why they are wrong. <http://www.cancer.gov/cancertopics/myths>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 21.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 21.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a noninfectious disease?
2. Define carcinogen, and give two examples.
3. What causes multiple sclerosis?
4. What is the single best way to reduce your risk of developing lung cancer?
5. Some people have allergies only at certain times of the year. Other people have allergies all year round. Give examples of allergens that might trigger the different types of allergic responses.
6. Explain how mutations can lead to cancer.
7. Compare and contrast type 1 and type 2 diabetes.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 21.2 Quiz in CK-12 MS Life Science Assessments.

## Points to Consider

Most types of cancer are noninfectious diseases. However, some types of cancer are caused by viruses. Fortunately, your body has ways to protect you from viruses and other pathogens.

- How does your body protect you from pathogens?
- What organs and body systems are involved?

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## 21.3 First Two Lines of Defense

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### Key Concepts

- Nonspecific barriers to pathogens
- Inflammation, phagocytosis, and fever

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### Standards

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### Lesson Objectives

- Describe the barriers that keep most pathogens out of the body.
- Explain how inflammation, phagocytosis, and fever help protect you from pathogens.

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### Lesson Vocabulary

- fever: higher-than-normal body temperature (above 98.6° F or 37° C) that may occur during illness
- inflammation: nonspecific reaction to infection or injury that includes redness, warmth, and pain at the site of infection or injury
- mucus: sticky, moist secretion of mucous membranes that traps pathogens and particles, preventing them from entering the body
- phagocyte: type of white blood cell that consumes and destroys pathogens and dead cells by the process of phagocytosis
- phagocytosis: process in which pathogens and dead cells are consumed and destroyed by a phagocyte

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### Teaching Strategies

#### Introducing the Lesson

Pique students' interest in learning about general (nonspecific) barriers to pathogens by tell them that their skin is crawling with bacteria. Say that about 1 trillion bacteria in 1000 different species live on a healthy person's skin. Explain that most skin bacteria are harmless and some are actually very helpful, providing a biological barrier to infection. For example, the bacteria may outcompete more dangerous bacteria and help wounds heal. Tell students they will learn more about these and other general barriers to pathogens when they read this lesson.

## Demonstration

Use the student-friendly narrated animation at the following URL to demonstrate the inflammatory response to your students. [http://wps.aw.com/bc\\_goodenough\\_boh\\_3/104/26720/6840553.cw/content/index.html](http://wps.aw.com/bc_goodenough_boh_3/104/26720/6840553.cw/content/index.html)

## Building Science Skills

Use the middle school lesson plans in the document “What’s Snot to Like?” at the following URL. The lesson plans explore the respiratory and immune systems through mucus. The activities most relevant to this Flexbook lesson include “Sticktoitiveness: Compare Airways With and Without a Mucus Layer,” “Goo-dness Gracious: An Investigation Using Simulated Mucus,” “Cleaning Crew Role-Play: Goblet Cells and Ciliated Cells,” and “Hairy Situation Role-Play: Cilia in the Respiratory System.” <http://www.moreheadplanetarium.org/sites/default/files/What'sSnottoLike.pdf>

## Differentiated Instruction

Visual and English language learners may have a better understanding of phagocytosis if they watch this simple animation of the process: <http://www.dnatube.com/video/2834/Phagocytosis-Animation>

## Enrichment

The high school immune system activity “Immunity Breakdown” at the URL below makes an excellent enrichment activity for middle school students. In the activity, pairs of students pretend to be doctors who have been asked to give a brief speech to students about what happens when a person has a problem with the immune system. Students will read and gather facts and then create a brief report that they will present to the class. [http://kidshealth.org/classroom/9to12/body/systems/immune\\_system.pdf](http://kidshealth.org/classroom/9to12/body/systems/immune_system.pdf)

## Science Inquiry

In this Flexbook lesson, students will read that hydrochloric acid in the stomach kills most pathogens that enter in food or water. Challenge groups of students to develop a research design to test the hypothesis that hydrochloric acid kills bacteria that commonly cause foodborne illness, such as *E. coli* or salmonella. Their research design should identify a dependent variable (e.g., bacterial colony growth), an independent variable (e.g., presence/absence of hydrochloric acid), as well as controls (e.g. same growing medium and temperature). The research design should also outline a procedure, provide a materials list, and identify safety hazards. Give groups a chance to share and discuss their research designs.

## Overcoming Misconceptions

Misconceptions about the cause and consequences of fever abound and may lead to unnecessary worry and doctor visits. You can find some of the common misconceptions at the following URL. Explain the correct facts to your students. [http://www.childrenshealthnetwork.org/CRS/CRS/pa\\_feverpho\\_hhg.htm](http://www.childrenshealthnetwork.org/CRS/CRS/pa_feverpho_hhg.htm)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 21.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 21.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. How does your skin protect you from pathogens?
2. Identify chemical barriers in the body's first line of defense.
3. Define phagocytosis, and describe how it occurs.
4. Assume that you scrape your knee. The next day, the scrape has become red, warm, and painful. Why are these signs that the scrape has become infected?
5. Explain how a fever helps fight pathogens.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 21.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The phagocytes that are part of the body's second line of defense attack any pathogens they encounter. They provide a general defense. Some white blood cells attack only certain pathogens. They provide a specific defense.

- How do you think specific pathogens can be identified by the body?
- Why do you think the body needs specific defenses as well as general defenses?

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## 21.4 Immune System Defenses

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### Key Concepts

- Immune system
- Specific immune responses
- Lymph and lymphocytes
- B cells and T cells
- Immunity
- Vaccination

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### Standards

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### Lesson Objectives

- Identify the parts of the immune system and the roles they play in immune responses.
- Compare and contrast immune responses involving B cell and those involving T cells.
- Define immunity, and explain two ways that immunity may be acquired.

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### Lesson Vocabulary

- antibody: large, Y-shaped molecule that binds to an antigen and marks it for destruction by a phagocyte
- immune response: immune system's reaction to a specific pathogen
- immune system: body system that fights to protect the body from specific pathogens
- immunity: ability of the immune system to launch a rapid attack against a specific pathogen and prevent disease because the immune system "remembers" the pathogen from a previous exposure
- lymph: yellowish liquid that leaks out of capillaries into spaces between cells and circulates through lymph vessels before returning to the blood
- lymph node: one of many small oval structures located along lymph vessels that filter pathogens out of lymph
- lymphocyte: type of white blood cell involved in an immune system response; B cell or T cell
- spleen: organ of the immune system located in the abdomen that filters pathogens out of the blood
- thymus gland: organ of the immune system located in the chest that stores lymphocytes called T cells while they mature
- tonsil: one of a pair of immune system organs located on either side of the throat that trap pathogens entering the body through the mouth or nose
- vaccination: process of deliberately exposing a person to a pathogen, usually by injection, so the person will develop immunity to it

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## Teaching Strategies

### Introducing the Lesson

Show the class an image of a child receiving a vaccine by injection (see URL below). Call on students to explain why getting a “shot” of vaccine may protect you from getting a specific disease in the future. Continue probing to elicit knowledge students already have about vaccinations and immunity, including what they know from personal experience. Accept all reasonable responses. Then tell students they will learn how vaccinations work when they read this lesson. <http://upload.wikimedia.org/wikipedia/commons/6/6a/Vaccination.jpg>

### Demonstration

Demonstrate how the immune system functions with the student-friendly cartoon video at this URL: <http://kidshealthis.org/kid/closet/movies/ISmovie.html>

### Activity

In the class activity “Acting Out the Immune Response” at the URL below, students will act out a nonspecific and then a specific response to an invading pathogen. Each student will have an assigned role in the activity, and props will be used. [https://www.aai.org/Education/Summer\\_Teachers/Docs/Archive/2003\\_Porter\\_Final.pdf](https://www.aai.org/Education/Summer_Teachers/Docs/Archive/2003_Porter_Final.pdf)

### Differentiated Instruction

Have students create a Frayer model by dividing a sheet of paper into four large squares labeled “Definition,” “Drawing,” “Example,” and “Non-example.” Then tell students to fill in the boxes for the term immunity.

### Enrichment

Suggest that students play the game “POX: Save the People” (available for free at the URL below), based on a popular board game. The game challenges 1-4 players to stop the spread of a deadly disease by vaccinating and treating people. The game is not only fun. It also teaches players about the concept of group immunity and the importance of vaccinations at the population level. <https://itunes.apple.com/us/app/pox-save-the-people/id475604824?mt=8>

### Science Inquiry

With the inquiry activity at the following URLs, students can use simple materials to model how memory cells lead to immunity. The first link is the student handout for the activity. The second link is the teacher’s guide. (student handout) [http://www.sciencebuddies.org/science-fair-projects/Classroom\\_Activity\\_Student\\_Immune\\_Response.shtml](http://www.sciencebuddies.org/science-fair-projects/Classroom_Activity_Student_Immune_Response.shtml) (student handout) (teacher’s guide) [http://www.sciencebuddies.org/science-fair-projects/Classroom\\_Activity\\_Educator\\_Immune\\_Response.shtml](http://www.sciencebuddies.org/science-fair-projects/Classroom_Activity_Educator_Immune_Response.shtml) (teacher’s guide)

### Overcoming Misconceptions

The short article at the following URL debunks several common (and potentially dangerous) myths about vaccines. Either assign the article for students to read or share the important points with your class. <http://www.historyofvaccines.org/content/articles/misconceptions-about-vaccines>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 21.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 21.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is an immune response?
2. Identify three immune system organs and their functions.
3. Some diseases are diagnosed by looking for antibodies in the patient's blood. Explain what a positive finding of antibodies means.
4. Compare and contrast how B cells and T cells respond to pathogens.
5. Explain how vaccinations can protect you from infectious diseases such as measles and chicken pox.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 21.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Diseases caused by the human papillomavirus (HPV) can be prevented with a vaccination. HPV infects organs of the reproductive system.

- What are some organs of the reproductive system?
- What is the function of the reproductive system?

## CHAPTER

## 22

# TE MS Reproductive Systems and Life Stages

## Chapter Outline

- 22.1 MALE REPRODUCTIVE SYSTEM**
- 22.2 FEMALE REPRODUCTIVE SYSTEM**
- 22.3 REPRODUCTION AND LIFE STAGES**
- 22.4 REPRODUCTIVE SYSTEM HEALTH**

## Chapter Overview

This chapter describes the structures and functions of the male and female reproductive systems, summarizes how reproduction occurs, and outlines major life stages. The chapter also identifies sexually transmitted infections and other reproductive system disorders, as well as ways to keep the reproductive system healthy.

## Online Resources

See the following Web site for an appropriate laboratory activity:

Have students do the simulation lab at the following URL. They will simulate the spread of a viral disease through the mixing of “body fluids,” and try to identify the original infected individual. Follow the assessment instructions to relate the activity to sexually transmitted infections, such as HIV/AIDS. <http://lpsl.coe.uga.edu/mile3/resa/gpsinaction/lessonplans/Virus.pdf>

These Web sites may also be helpful:

You can find a variety of teaching resources on the male and female reproductive systems, fetal development, and birth at the following URL. Resources include quizzes, diagrams, and videos. <http://www.neok12.com/Reproductive-System.htm>

You can use the lesson plan and student reading at the URL below to teach chapter content. The lesson plan provides suggestions for assessing students’ prior knowledge and preparing them for the reading. The reading has “Stopping to Think” questions for students to mull over the information as they read. [http://sepuplhs.org/pdfs/ials\\_humanreproduction.pdf](http://sepuplhs.org/pdfs/ials_humanreproduction.pdf)

The following URLs provide an excellent series of middle school lessons on the male and female reproductive systems and/or fertilization and pregnancy. The lesson plans include background information, handouts, discussion questions, activities, student-friendly links, quizzes, and more. [http://kidshealth.org/classroom/6to8/body/systems/male\\_reproductive.pdf](http://kidshealth.org/classroom/6to8/body/systems/male_reproductive.pdf) [http://classroom.kidshealth.org/classroom/6to8/body/systems/female\\_reproductive.pdf](http://classroom.kidshealth.org/classroom/6to8/body/systems/female_reproductive.pdf) <http://www.uniview.co.uk/pdf/1548HumanReproductionChildbirth.pdf>

Students may be too embarrassed to ask questions about puberty, sexual development, and social and emotional issues of adolescence. Suggest that they read the relevant articles at this URL if they want more information about specific topics in these areas: <http://kidshealth.org/kid/grow/>

Students can access straightforward fact sheets on several common sexually transmitted infections at this URL: <http://www.cdc.gov/std/>

Peruse the PDF book, “Games for Adolescent Reproductive Health” at the URL below to learn how and why using games is an effective way to teach adolescents about reproductive health. The book includes 45 games. [http://www.iwte.org/ideas/10\\_games.pdf](http://www.iwte.org/ideas/10_games.pdf)

**TABLE 22.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
22.1 Male Reproductive System	1.0
22.2 Female Reproductive System	1.5
22.3 Reproduction and Life Stages	3.5
22.4 Reproductive System Health	1.0

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## 22.1 Male Reproductive System

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### Key Concepts

- Organs and functions of the male reproductive system
- Sperm and sperm production

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### Standards

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### Lesson Objectives

- Identify functions of the male reproductive system.
- Describe organs of the male reproductive system.
- Describe sperm, and explain how they are produced.

---

### Lesson Vocabulary

- epididymis: male reproductive organ on top of the testes where sperm mature
- penis: external, cylinder-shaped male organ containing the urethra through which urine and semen pass out of the body
- prostate gland: male reproductive organ that secretes a fluid to help form semen
- reproductive system: body system that controls reproduction
- semen: whitish liquid containing sperm and secretions from the prostate gland and that leaves the male body through the urethra in the penis
- testis (testes, plural): one of a pair of oval male reproductive organs that produce sperm and secrete the hormone testosterone
- testosterone: main male sex hormone that causes most of the changes of puberty and is needed by an adult male for the production of sperm
- vas deferens: tube-like male reproductive organ that carries sperm from the epididymis to the urethra

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### Teaching Strategies

#### Introducing the Lesson

Remind students that all living things must be able to reproduce themselves or their species will go extinct. Point out that human beings start out no larger than a human egg, which is smaller than a grain of sand and just barely visible to the unaided eye. Add that the egg must be fertilized by a sperm cell before it goes through the amazing

changes that occur during development and growth inside the mother. For example, during the nine months of a normal pregnancy, the individual grows in size to become 2 billion times larger than the egg. Tell students they will learn about all of these events in this chapter, starting in this lesson with the production of sperm cells by the male reproductive system.

### Demonstration

Show the class the video at the URL below to demonstrate the structures and functions of the male reproductive system. <http://www.neok12.com/video/Reproductive-System/zX437b6e7268685e47745c41.htm>

### Activity

Students can explore the male reproductive system in depth at the following URL. The interactive Web site has detailed images and descriptions that allow students to learn about the anatomy and physiology of the male reproductive system and its structures. They can find answers to any questions they may have about the male reproductive system without having to ask potentially embarrassing questions in class. <http://www.innerbody.com/>

### Differentiated Instruction

Give students an unlabeled diagram of the male reproductive system (see page 20 of the following URL), and ask them to label the structures. The diagram at the URL below includes a word bank. [http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs\\_reproductive\\_system\\_tg.pdf](http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs_reproductive_system_tg.pdf)

### Enrichment

Curious students might be interested in the human sperm facts and figures in the article at this URL: [http://www.huffingtonpost.com/2013/11/20/nine-things-you-never-knew-about-sperm-photos\\_n\\_4268031.html](http://www.huffingtonpost.com/2013/11/20/nine-things-you-never-knew-about-sperm-photos_n_4268031.html)

### Science Inquiry

Students can work together to create a model of the male reproductive system and use it to simulate the path of sperm through the system. Divide the class into groups, and assign each group an organ of the male reproductive system. In a large area, ask students to sit on the floor with their group. Groups must arrange themselves so they correctly model the relative positions of the organs they represent. Select a student to act as the “sperm.” The sperm will begin the journey standing in the testes group. The members of the testes group will provide information about the sperm and tell the sperm where to go next. The process continues as the sperm travels throughout the male reproductive system.

### Overcoming Misconceptions

Avoid giving students the idea that males secrete only testosterone (and females secrete only estrogen). In fact, that both sexes secrete both hormones. However, males secrete mainly testosterone (and females secrete mainly estrogen). The hormones also affect males and females differently.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 22.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 22.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What are the two main roles of the male reproductive system?
2. Name three male reproductive organs, and identify their reproductive functions.
3. What are sperm? What is the function of the tail of a sperm?
4. A man who doesn't want to have any more children may have a procedure in which the vas deferens is cut. Why does this procedure prohibit him from having more children?
5. Explain how sperm form and mature.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 22.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The female reproductive system has different functions and organs than the male reproductive system.

- What are the functions of the female reproductive system?
- What are some of the organs of the female reproductive system?

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## 22.2 Female Reproductive System

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### Key Concepts

- Organs and functions of the female reproductive system
- Eggs and their production
- Menstrual cycle

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### Standards

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### Lesson Objectives

- Identify functions of the female reproductive system.
- Describe organs of the female reproductive system.
- Describe eggs, and explain how they are produced.
- Summarize the monthly cycle of the female reproductive system.

---

### Lesson Vocabulary

- estrogen: main female sex hormone that causes most of the changes of puberty and is needed by an adult female to mature and release eggs from the ovaries
- fallopian tube: one of a pair of female reproductive organs consisting of a long, thin tube where fertilization normally takes place
- menstrual cycle: series of changes in the reproductive system of sexually mature females that repeats every month on average; includes ovulation and, if pregnancy does not occur, also includes menstruation
- menstruation: passage of blood from the uterus during a menstrual cycle; commonly called menstrual period
- ovary: one of a pair of female reproductive organs that produce eggs and secrete the hormone estrogen
- ovulation: event in which an egg bursts out of its follicle and through the wall of an ovary
- uterus: hollow female reproductive organ with muscular walls where a baby develops until birth
- vagina: cylinder-shaped female reproductive organ where sperm are deposited and through which a baby passes during birth

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## Teaching Strategies

### Introducing the Lesson

Tell students that the only human organ system that differs significantly between males and females is the reproductive system. Call on volunteers to say some of the ways they think the female reproductive system might differ from the male reproductive system. Accept all reasonable responses, and then tell students they will find out when they read this lesson.

### Demonstration

Show the class the video at the URL below to demonstrate the structures and functions of the female reproductive system. <http://www.neok12.com/video/Reproductive-System/zX615355515376087a725b7f.htm>

### Activity

Suggest that students use the following interactive Web site to explore the female reproductive system. At the site, they will find detailed images and descriptions pertaining to the female reproductive system and its structures. Using the interactive, they can find information that they may find it embarrassing to ask about in front of their classmates. <http://www.innerbody.com/>

### Differentiated Instruction

Give students an unlabeled diagram of the female reproductive system (see page 21 of the following URL), and ask them to label the structures. The diagram at the URL below includes a word bank. [http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs\\_reproductive\\_system\\_tg.pdf](http://school.discoveryeducation.com/teachersguides/pdf/lifescience/ul/hbs_reproductive_system_tg.pdf)

### Enrichment

Interested students might enjoy reading the following fascinating facts about human eggs: <http://www.cbsnews.com/pictures/human-eggs-9-fascinating-facts/>

### Science Inquiry

Students can work cooperatively to create a model of the female reproductive system using one of the following strategies. First divide the class into groups, and assign each group one of the female reproductive organs. Then have groups work together to complete the model. Same-sex students might be more comfortable working together within each group.

- Have students create a large chalk drawing of the female reproductive system in the parking lot. Direct one group after the other to draw and label their assigned organ, according to a predetermined scale. For example, the first group will draw and label the ovaries, including ova inside the ovaries. The next group will draw and label the fallopian tubes, including the fimbria (“fingers”). Have groups continue adding to the drawing until it is finished.
- Have students will create a 3-D model of the female reproductive system in the classroom. Each group will make a 3-D representation of their assigned organ using materials you provide or materials they bring from home, again according to a predetermined scale. For example, the ovaries group might use an empty plastic

ball with beads inside of it to represent each ovary. The Fallopian tube group might use a piece of plastic tubing and short pieces of yarn (for fimbria). Have groups assemble their “organs” on a table in the classroom to represent the entire reproductive system. As each group adds its organ to the model, ask students to explain how it represents that structure and its function in the reproductive system.

## Overcoming Misconceptions

You can find several common misconceptions about the menstrual cycle at the URL below (see page 1). Discuss with your class why each misconception is false, using the information provided. [http://www.jnfpb.org/guidance/Misconceptions\\_And\\_Sexual\\_And\\_Reproductive\\_Health-November%2022,%202011.pdf](http://www.jnfpb.org/guidance/Misconceptions_And_Sexual_And_Reproductive_Health-November%2022,%202011.pdf)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 22.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 22.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. List three functions of the female reproductive system
2. Identify three organs of the female reproductive system, and state their functions.
3. Describe what happens during ovulation.
4. If a woman’s fallopian tubes are blocked, she is unable to become pregnant even if she produces healthy eggs. Explain why.
5. What is menstruation, and why does it occur?

### Lesson Quiz

Check students’ mastery of the lesson with Lesson 22.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

If an egg is fertilized, this event takes place in a fallopian tube.

- What happens next to the fertilized egg?
- As an embryo grows into a fetus, the mother must provide nourishment to her offspring. How do nutrients pass from the mother to the fetus?

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## 22.3 Reproduction and Life Stages

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### Key Concepts

- Fertilization, embryo, and fetus
- Pregnancy and birth
- Infancy, childhood, puberty, and adolescence
- Stages of adulthood

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### Standards

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### Lesson Objectives

- Summarize events from fertilization to birth.
- Describe pregnancy and birth.
- Outline the major changes that occur from birth to adulthood.
- Give an overview of early, middle, and late adulthood.

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### Lesson Vocabulary

- adolescence: stage of life between the start of puberty and the beginning of adulthood that includes physical, mental, emotional, and social changes
- amniotic sac: membrane that surrounds a fetus and contains amniotic fluid, which cushions the fetus and helps protect it from injury
- blastocyst: fluid-filled ball of cells that forms within a few days of fertilization from a human zygote
- childhood: stage of human life that occurs between the age of 1 year and the start of puberty
- fetus: stage of a developing human being from the eighth week following fertilization until birth
- implantation: process in which a blastocyst implants in the lining of the uterus about one week after fertilization
- infancy: stage of human life between birth and the first birthday
- pregnancy: carrying of one or more offspring by an expectant mother from the time of implantation in the uterus until birth
- puberty: stage of life when a child becomes sexually mature and grows rapidly; occurs from about 10 to 16 years in girls and 12 to 18 years in boys
- umbilical cord: long tube containing two arteries and a vein that connects a fetus to the placenta

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## Teaching Strategies

### Introducing the Lesson

Introduce the lesson by sharing with the class the excellent animated video at the following URL. It shows the process of fertilization and the first few weeks of life, up to the formation of the embryo. Tell students they will learn more about fertilization and embryonic development in this lesson. <http://www.neok12.com/video/Reproductive-System/zX675f62004567690f705a63.htm>

### Demonstration

Demonstrate the process of birth by showing students the amazing animation at this URL: <http://www.neok12.com/video/Reproductive-System/zX564d664d756a7602447a55.htm>

### Activity

Students can use the interactive body at the URL below to learn about the changes that males and females go through at puberty. By clicking on “hotspots” on the body, they can focus on changes in specific organs and structures, including the hypothalamus, which triggers the changes of puberty. <http://www.bbc.co.uk/science/humanbody/body/interactives/lifecycle/teenagers/>

### Cooperative Learning

Use the cooperative learning activity at the following URL when you teach your students about puberty. This group activity is designed to help young teens identify common concerns about their changing bodies in an anonymous way. It also allows students to recognize normal variations in shape, size, and rate of development of their body and reproductive organs. The activity may reassure students who aren’t sure what to expect at puberty and wonder if they are developing normally. <http://recapp.etr.org/recapp/index.cfm?fuseaction=pages.LearningActivitiesDetail&PageID=17>

### Differentiated Instruction

Pair English language learners, less proficient readers, or visual learners with other students in the class. Tell partners to create a visual timeline for growth and development before or after birth. They should include major milestones and approximate ages when they normally occur, illustrated with their own sketches or images they print from the Internet. Display their best efforts in the classroom and encourage other students to examine them.

### Enrichment

Assign one or more of these topics for students to investigate and share with the class:

- Trend in earlier puberty in girls (what causes it, how it affects girls socially and emotionally)
- Multiple births (how often they occur, what causes them, fraternal vs identical twins)
- Fetal alcohol syndrome (causes and consequences)
- Folic acid deficiency during fetal development (effects on fetus, how to prevent it)
- Gestational diabetes (what it is, effects on mother and fetus, how it is treated)

## Science Inquiry

Have students read about the science project idea at the following URL and then design a procedure to test the hypothesis that lung capacity decreases with increasing age in adulthood. Tell them to identify the dependent and independent variables in their investigation and also any controls. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/HumBio\\_p003.shtml#summary](http://www.sciencebuddies.org/science-fair-projects/project_ideas/HumBio_p003.shtml#summary)

## Real-World Connection

Explain that receiving prenatal care during pregnancy greatly increases a woman's chance of having a healthy baby. Getting regular prenatal checkups is an effective way to catch any potential problems early and to monitor fetal development. Have students investigate what prenatal services are available in their community. They can use a local phone book and the Internet. Have them try to find answers to questions such as these:

1. Who offers prenatal care?
2. What does prenatal care include?
3. What other services are provided?
4. How often during pregnancy should a woman receive prenatal care?
5. How much does a typical prenatal-care visit cost?

## Overcoming Misconceptions

Ask students whether the following statements are true or false. Then explain why each statement is a misconception.

- Fertilization happens in the vagina.
- The fetus does not need oxygen until it is born.
- The fetus does not produce waste products in the womb.
- The sex of the zygote is not determined until after it starts to go through cell division.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 22.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 22.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What happens during fertilization? Where does it normally take place?
2. Describe the blastocyst stage.
3. What is implantation? When does it occur?
4. Identify the three stages of adulthood.
5. Why do you think an embryo would be more susceptible than a fetus to damage by toxins?
6. Create a timeline showing a few of the important changes that occur from birth to adulthood.
7. Explain the role of the placenta during fetal development.

8. Compare and contrast puberty and adolescence.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 22.3 Quiz in CK-12 MS Life Science Assessments.

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### Points to Consider

Many diseases become more common as people grow older. However, sexually transmitted infections (STIs) are more common in teens and young adults.

- What are some examples of STIs?
- How can STIs be prevented?

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## 22.4 Reproductive System Health

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### Key Concepts

- Sexually transmitted infections
- Other reproductive system disorders
- Keeping the reproductive system healthy

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### Standards

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### Lesson Objectives

- Identify myths about STIs, and distinguish between bacterial and viral STIs.
- Describe other male and female reproductive system disorders.
- List ways to keep the reproductive system healthy.

---

### Lesson Vocabulary

- acquired immunodeficiency syndrome (AIDS): disease characterized by rare infections due to a very low number of lymphocytes; caused by human immunodeficiency virus (HIV)
- chlamydia: most common sexually transmitted bacterial infection in the U.S.
- genital herpes: common sexually transmitted infection that is caused by a herpes virus and that may cause repeated outbreaks of painful genital blisters throughout life
- genital warts: common sexually transmitted infection that is caused by the human papilloma virus (HPV) and that causes warts on the genitals and may cause cancer later in life
- gonorrhea: common sexually transmitted bacterial infection that may cause painful urination and a discharge from the vagina or penis
- human immunodeficiency virus (HIV): virus that is transmitted sexually or through contact with infected body fluids and that destroys lymphocytes and may cause acquired immunodeficiency syndrome (AIDS)
- human papilloma virus (HPV): virus that is transmitted sexually and that causes genital warts and may cause cancer later in life
- sexually transmitted infection (STI): disease that spreads mainly through sexual contact and is caused by pathogens that enter the body through the reproductive organs or in some cases through contact with infected body fluids such as blood
- syphilis: sexually transmitted infection caused by bacteria that starts out as a sore on the genitals and can eventually cause death if it goes untreated

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## Teaching Strategies

### Introducing the Lesson

Define sexually transmitted infection (STI) and explain that both viruses and bacteria may cause STIs. Then share the following facts and figures about STIs to provide context when students learn more about them in this lesson.

- There are approximately 9 million new cases of STIs among 15-24 year olds in the U.S. each year. This represents almost half of the total new cases of STIs.
- Chlamydia is the most common bacterial STI among teenagers. Gonorrhea is another common bacterial STI in teens.
- Chlamydia and gonorrhea often do not cause symptoms, so they may go untreated. Untreated chlamydia or gonorrhea can cause infertility (inability to bear children).
- HIV is a sexually transmitted virus that may lead to AIDS. Having an STI makes an individual more likely to become infected with HIV if exposed to it. About 13% of new HIV diagnoses each year are made in people under the age of 25.

### Cooperative Learning

Use the cooperative learning activity at the following URL so groups of students can research and create posters to share important information about specific STIs. Information will include how the STIs are transmitted, the types of symptoms they produce, how they can be prevented, and how they are treated. <http://recapp.etr.org/recapp/index.cfm?fuseaction=pages.LearningActivitiesDetail&PageID=133>

### Activity

Have small groups of students play the “Down There Bingo” and/or “Word Bird” game (see page 16 of the PDF document below). The games are a silly way to introduce and discuss reproductive health terminology that might otherwise be embarrassing to some students. [http://www.iwtc.org/ideas/10\\_games.pdf](http://www.iwtc.org/ideas/10_games.pdf)

### Differentiated Instruction

Have students make a concept map to summarize the information in the Flexbook lesson on sexually transmitted infections. This will help them focus on the main concepts.

### Enrichment

Ask one or more boys to create a Web page for young teen boys on testicular cancer and testicular self examinations. The Web page should include statistics on testicular cancer rates by age and a diagram or video showing how to do a testicular self exam. Urge the other boys in the class to visit the Web page.

### Enrichment

Ask one or more girls to create a Web page for young teen girls on menstrual health. The Web page should include a description of what is normal as well as identify potential causes for concern. Encourage the other girls in class to read the information on the Web page.

## Science Inquiry

The games “Family Feud” and “Who Wants to Be a Zillionaire?” (page 23 of the document below) require students to do research to develop or answer questions. They are a fun way to encourage students to do inquiry on specific topics in reproductive health. [http://www.iwtc.org/ideas/10\\_games.pdf](http://www.iwtc.org/ideas/10_games.pdf)

## Overcoming Misconceptions

You can find several common misconceptions about STIs at the URL below (see page 2). Discuss with your class why each misconception is false, using the information provided. [http://www.jnfpb.org/guidance/Misconceptions\\_And\\_Sexual\\_And\\_Reproductive\\_Health-November%2022,%202011.pdf](http://www.jnfpb.org/guidance/Misconceptions_And_Sexual_And_Reproductive_Health-November%2022,%202011.pdf)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 22.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 22.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a sexually transmitted infection?
2. Identify some noninfectious reproductive system disorders.
3. List ways to keep the reproductive system healthy.
4. How do you think myths about STIs contribute to their spread?
5. Compare and contrast bacterial and viral STIs. Include examples of each type of STI.

### Lesson Quiz

Check students’ mastery of the lesson with Lesson 22.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Reproduction is important not only to families but also to planet Earth. Human reproduction has led to rapid growth of the human population.

- How big is the human population?
- Do you think that Earth is overpopulated when it comes to human beings?

## CHAPTER

## 23

## TE MS Introduction to Ecology

## Chapter Outline

23.1 WHAT IS ECOLOGY?

23.2 POPULATIONS

23.3 COMMUNITIES

23.4 ECOSYSTEMS

23.5 BIOMES

## Chapter Overview

This chapter introduces ecology, distinguishes between biotic and abiotic environmental factors, and defines basic ecological terms. It also provides detailed information on each of the levels of organization in ecology, including the population, community, ecosystem, biome, and biosphere.

## Online Resources

See the following Web sites for appropriate laboratory activities:

The science fair project at the following URL is a good classroom lab activity for students to investigate how camouflage helps prey species avoid predation. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/Zoo\\_p012.shtml#summary](http://www.sciencebuddies.org/science-fair-projects/project_ideas/Zoo_p012.shtml#summary)

In the “Build a Biome” lab at the URL below, groups of students will be assigned a particular biome and then determine how different types of plants grow in their assigned biome. They will compare their results with those of other groups. <http://mypages.iit.edu/~smile/bi9439.html>

These Web sites may also be helpful:

You can find links to many activities, worksheets, labs, and other teaching resources on ecology at these URLs: <http://www.nclark.net/Ecology> [http://science-class.net/archive/science-class/Ecology/ecosystems\\_biomes.htm](http://science-class.net/archive/science-class/Ecology/ecosystems_biomes.htm)

For tutorials on the world’s biomes, go to these URLs: [http://www.blueplanetbiomes.org/world\\_biomes.htm](http://www.blueplanetbiomes.org/world_biomes.htm) <http://www.ucmp.berkeley.edu/exhibits/biomes/index.php> <http://www.worldbiomes.com/>

TABLE 23.1: Lesson Pacing

Lesson	Class Period(s) (60 min)
23.1 What Is Ecology?	1.0
23.2 Populations	2.0
23.3 Communities	2.0
23.4 Ecosystems	1.0
23.5 Biomes	2.5

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## 23.1 What Is Ecology?

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### Key Concepts

- Definition of ecology
- Biotic and abiotic environmental factors
- Levels of organization in ecology

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### Standards

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### Lesson Objectives

- Define ecology.
- Distinguish between biotic and abiotic factors in the environment.
- Outline levels of organization in ecology.

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### Lesson Vocabulary

- abiotic factor: aspect of the environment that has never been alive, such as sunlight, minerals, temperature, or moisture
- biosphere: highest level of organization in ecology that includes all the parts of Earth where life can be found and consists of all the world's biomes, both terrestrial and aquatic
- biotic factor: living or once-living aspect of the environment, such as a living organism or the remains of a dead organism
- ecology: science of how living things interact with each other and their environment

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### Teaching Strategies

#### Introducing the Lesson

Show the short video “Introduction to Ecology: Ecosystems and Biomes” at the URL below to give students an overview of lesson content. The video uses simple, compelling narrative and beautiful visuals to introduce and emphasize the main points of the lesson. [https://www.youtube.com/watch?v=F-0rTICAT\\_c](https://www.youtube.com/watch?v=F-0rTICAT_c)

## Activity

With the activity at the following URL, students will learn about the different ecological levels (organism, population, community, ecosystem, biome, and biosphere) by choosing an organism and then illustrating a pyramid about that organism. After completing the activity, students will be able to define and explain the relationships among the different levels of organization. They will also be able to explain some of the reasons why different regions of the globe have different climates, and thus support different biomes. <http://www.mysciencebox.org/ecoorg>

## Differentiated Instruction

Help students distinguish between biotic and abiotic environmental factors by having them make a compare/contrast table like the sample table below.

Type of Environmental Factor	Definition	Examples
Biotic factor	aspect of the environment that is living or was once living	living organisms, remains of dead organisms
Abiotic factor	aspect of the environment that has never been alive	sunlight, minerals, temperature, water

## Enrichment

Research has determined that different areas of human skin have different communities of bacteria because of variations in skin moisture and oil. Have students learn more about this research and then create a diagram of the human body on which they indicate this variation. For example, they should show which areas of the body are moist and which areas are dry and the types of bacteria most commonly found in the different areas. Ask the students to display and explain their diagram to the rest of the class. Tell them to relate the presentation to the ecological concepts in the Flexbook lesson.

## Science Inquiry

With the “Salt Tolerance of Seeds” inquiry activity at the URL below, students will investigate how an abiotic environmental factor influences living things. They will carry out a procedure to determine how salt affects seed germination. <http://www.nclark.net/SeedGerminationLab.doc>

## Overcoming Misconceptions

There are many common misconceptions in ecology. You can read about several of them at the following URLs, which also discuss how to probe for and overcome the misconceptions. <http://ecomisconceptions.binghamton.edu/intro.htm> <http://beyondpenguins.ehe.osu.edu/issue/tundra-life-in-the-polar-extremes/common-misconceptions-about-biomes-and-ecosystems>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 23.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 23.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is ecology?
2. Define the biosphere.
3. Make an illustrated chart to show the different levels of organization in ecology.
4. Explain why organisms depend on their environment.
5. Compare and contrast biotic and abiotic factors in the environment.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 23.1 Quiz in CK-12 MS Life Science Assessments.

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### Points to Consider

The population is an important level of organization in ecology. It is also the unit of microevolution.

- What is a population?
- How can a population grow?

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## 23.2 Populations

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### Key Concepts

- Definition of population
- Measures of population size, growth, and structure
- History of human population growth and predictions for future growth

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### Standards

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### Lesson Objectives

- Define population.
- Identify measures of population size, growth, and structure.
- Describe how the human population grew in the past and is predicted to grow in the future.

---

### Lesson Vocabulary

- age-sex structure: numbers of individuals of each sex and age (or age group) in a population
- carrying capacity: largest population size of a species that can be supported in an area without harming the environment
- demographic transition: shift that occurred in some human populations, starting as early as the 1700s, which included a decrease in death rates, followed somewhat later by a decrease in birth rates, so that population growth changed from slow to rapid to slow again
- exponential growth: pattern of population growth in which a population starts out growing slowly and grows at an increasing rate as population size increases, so that the larger the population becomes, the more quickly it grows
- logistic growth: pattern of population growth in which a population starts out growing slowly, increases its rate of growth, and then grows more slowly as the population size approaches the carrying capacity
- population density: average number of individuals in a population per unit of area, such as the average number of individuals per square kilometer
- population distribution: measure of how individuals in a population are spread out over the area they occupy
- population growth rate: measure of how quickly a population changes in size over time
- population pyramid: special bar graph that represents the numbers of individuals of each sex and age (or age group) in a population

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## Teaching Strategies

### Introducing the Lesson

Display the human population clock at the URL below. Have students count how many people are added to Earth's human population in a given time interval, such as 30 seconds or a minute. Challenge them to predict how many people there are likely to be at some future date, such as 2050. Tell students they will learn why the human population is growing so quickly and how big it is likely to become when they read this lesson. <http://www.census.gov/popclock/>

### Building Science Skills

Have students do the “Population Circle” activity at the following URL. In the activity, they will simulate human population growth over the past 500 years and discover that most of the growth in the human population occurred in the last 200 years. <http://www.worldof7billion.org/wp-content/uploads/2014/08/population-circle-7b.pdf>

### Differentiated Instruction

The concept of population is important in both ecology and evolution. Make sure students know the scientific meaning of the term (“group of individuals of the same species that live in the same area”). Point out that individuals of other species may also live in the same area, but they make up their own populations. Remind students that populations of different species in the same area make up a community. If you started a word wall for the class, ask a pair of students to add the word population to it.

### Enrichment

Suggest that analytical thinkers do the debate activity at the URL below. Students will take a position and articulate their views on several contemporary issues relating to a human population of over 7 billion people and their resource consumption trends. <http://www.worldof7billion.org/wp-content/uploads/2014/08/7-Billion-Where-do-you-Stand.pdf>

### Science Inquiry

The simple simulation at the following URLs demonstrates how the spread of an infectious disease can result in an exponential increase in the number of infected individuals. This is followed by discussion questions and a graphing activity that help students understand exponential and logistic population growth. (teacher notes) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/InfectiousDiseaseTeachPrep.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/InfectiousDiseaseTeachPrep.pdf) (teacher notes) (student handout) [http://serendip.brynmawr.edu/sci\\_edu/waldron/pdf/InfectiousDiseaseProtocol.pdf](http://serendip.brynmawr.edu/sci_edu/waldron/pdf/InfectiousDiseaseProtocol.pdf) (student handout)

### Real-World Connection

Have students read about recent and projected trends in the growth of real-world human populations, as well as about relationships among population growth, the economy, and the environment. The first URL below is an article about the issues. Then have students do the exercises at the second URL. The third URL is an answer key. <http://www.worldbank.org/depweb/english/modules/social/pgr/index.html> <http://www.worldbank.org/depweb/english/modules/social/pgr/textq.html> <http://www.worldbank.org/depweb/english/modules/social/pgr/texta.html>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 23.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 23.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Define population.
2. What is a population pyramid?
3. What are some changes that caused the original demographic transition?
4. Describe the growth of a population that in a given year has 10 births, 8 deaths, and no migration.
5. If the human population reaches predicted levels by 2050, how do you think this may affect the environment?
6. Compare and contrast the concepts of population density and population distribution.
7. Relate carrying capacity to logistic growth of a population.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 23.2 Quiz in CK-12 MS Life Science Assessments.

---

## Points to Consider

A population doesn't exist alone. It is part of a community.

- What is a community?
- How might populations in a community interact?

---

## 23.3 Communities

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### Key Concepts

- Definition of community
- Predator-prey relationships
- Intraspecific and interspecific competition
- Types of symbiotic relationships

---

### Standards

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### Lesson Objectives

- Define community.
- Explain how predation affects predator and prey populations.
- Describe outcomes of intraspecific and interspecific competition.
- Identify three types of symbiotic relationships.

---

### Lesson Vocabulary

- commensalism: type of symbiotic relationship in which one species benefits while the other species is not affected
- community: biotic component of an ecosystem that consists of all the populations of all the species that live in the same area
- competition: relationship between organisms that depend on the same resources; may be intraspecific (between members of the same species) or interspecific (between members of different species)
- host: species that is harmed by a parasite in a parasitic relationship
- keystone species: predator species that plays a special role in its community because changes in its population affect the populations of many other species in the community
- mutualism: type of symbiotic relationship in which both species benefit from the relationship
- parasite: species that benefits and harms a host in a parasitic relationship
- parasitism: type of symbiotic relationship in which one species benefits and the other species is harmed
- predation: relationship between species in a community in which members of one species consume members of another species
- predator: species that consumes the prey species in a predator-prey relationship
- prey: species that is consumed by a predator species in a predator-prey relationship
- symbiosis: close relationship between two species in a community in which at least one species benefits, while the other species may benefit, be harmed, or be unaffected; types of symbiosis include mutualism, parasitism, and commensalism

---

## Teaching Strategies

### Introducing the Lesson

The activity at the following URL is an excellent way to introduce the concept of ecological community. First students will think of several types of organisms that live in different communities. Then they will use soil samples to investigate organisms in a particular community and how they might be related. <http://mypages.iit.edu/~smile/bi9115.html>

### Building Science Skills

At the URL below, have students model predator-prey relationships and how they affect population sizes with a predation simulation. By changing variables in the model, students can observe how population sizes are affected. Ask students to share what they learn about predation from the model. <http://concord.org/stem-resources/competition>

### Cooperative Learning

Pairs of students can investigate symbiotic relationships among organisms in a thermal vent community with the activity at this URL: [http://www.pbs.org/wgbh/nova/education/activities/2609\\_abyss.html](http://www.pbs.org/wgbh/nova/education/activities/2609_abyss.html)

### Activity

Use the activity at the following URL to teach students about the importance of interspecific community relationships in the evolution of species. Students will begin the activity by discussing adaptations that have evolved from generations of predator-prey interactions. Next, they will investigate a classic evolutionary “arms race” between two particular species: newts and garter snakes. Then, they will explore the complex symbiotic relationships among leaf-cutter ants, the fungus they grow for food, and the bacteria they use to protect the fungus crop from mold. Finally, students will go online to explore a virtual coral reef and document the different types of relationships they find among the organisms that live there. [http://www.pbslearningmedia.org/resource/tdc02.sci.life.div.lp\\_armsrace/evolutionary-arms-race/](http://www.pbslearningmedia.org/resource/tdc02.sci.life.div.lp_armsrace/evolutionary-arms-race/)

### Differentiated Instruction

Pass out copies of the graphic organizer about symbiosis at the following URL. Tell students to fill it in as they read about symbiosis in the Flexbook lesson. [http://science-class.net/archive/science-class/Graphic\\_Organizers/GO\\_3definitions\\_symbiosis.pdf](http://science-class.net/archive/science-class/Graphic_Organizers/GO_3definitions_symbiosis.pdf)

### Enrichment

This Flexbook lesson has a large number of new vocabulary terms. Ask one or more students to create a word game such as a crossword puzzle for some or all of the new terms. Make copies of their puzzles available for other students to complete.

## Science Inquiry

With the inquiry-based lesson at the URL below, students can study the ecosystem of a decomposing log. Specific objectives of the lesson include understanding a log's decomposition cycle, identifying types of species living in a log habitat, understanding the roles of organisms at different trophic levels, collecting and documenting decomposition data through drawings and graphs, and analyzing the data to determine effects the species have on each other and their habitat. <http://nationalzoo.si.edu/Education/ClassroomScience/DecomposingLogs/Teacher/default.cfm>

## Real-World Connection

In the activity at the following URL, students will learn to graph population data and then use their graphs to evaluate one of the most famous examples of community change: the predator-prey population cycle of the snowshoe hare and the Canada lynx. The data come from the 300-years' worth of real data collected by trappers of the Hudson Bay Company. The activity gives students a chance to use actual data and develop hypotheses about community changes in the real world. <http://www.mysciencebox.org/harelynx>

## Math Connection

Use the predator-prey worksheet at the URL below to give students practice analyzing and graphing numerical data while reinforcing their understanding of the predator-prey relationship. [http://www.biologycorner.com/worksheets/predator\\_pre\\_graphing.html](http://www.biologycorner.com/worksheets/predator_pre_graphing.html)

## Overcoming Misconceptions

Students commonly hold the following misconceptions about predator and prey populations. Be sure to discuss the correct conceptions, which are given below in brackets.

- Predator and prey populations are similar in size.

[Prey populations tend to be larger than predator populations.]

- The sizes of predator and prey populations have no bearing on each other.

[The sizes of predator and prey populations influence each other in predictable ways.]

---

## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 23.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 23.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Define community.
2. Describe two potential outcomes of interspecific competition.
3. Identify three types of symbiosis.
4. After a rainy summer and excessive weed growth, a population of mice has doubled in size because of a greater food supply. The main predators of the mice are owls. Predict how the owl population in the same community is likely to change.
5. Explain how camouflage could benefit both predator and prey species.
6. Why do parasites usually not kill their host?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 23.3 Quiz in CK-12 MS Life Science Assessments.

---

### Points to Consider

A community is the biotic component of an ecosystem.

- What is an ecosystem?
- What are some examples of ecosystems?

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## 23.4 Ecosystems

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### Key Concepts

- Definition of ecosystem
- Energy and matter in ecosystems
- Niche, habitat, and the competitive exclusion principle

---

### Standards

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### Lesson Objectives

- Define ecosystem.
- Describe the role of energy and matter in ecosystems.
- Define niche and habitat, and explain the competitive exclusion principle.

---

### Lesson Vocabulary

- competitive exclusion principle: law that two different species cannot occupy the same niche in the same habitat at the same time
- ecosystem: unit of nature that consists of all the biotic and abiotic factors in an area and all the ways in which they interact
- habitat: physical environment in which a species lives and to which it has adapted
- niche: role that a particular species plays in its ecosystem, including all the ways that the \*species: interacts with the biotic and abiotic factors in the ecosystem

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### Teaching Strategies

#### Introducing the Lesson

Use the “talking” red wolf video at the following URL for a humorous introduction to the habitat and niche concepts of an ecosystem. <https://www.youtube.com/watch?v=2L6N2diE8jc>

#### Discussion

In the media-rich lesson at the following URL, students will use a systems-thinking approach to explore and discuss the components and processes of ecosystems. They will analyze both a hypothetical and a local ecosystem by

identifying abiotic and biotic components and their relationships. The lesson provides discussion questions and links to online media. <http://www.pbslearningmedia.org/resource/lsp07.sci.life.eco.lpecosystems/exploring-the-systems-in-ecosystems/>

### Building Science Skills

Students can discover what ecosystems are by creating and studying miniature ecosystems with the activity at the URL below. Students will build a terrarium column—a two-layer, soda-bottle tower with soil and plants on the top and a water source on the bottom. The terrarium columns can be used throughout the ecology unit to practice water- and soil-quality monitoring and to make and record observations. Later in the unit, students can conduct independent investigations with their terrarium columns. Links to ideas for further experimentation are provided at the URL. <http://www.mysciencebox.org/tac>

### Activity

With the lesson plan at the following URL, students can focus on the coral reef ecosystem to learn about important ecosystem concepts. They will learn how the biotic and abiotic parts of the ecosystem interact, using videos, interactive activities, handouts, hands-on activities, and class discussions. <http://www.pbslearningmedia.org/resource/hew06.sci.life.eco.lpecosystem/the-coral-reef-ecosystem/>

### Differentiated Instruction

Have students fill in this Frayer model worksheet for the term ecosystem: [http://science-class.net/archive/science-class/Graphic\\_Organizers/GO\\_ecosystem.pdf](http://science-class.net/archive/science-class/Graphic_Organizers/GO_ecosystem.pdf)

### Enrichment

Suggest that interested students create a mini-pond ecosystem in a glass jar and use it to investigate the diversity of a pond ecosystem. Students can follow the instructions at the URL below. The PDF file contains background information, a materials list, a detailed procedure, and several questions to guide students in drawing conclusions from their investigation. [http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems\\_Biomes/Miniecosystem.pdf](http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems_Biomes/Miniecosystem.pdf)

### Science Inquiry

Challenge students to play the game at the URL below in which they will attempt to restore a prairie ecosystem. They will rely on a field guide to choose the correct types of plants and animals for the ecosystem. Doing the activity will require them to apply ecological principles, as well as teach them about the prairie ecosystem. <http://www.bellmuseum.umn.edu/games/prairie/build/index.html>

### Overcoming Misconceptions

Three common student misconceptions about ecosystems are listed below. Discuss with your class why these misconceptions are false.

- Varying the population size of a species may not affect an ecosystem because some organisms are not important.

[Discuss how all organisms are important in an ecosystem. Varying a species' population size may not affect all other species equally, but it will affect at least some other species and the ecosystem as a whole.)

- Ecosystems are not a functioning whole but simply a collection of organisms.

[Discuss how ecosystems include not just the organisms but also the interactions between organisms and between the organisms and their physical environment.]

- Species coexist in ecosystems because of their compatible needs and behaviors; that is, they need to get along.

[Within an ecosystem, species compete for resources and feed on one another. Species live in the same ecosystem because of similar adaptations and environmental needs.]

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 23.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 23.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is an ecosystem?
2. Define niche.
3. Two different species of birds live in the same habitat and eat the same foods. What can you conclude about the niches of the two species?
4. Relate the competitive exclusion principle to the concepts of niche, habitat, and competition.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 23.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Similar ecosystems are found in different parts of the world. For example, forests and deserts are found on almost all of Earth's continents.

- What factors do you think determine where a particular terrestrial ecosystem is found?
- Think about your own ecosystem. Where else in the world might a similar ecosystem be found?

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## 23.5 Biomes

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### Key Concepts

- Definition of biome
- Climate and terrestrial biomes
- Freshwater and marine biomes

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### Standards

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### Lesson Objectives

- Define biome.
- Explain how climate affects terrestrial biomes, and give examples of terrestrial biomes.
- Identify freshwater and marine biomes and relate them to sunlight and nutrients.

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### Lesson Vocabulary

- aphotic zone: part of a body of water that is deeper than 200 meters where not enough sunlight penetrates to allow photosynthesis to take place
- aquatic biome: water-based biome, or group of similar water-based ecosystems; any freshwater or marine biome
- biome: group of similar ecosystems with the same general abiotic factors and primary producers, such as the littoral zone in water or the tropical rainforest on land
- climate: average weather in a place over a long period of time
- freshwater biome: group of similar ecosystems that are based in fresh water, such as the littoral zone near the shore of a lake or the profundal zone at the bottom of a lake
- marine biome: group of similar, salt-water based ecosystems in the ocean, such as the intertidal zone along a coast or the benthic zone at the bottom of the ocean
- photic zone: top 200 meters of a body of water where enough sunlight penetrates to allow photosynthesis to take place
- terrestrial biome: group of similar, land-based ecosystems, such as tropical rainforests, temperate grasslands, or tundras

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## Teaching Strategies

### Introducing the Lesson

Ask the class to recall from the lesson “What Is Ecology?” the definition of biome (“group of similar ecosystems with the same general abiotic factors and primary producers”). Have students try to name examples of biomes, including the biome where they live (e.g., tropical rainforest, temperate grassland). Tell students they will learn more about biomes in this lesson.

### Activity

Have students play the biome games at the URLs below. In the first game, they will analyze temperature and precipitation graphs from different cities and try to match them to biomes where the cities would be located. In the second game, students will predict the biomes of various plants. <http://earthobservatory.nasa.gov/Experiments/Biome/graphindex.php> <http://earthobservatory.nasa.gov/Experiments/Biome/plantindex.php>

### Building Science Skills

In the module “Understanding Habitat: The Temperate Forest Biome,” students will work in teams to define, locate, and determine characteristics of the temperate forest biome. Then they will use an online interactive field study to “walk through” a fictional temperate forest. As part of the virtual study, they will use scientific methods and tools to collect various abiotic measurements. An optional extension activity involves exploring biodiversity in a local temperate forest. <http://nationalzoo.si.edu/education/conservationcentral/pdfs/Module%202.pdf>

### Differentiated Instruction

Divide the class into five groups, and have them do the activity at the URL below. Mix students with different learning styles or proficiencies within each group. Members of each group will work together to create a Venn diagram comparing two biomes. The Venn diagram should show what features are distinct to each biome and what features they have in common. Each group will have a different pair of biomes to investigate. Give groups a chance to share their work with the rest of the class. [http://www.biologycorner.com/worksheets/comparing\\_ecosystems.html](http://www.biologycorner.com/worksheets/comparing_ecosystems.html)

### Enrichment

Have students select a biome that interests them (other than their own), and ask them to create a brochure for that biome. Make copies of the finished brochures available for the class to view. The students can find research and brochure ideas at these URLs: [http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems\\_Biomes/biomes\\_brochure.htm](http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems_Biomes/biomes_brochure.htm) [http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems\\_Biomes/BiomesBrochure.pdf](http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems_Biomes/BiomesBrochure.pdf)

### Science Inquiry

With the inquiry project at the following URL, students can model two different terrestrial biomes to investigate the effects of climatic factors on the growth of primary producers. Links are provided to background information, a materials list, and a procedure. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/EnvSci\\_p046.shtml#summary](http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p046.shtml#summary)

## Real-World Connection

With the Smithsonian module at the following URL, students can apply biome and related concepts to their own backyard. In the module, students will locate the biome in which they live, explore a local habitat, and conduct a biological inventory to assess habitat health and natural and human impacts to the environment. <http://nationalzoo.si.edu/education/conservationcentral/pdfs/Module%201.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 23.5 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 23.5 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a biome?
2. Identify three terrestrial biomes.
3. Describe the intertidal zone.
4. Randomly choose a location on the map in Figure 23.19. Identify its biome and then research that biome to find out what plants and animals you might find there.
5. Explain the relationship between climate and terrestrial biomes.
6. Compare and contrast the photic and aphotic zones of a body of water.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 23.5 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

In all biomes, ecosystems need a constant input of energy. Matter, on the other hand, is constantly recycled in ecosystems.

- Where do most ecosystems get energy?
- What are some examples of cycles of matter?

# CHAPTER 24

## TE MS Ecosystem Dynamics

### Chapter Outline

- 24.1 FLOW OF ENERGY**
- 24.2 CYCLES OF MATTER**
- 24.3 ECOSYSTEM CHANGE**

### Chapter Overview

This chapter explains how energy flows through ecosystems. It describes how living things are classified based on the way they obtain energy and shows how food chains and food webs model the flow of energy. The chapter also outlines how water, carbon, and nitrogen are recycled through ecosystems and how ecosystems change through time.

### Online Resources

See the following Web sites for appropriate laboratory activities:

In the lab described at the following URL, groups of students will carry out a field study of a 10 m x 10 m outdoor area in which they will identify organisms living in the soil, plants, insects, and any other animals living within the study site. Groups will also examine abiotic factors at the site. After gathering the field data, groups will share data and then respond to a series of questions concerning their data in a paper. Answering the questions will require application of basic ecological concepts. For example, they will develop a food web and energy flow diagram for their site and describe any ecological relationships they observed. [http://www.accessexcellence.org/AE/AEC/AEF/1995/sinclair\\_ecosystem.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/sinclair_ecosystem.php)

With the classic owl pellet lab at the first URL below, students can dissect an owl pellet to learn more about the owl's niche by determining the organisms it consumes. For a virtual owl pellet dissection activity, go to the second URL. <http://www.biologycorner.com/worksheets/owlpellet.html> <http://kidwings.com/nests-of-knowledge/virtual-pellet/>

Students can model ecological succession in a jar ecosystem with the lab activity at this URL: [class/Lessons/Ecology/Ecosystems\\_Biomes/succession\\_in\\_a\\_Jar.pdf](http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems_Biomes/succession_in_a_Jar.pdf) [[http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems\\_Biomes/succession\\_in\\_a\\_Jar.pdf](http://science-class.net/archive/science-class/Lessons/Ecology/Ecosystems_Biomes/succession_in_a_Jar.pdf)]

These Web sites may also be helpful:

Go to the following URLs for links to a wide variety of teaching resources on ecological concepts in this chapter: <http://www.nclark.net/Ecology> [http://science-class.net/archive/science-class/Ecology/ecosystems\\_biomes.htm](http://science-class.net/archive/science-class/Ecology/ecosystems_biomes.htm) <http://science-class.net/archive/science-class/Ecology/succession.htm>

**TABLE 24.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
24.1 Flow of Energy	2.0
24.2 Cycles of Matter	2.0

**TABLE 24.1:** (continued)

Lesson	Class Period(s) (60 min)
24.3 Ecosystem Change	1.0

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## 24.1 Flow of Energy

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### Key Concepts

- Types of organisms and energy
- Food chains and food webs
- Trophic levels, energy, and biomass

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### Standards

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### Lesson Objectives

- Explain how living things are classified based on the way they obtain energy.
- Show how food chains and food webs model the flow of energy through ecosystems.
- Identify trophic levels, and state how they are related to energy and biomass.

---

### Lesson Vocabulary

- biomass: total mass of organisms at a given trophic level in a food chain or food web
- chemoautotroph: type of producer that uses chemical energy to make organic compounds by the process of chemosynthesis
- chemosynthesis: process of using chemical energy to make organic compounds
- consumer: type of organism that obtains food by eating or absorbing other organisms
- decomposer: type of organism that obtains food by breaking down the remains of dead organisms or other organic wastes
- detritivore: type of decomposer that obtains energy and matter by breaking down dead leaves and other organic debris that collects on the ground or at the bottom of a body of water
- food chain: diagram that represents a single pathway by which energy flows through an ecosystem
- food web: diagram that represents several intersecting pathways by which energy flows through an ecosystem
- photoautotroph: type of producer that uses light energy to produce organic compounds by the process of photosynthesis
- producer: type of organism that uses light or chemical energy to produce organic compounds for itself and other living things
- saprotroph: type of decomposer that feeds on any remaining organic matter that is left after other decomposers do their work
- scavenger: type of decomposer that consumes the soft tissues of dead animals
- trophic level: feeding position in a food chain or food web

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## Teaching Strategies

### Introducing the Lesson

Students are likely to have seen food chains in previous science classes. Help them recall what they already know. First show them a simple food chain diagram (see URL below). Then probe their prior knowledge by asking them what the food chain represents (one way that energy may flow through an ecosystem). Tell students they will learn more about food chains and the flow of energy through ecosystems in this lesson. [http://upload.wikimedia.org/wikipedia/commons/thumb/2/2b/Simplified\\_food\\_chain.svg/395px-Simplified\\_food\\_chain.svg.png](http://upload.wikimedia.org/wikipedia/commons/thumb/2/2b/Simplified_food_chain.svg/395px-Simplified_food_chain.svg.png)

### Activity

Students can review food chains and the roles of organisms in food chains with the card-sorting activity at the following URL. Cards representing different individuals in an ecosystem are first sorted by herbivore, carnivore, detritivore, and omnivore. Then the cards are reordered to create several food chains. The activity also introduces the idea of an energy pyramid. At the URL, there are links to a lesson plan, cards for sorting, and an energy pyramid overhead. <http://www.mysciencebox.org/foodchain>

### Cooperative Learning

With the Smithsonian activity at the URL below, students will play an active game to predict a likely food chain for a given habitat. Students will assume the roles of animals, play tag, and simulate feeding relationships. From the activity, they will understand that energy is lost through breathing, heating, and moving; and that energy is transferred when it passes from one organism to another. <http://forces.si.edu/ltop/pdfs/6-8-StrikingABalance.pdf>

### Building Science Skills

Have students do the activity at the following URL. They will become familiar with common organisms found in a pond, discover their importance in a balanced aquatic habitat, and create pond food webs. Students will also investigate how an environmental change (such as pollution, disease, or the introduction of exotic species) affects a pond habitat. <http://sciencespot.net/Media/pondfoodwebinfo.pdf>

### Differentiated Instruction

Use the free worksheet at the URL below to give students extra practice with food webs and related concepts. First students will label the levels (e.g., producer) and individual organisms (e.g., herbivore) in a food web diagram. Then they will create a food web diagram for a given set of organisms. Discuss the completed worksheets with students and make sure any errors are corrected. <http://www.biologycorner.com/worksheets/foodweb.htm>

### Enrichment

The Mono Lake activity at the URL below is recommended for students who are self-directed and creative. Students will do a Web quest to gather information and then create a Mono Lake Field Guide. Many links are supplied in the activity, from which students will learn about the organisms that live in this extreme habitat and their complex food web. They will use the information to create pages for a field guide, incorporating writing and art. <http://serc.carleton.edu/microbelife/k12/alkaline/WQintro.html>

## Science Inquiry

In the activity at the URL below, students will choose an organism and research its life cycle, sample food chain, and habitat. The student research will then be assembled in two different ways. First, students will use their organisms to create a food web that stretches the length and width of the classroom. Second, they will write a field guide page for their organism and assemble the pages to create a field guide booklet. <http://www.mysciencebox.org/foodwebs>

## Overcoming Misconceptions

Listed below are some common student misconceptions about food chains and webs. Be attuned for such misconceptions in your students.

- Organisms higher in a food web eat everything that is lower in the food web.
- There are more herbivores than carnivores because people keep and breed herbivores.
- Food chains involve consumers but not producers.
- The role of decomposers in food chains and webs is to release that is cycled back to plants (producers).

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 24.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 24.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Identify three major categories of living things based on how they obtain energy.
2. What is a food chain? Why are food chains simpler than actual feeding relationships in nature?
3. Define trophic level. How does an organism at trophic level 2 obtain energy?
4. At which trophic levels are you consuming when you eat a cheeseburger and French fries?
5. Compare and contrast three types of decomposers.
6. Explain why food chains and webs rarely have more than four trophic levels.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 24.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Energy must constantly be added to an ecosystem for use by organisms. Matter, on the other hand, is continuously recycled through ecosystems.

- Give an example of a cycle of matter.

- What role do living things play in this cycle?

---

## 24.2 Cycles of Matter

---

### Key Concepts

- Definition of biogeochemical cycle
- Water cycle
- Carbon cycle
- Nitrogen cycle

---

### Standards

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### Lesson Objectives

- Define biogeochemical cycle.
- Describe the processes of the water cycle.
- Summarize the carbon cycle.
- Outline the nitrogen cycle.

---

### Lesson Vocabulary

- biogeochemical cycle: cycle in which a chemical element or water is passed back and forth through biotic and abiotic components of ecosystems
- carbon cycle: biogeochemical cycle in which carbon passes back and forth between sedimentary rocks, fossil fuels, the atmosphere, the ocean, and organisms
- condensation: process in which a gas such as water vapor changes from the gaseous to liquid state
- evaporation: process in which a liquid such as water changes from the liquid to gaseous state
- groundwater: water that soaks into the ground and is stored in underground rocks
- nitrogen cycle: biogeochemical cycle in which nitrogen passes back and forth between the atmosphere and organisms, including specialized bacteria in the soil
- precipitation: process in which moisture falls from clouds to the ground; may include rain, snow, sleet, hail, or freezing rain
- runoff: water that flows over the land from precipitation or melting snow or ice
- sublimation: process in which snow or ice changes directly to water vapor without first changing to liquid water
- water cycle: biogeochemical cycle in which water passes back and forth between the ocean, ground, atmosphere, and organisms

---

## Teaching Strategies

### Introducing the Lesson

Students are likely to be familiar with the water cycle from prior science classes. Help them recall what they already know. Show them a simple, unlabeled diagram of the water cycle, like the diagram at the URL below. Then challenge them to name the processes represented in the diagram. Tell students they will learn more about the water cycle and other cycles of matter in this lesson. [http://upload.wikimedia.org/wikipedia/commons/f/fd/Simple\\_Water\\_Cycle.JPG](http://upload.wikimedia.org/wikipedia/commons/f/fd/Simple_Water_Cycle.JPG)

### Activity

Students can simulate the movement of a carbon molecule through the carbon cycle by playing “The Carbon Cycle Game” at the following URL. Students will roll dice to determine how they move between parts of the cycle. Learning objectives include describing how carbon moves in the carbon cycle and timing its movement from one part of the cycle to another. [http://oceanservice.noaa.gov/education/pd/climate/teachingclimate/carbon\\_cycle\\_game.pdf](http://oceanservice.noaa.gov/education/pd/climate/teachingclimate/carbon_cycle_game.pdf)

### Activity

Have students play the card game “Around and Around Nitrogen Goes” at the URL below. The game is a fun way to reinforce the student’s understanding of the nitrogen cycle. The game also illustrates how the nitrogen cycle affects plant growth and how various factors affect the nitrogen cycle. <http://www.cfaitc.org/lessonplans/pdf/402a.pdf>

### Differentiated Instruction

Define the word parts that make up the lesson vocabulary terms photoautotroph and chemoautotroph.

- photo : “relating to light”
- chemo- (or chemi-); “relating to chemicals”
- auto-: “self”
- -troph: “food”

Give students examples of more common words that contain the same word parts (e.g., photograph, chemical, automatic). Ask them to think of other common words containing the word parts. Then work with students to put the word parts together and define photoautotroph and chemoautotroph.

### Enrichment

Ask a few interested students to investigate and create a diagram to represent a cycle of matter not covered in the Flexbook lesson, such as a cycle of oxygen or calcium.

### Science Inquiry

In the “Web-o-Cycles” activity at the following URL, groups of students will investigate the different cycles of matter in the Flexbook lesson (water, carbon, and nitrogen cycles) and create diagrams to model them. Then groups will identify ways their cycle interacts with other cycles. Finally, they will use yarn and other materials to model the interactions. <http://serc.carleton.edu/NAGTWorkshops/complexsystems/activities/webocycle.html>

## Language Arts Connection

The activity at the following URL combines language arts, design, and life science. In the activity, students will design a habitat for worms that will serve as composters for their home or school. Students will learn about composting, nutrient cycles, and the importance of decomposition in their local environment. This exercise will compliment many language arts lessons, helping students evaluate data, participate in society, and communicate effectively about a design and ecological concepts. <http://dx.cooperhewitt.org/lessonplan/soil-a-design-youll-dig-de-signing-a-habitat-for-worms/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 24.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 24.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a biogeochemical cycle?
2. Identify three ways in which water vapor enters the atmosphere in the water cycle.
3. Describe three ways that carbon can enter the ocean in the carbon cycle.
4. What roles do bacteria play in the nitrogen cycle?
5. A farmer may plant a field with a legume crop to improve the soil. How does this work?
6. Compare and contrast exchange pools and reservoirs in biogeochemical cycles. Give an example of each from the water and carbon cycles.
7. Explain the role of decomposers in the nitrogen cycle.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 24.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Ecosystem dynamics include more than the flow of energy and recycling of matter. Ecosystems are also dynamic because they change through time.

- What are some ways ecosystems might change through time?
- Do you think there are any ecosystems that do not change through time?

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## 24.3 Ecosystem Change

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### Key Concepts

- Ecological succession
- Primary succession
- Secondary succession
- Climax community

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### Standards

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### Lesson Objectives

- Define ecological succession.
- Explain how primary succession occurs.
- Explain why secondary succession occurs more rapidly than primary succession.
- Discuss the concept of climax community.

---

### Lesson Vocabulary

- climax community: final, stable community resulting from ecological succession that is theoretically possible but unlikely in most real-world ecosystems
- ecological succession: change in the numbers and types of species in an ecosystem over time
- pioneer species: first species that colonize an ecosystem after it has been disturbed
- primary succession: type of ecological succession that occurs in an area that has never before been colonized by living things and lacks soil
- secondary succession: type of ecological succession that occurs in a formerly inhabited area that was disturbed but already has soil

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### Teaching Strategies

#### Introducing the Lesson

Introduce the idea of ecological succession with a dramatic ecosystem change. Show students the video below of the enormous 1980 eruption of Mount Saint Helens in Washington State. The video shows how the ecosystem was devastated by the blast and how many living things perished. Tell the class that all ecosystems are constantly

changing and this is just an extreme example. <http://www.discovery.com/tv-shows/discovery-presents/videos/understanding-volcanoes-mt-saint-helens/>

### Building Science Skills

This activity builds on the Introducing the Lesson video above. Students can learn about and analyze ecological succession on Mount St. Helens following the 1980 eruption and then predict future changes for the ecosystem. Have them read the well-illustrated article and answer the questions at the first URL below. The second URL provides answers to the questions. (Student handout) <http://dnet01.ode.state.oh.us/IMS.ItemDetails/LessonDetail.aspx?id=0907f84c805320b1> (Student handout) (Teacher page) [https://www.plt.org/stuff/contentmgr/files/1/47089543432aae6ee76a2c1d9fd698cf/files/focus\\_on\\_forests\\_activity\\_2\\_tp\\_mount\\_st\\_helens.pdf](https://www.plt.org/stuff/contentmgr/files/1/47089543432aae6ee76a2c1d9fd698cf/files/focus_on_forests_activity_2_tp_mount_st_helens.pdf) (Teacher page)

### Building Science Skills

Handout copies of the worksheet at the following URL to use as a class activity or homework assignment. Students will place the stages of succession of two aquatic ecosystems into sequence. They will also describe changes in an ecosystem and make predictions about changes that will take place from one stage of succession to another. <http://www.nclark.net/Succession.doc>

### Activity

Use the lesson at the URL below, “The Long and Short Story of Ecological Succession,” to teach the concept that changes in ecosystems can range from very slow to very rapid. Instruction and review are included in a game format that provides a platform for discussion. The lesson plan includes options for differentiated instruction and enrichment. <http://dnet01.ode.state.oh.us/IMS.ItemDetails/LessonDetail.aspx?id=0907f84c805320b1>

### Differentiated Instruction

Work with students to create a flow chart that summarizes how primary succession occurs. Then have students illustrate their copy of the flow chart to show what organisms are present at each stage.

### Enrichment

Students can read a more sophisticated discussion of climax communities at the following URL. It includes a brief history of the term and how it has been used since it was first introduced about a century ago. <http://science.jrank.org/pages/1515/Climax-Ecological.html>

### Science Inquiry

Have students apply lesson concepts about ecological succession to predict how the school athletic field or similar well-maintained outdoor area might appear after various intervals of time if it were no longer maintained. For example, if the athletic field was not mowed and was left completely alone, how might it look after 1 year, 10 years, and 50 years? Discuss how students arrived at their predictions and the succession of species they predicted.

### Overcoming Misconceptions

Students often have the misconception that ecosystems are static entities, which change little over time. Make sure students are exposed to adequate examples of ecosystem change to appreciate that ecosystems are always changing

as a result of natural hazards, environmental changes, and human activities.

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 24.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 24.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is ecological succession?
2. Define climax community, and state why climax communities are unlikely.
3. Assume that a flood washed out all of the plants in a large area along the bank of a river. It left behind nothing but soil. How will ecological succession occur in this area?
4. Compare and contrast primary and secondary succession.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 24.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Many ecosystems have changed because of human actions. The human species is responsible for a range of environmental problems.

- What environmental problems have human actions caused?
- How have these environmental problems affected living things?

## CHAPTER

## 25

## TE MS Environmental Problems

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Chapter Outline

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- 25.1 AIR POLLUTION
  - 25.2 WATER POLLUTION
  - 25.3 NATURAL RESOURCES
  - 25.4 BIODIVERSITY AND EXTINCTION
- 

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Chapter Overview

This chapter identifies causes and effects of outdoor air pollution, indoor air pollution, and water pollution. It also describes how natural resources are used, distinguishes between renewable and nonrenewable resources, and explains how to conserve natural resources. In addition, the chapter discusses the benefits of biodiversity and how habitat loss and other environmental problems are causing a sixth mass extinction.

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Online Resources

See the following Web sites for appropriate laboratory activities:

Have students use online models and data to explore the problem of air pollution. They will experiment with the flow of pollutants through the air and factors that affect it using real-time air quality data maps and computational models. By the end of the lab, students will be able to predict the effects of human development on a region's future air quality. <http://concord.org/stem-resources/will-air-be-clean-enough-breathe>

The lab activity “Smog Alert” at the URL below (pages 121–123) allows students to create artificial “smog” in a jar. By doing the lab, students will recognize that invisible air pollutants and weather conditions are involved in creating smog, understand that not all air pollution is visible, and appreciate that human activities can cause air pollution. <http://www.epa.gov/airnow/teachers/toolkit/teachers-toolkit-6-8-508.pdf>

In the lab activity described at the following URL, groups of students will undertake a terrestrial biodiversity survey in order to examine the impact of humans on the environment. Through a series of investigations, students will develop their own hypothesis about human impacts and then test it on a site not previously examined. Final analysis and discussion of the results will allow students to develop a theory about the effects of human actions on biodiversity. [http://www.accessexcellence.org/AE/AEC/AEF/1995/schenck\\_survey.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/schenck_survey.php)

These Web sites may also be helpful:

See this PDF document from the EPA to find several excellent middle school lesson plans on air pollution: <http://www.epa.gov/airnow/teachers/toolkit/teachers-toolkit-6-8-508.pdf>

At the following URL, you can search for dozens of middle school alternative energy activities. <http://www1.eere.energy.gov/education/lessonplans/default.aspx>

Direct students to this URL to become “Energy Star Kids.” By exploring the interactive Web site, they will have fun learning about energy resources and conservation, including specific ways they can help save energy and reduce global warming. [http://www.energystar.gov/index.cfm?c=kids.kids\\_index](http://www.energystar.gov/index.cfm?c=kids.kids_index)

At the URLs below, you can find links to many lesson plans relating to pollution, biodiversity, exotic species, and other conservation issues. <http://www.naturalinquirer.org/Lesson-Plans-v-42.html> <http://oceanservice.noaa.gov/education/lessons/welcome.html> <http://www.pbs.org/pov/borders/2004/educators/index.html>

**TABLE 25.1:** Lesson Pacing

Lesson	Class Period(s) (60 min)
25.1 Air Pollution	1.5
25.2 Water Pollution	1.5
25.3 Natural Resources	2.5
25.4 Biodiversity and Extinction	2.0

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## 25.1 Air Pollution

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### Key Concepts

- Definition of air pollution
  - Causes and effects of outdoor air pollution
  - Sources and control of indoor air pollution
- 

### Standards

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### Lesson Objectives

- Define air pollution.
  - Identify causes and effects of outdoor air pollution.
  - Describe sources and ways of controlling indoor air pollution.
- 

### Lesson Vocabulary

- acid rain: rain that is more acidic (has a lower pH) than normal rain because certain pollutants in the air form acids when they mix with water in the air
  - air pollution: chemical substances and particles released into the atmosphere, mainly by human actions
  - global climate change: worldwide increase in Earth's temperature caused by the addition of greenhouse gases to the atmosphere due to human actions
  - greenhouse effect: natural retention of heat on Earth by gases in the atmosphere, which keeps Earth's temperature within a range that allows life
- 

### Teaching Strategies

#### Introducing the Lesson

Show the class a current air quality index map (see URL below). Have them use the map to identify the areas with the best and worst air quality and also the air quality where they live.

- Ask: What is the air quality index based on?

Answer: the amounts of certain pollutants in the air Tell students they will learn more about air pollution in this lesson. <http://www.airnow.gov/>

## Activity

With the lesson plan at the following URL, students can learn about the chemical reactions that release various pollutants into the atmosphere and what happens when pollutants in the air are exposed to sunlight. They will model incomplete combustion using interlocking toy blocks. They will also explore the connection between air quality and environmental health. <http://www.pbslearningmedia.org/resource/envh10.health.lp58b/understanding-air-air-pollution-and-modeling-pollutants-with-legosupsup-bricks/>

## Building Science Skills

The STEM module “What Is the Future of Earth’s Climate?” at the following URL allows students to explore interactions between factors in the climate system that affect Earth’s atmospheric temperature. They will examine graphs of greenhouse gas concentration and temperature change, and they will also run experiments with computational models to compare the effects of different levels of anthropogenic carbon dioxide emissions. By the end of the module, students will be able to explain why virtually all scientists agree that Earth’s climate is changing due to human actions. <http://concord.org/stem-resources/what-future-earths-climate>

## Differentiated Instruction

Pair less proficient readers with other students, and ask partners to make an outline of the lesson. Tell them to use the headings and subheadings in the lesson to create a general outline before they read. Then, as they read the lesson, they should add important details to the outline.

## Enrichment

Ask one or more interested students to investigate the Clean Air Act. For example, they should find out what it is and its history, how it has affected air pollution and human health, its impact on the economy, and where it has fallen short. Suggest that students start with the URLs below. Encourage them to share what they learn with the rest of the class using some type of visual format, such as a Web page, poster, or PowerPoint presentation. <http://www.epa.gov/air/caa/> [http://www.ucsusa.org/global\\_warming/solutions/reduce-emissions/the-clean-air-act.html#.VIsxpP10z3g](http://www.ucsusa.org/global_warming/solutions/reduce-emissions/the-clean-air-act.html#.VIsxpP10z3g) <http://thinkprogress.org/climate/2014/08/22/3474535/epa-report-cleaner-air/>

## Science Inquiry

Students can model acid rain and investigate how it affects aquatic life with the inquiry project at the following URL. The URL has links for background information, a materials list, and a procedure. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/EnvSci\\_p016.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p016.shtml)

## Health Connection

Have students do the activity “Symptoms Scenario” on pages 83–102 of the following PDF document. In the activity, students will analyze realistic scenarios to identify some of the health symptoms associated with specific air pollutants (ozone and particle pollution), identify preventive measures that people can take to protect their health, and understand which segments of the population are most at risk from air pollution. The document includes a background reading, student worksheets, and all other necessary materials for the activity. <http://www.epa.gov/airnow/teachers/toolkit/teachers-toolkit-6-8-508.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 25.1 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 25.1 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. Identify causes of outdoor air pollution.
2. What is acid rain? What causes it, and what are its effects?
3. Describe the natural greenhouse effect.
4. Create a public service announcement about indoor air pollution. Focus on practical tips for improving the quality of indoor air.
5. Explain how human actions contribute to the greenhouse effect and global climate change.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 25.1 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Acid rain from air pollution can pollute bodies of water.

- What are some other causes of water pollution?
- How does water pollution affect living things?

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## 25.2 Water Pollution

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### Key Concepts

- Definition of water pollution
- Nonpoint-source pollution, runoff, algal blooms, and dead zones
- Point-source pollution and thermal pollution
- Ocean pollution and ocean acidification

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### Standards

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### Lesson Objectives

- Define water pollution.
- Explain how fertilizer in runoff leads to algal blooms and dead zones.
- Give examples of point-source pollution, and define thermal pollution.
- Describe how the ocean is being polluted with trash and why ocean water is becoming more acidic.

---

### Lesson Vocabulary

- algal bloom: excessive growth of algae in a body of water because of pollution with fertilizer in runoff
- dead zone: area in a body of water where there is too little oxygen to support living things
- nonpoint-source pollution: pollution that enters the environment from many different places, such as fertilizer in runoff that flows from land into a body of water
- ocean acidification: increasing acidity of ocean water because it is dissolving more carbon dioxide from the atmosphere
- point-source pollution: pollution that enters the environment from a single place, such as waste water from a factory discharged into a body of water through a pipe
- thermal pollution: reduction in the quality of water because of an increase in water temperature
- waterborne disease: disease caused by drinking water that contains pathogens
- water pollution: addition of chemicals, sewage, trash, or heat to water resources
- wetland: habitat such as a swamp, marsh, or bog where the ground is soggy or covered with water much of the year

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## Teaching Strategies

### Introducing the Lesson

Introduce water, its relative scarcity, and how it is being threatened by pollution and overuse by showing students the brief National Geographic video “Why Care About Water?” at this URL: <http://video.nationalgeographic.com/video/env-freshwater-whycare>

### Building Science Skills

The lesson plan available at the URL below allows students to measure and study the effects of water quality on aquatic organisms. Specific objectives of the lesson plan include demonstrating a scientific method of measuring turbidity, relating turbidity to the ability of aquatic organisms to get energy from sunlight, understanding cause-and-effect relationships between human activities on land and water quality, and brainstorming ways to protect the health of water resources. <http://nationalzoo.si.edu/Education/ClassroomScience/Turbidity/Teacher/default.cfm>

### Cooperative Learning

With the hands-on class activities at the following URL, students will work cooperatively to answer the following questions: Who is responsible for pollution of water resources and the subsequent clean up? What are the most effective ways to clean up polluted water? The activities are interdisciplinary in nature and involve the use of critical thinking and analysis to solve problems. [http://www.accessexcellence.org/AE/AEC/AEF/1996/hood\\_water.php](http://www.accessexcellence.org/AE/AEC/AEF/1996/hood_water.php)

### Differentiated Instruction

Use a think-pair-share activity to help students understand lesson content. After students read the lesson, have them think about the causes and effects of water pollution. Then pair less proficient readers with other students, and have partners share their ideas about the causes and effects.

### Enrichment

Challenge students to delve deeper into the problem of water pollution with the STEM module “Will There Be Enough Fresh Water?” at the following URL. Students will use modeling and simulation to explore the distribution and uses of fresh water on Earth, the sustainability of freshwater resources, and ways people can maintain and replenish freshwater supplies into the future. <http://concord.org/stem-resources/will-there-be-enough-fresh-water>

### Science Inquiry

Students can study the effects of fertilizer on aquatic ecosystems with the inquiry activity at the URL below. In the activity, they will test the effects of liquid fertilizer on an aquatic environment containing small aquatic animals and plants. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/EnvSci\\_p017.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p017.shtml)

### Real-World Connection

Students can investigate ocean acidification using real-world data with the activities at this URL: [http://dataintheclasroom.noaa.gov/SitePages/oa/index#.VGtfb\\_10z3h](http://dataintheclasroom.noaa.gov/SitePages/oa/index#.VGtfb_10z3h)

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 25.2 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 25.2 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a dead zone? How does it develop?
2. What are wetlands? How do they reduce water pollution?
3. Define thermal pollution, and state when it occurs.
4. After a month of heavy rain, a formerly clear pond on a golf course is covered with slimy green algae. What do you think happened?
5. Compare and contrast point-source and nonpoint-source water pollution. Which type of pollution do you think would be easier to control?
6. Explain the process of ocean acidification. Why does it threaten the survival of many aquatic organisms?

### Lesson Quiz

Check students' mastery of the lesson with Lesson 25.2 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Water is one of our most important natural resources.

- What is a natural resource? Besides water, what are some other examples of natural resources?
- What is the difference between renewable and nonrenewable natural resources?

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## 25.3 Natural Resources

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### Key Concepts

- Definition of natural resource
- Renewable vs. nonrenewable natural resources
- Types of energy resources
- Conservation of natural resources

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### Standards

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### Lesson Objectives

- Define natural resource.
- Distinguish between renewable and nonrenewable natural resources.
- Identify pros and cons of different types of energy resources.
- Explain how to conserve natural resources by reducing, reusing, and recycling.

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### Lesson Vocabulary

- biomass energy: energy obtained by burning or decomposing organic matter
- fossil fuel: nonrenewable natural resource that forms over hundreds of millions of years from dead organisms and is burned for energy; coal, oil, or natural gas
- natural resource: something supplied by nature that helps support life, such as water, oxygen, or soil
- nonrenewable resource: any natural resource that cannot be remade or that takes too long to remake to keep up with human use
- recycling: breaking down and processing a used item so its components can be reused
- renewable resource: any natural resource that exists in limitless amounts or can be remade or recycled quickly enough to keep up with human use
- soil: naturally occurring substance that consists of tiny pieces of rock, minerals, and decaying organic matter and is needed for the growth of most plants
- solar energy: form of energy in sunlight
- sustainable use: use of natural resources in a way that meets present human needs and also conserves resources for future generations
- wind energy: form of energy in blowing wind

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## Teaching Strategies

### Introducing the Lesson

Students are likely to be familiar with natural resources from prior classes. Help them recall what they already know.

- Ask: What is a natural resource?

Answer: A natural resource is something in nature that helps support life.

- Ask: What is a renewable resource?

Answer: A renewable resource is a natural resource that is limitless in supply or else can be remade or recycled as quickly as it is used.

- Ask: What is a nonrenewable resource?

Answer: A nonrenewable resource is a natural resource that is limited in supply and can't be remade or at least not as quickly as it is used. Tell students they will learn more about natural resources in this lesson.

### Building Science Skills

Assign the set of STEM activities at the following URL so students can explore the natural resources that are needed for food production. In the activities, students will investigate land use and soil quality using graphs and computational models to try to answer the question of how to feed the growing human population. <http://concord.org/stem-resources/can-we-feed-growing-population>

### Activity

Use the multifaceted activity at the URL below when you teach your students about sustainable use of natural resources. Students will experience an inequitable resource distribution (using a circular cake or pizza) and calculate their ecological footprint. Students will also assess their actual resource use and learn more about sustainable living strategies. Finally, they will be challenged to reflect on their own patterns of consumption and to suggest ways they could reduce their resource use. <http://www.pbslearningmedia.org/resource/psu06-e21.sci.energybudget/managing-your-energy-budget/>

### Cooperative Learning

With the team activity at the following URL, students will use the engineering design process to create a useful product of their choice out of recyclable items and “trash.” The class will be given a “landfill” of potentially reusable items, such as aluminum cans, plastic bottles, scrap paper, juice boxes, chip bags, egg cartons, and milk cartons. Each team will also be allowed a limited amount of bonding materials, such as duct tape, hot glue, and string. The activity addresses the importance of reuse and encourages students to look at ways they can reuse items they would typically throw away. Students are further prompted to consider problems with growing landfills and efforts by engineers and others to reduce pollution, emissions, and trash production. <http://teachers.egfi-k12.org/life-after-trash/>

## Differentiated Instruction

Have students make a main ideas/details chart for the lesson. First they should divide a sheet of paper down the middle to create two columns. In the left columns they should list the main ideas. Then they should add supporting details for the main ideas in the right column.

## Enrichment

Encourage interested students to learn more about the pros and cons of renewable and nonrenewable energy resources with the online module at the following URL. By the end of the module, students will be able to compare the costs and benefits of different sources used for generating electricity. Suggest that the students create a PowerPoint presentation to share with the class interesting facts and important insights they gain from the activities in the module. <http://concord.org/stem-resources/what-are-our-energy-choices>

## Science Inquiry

An inquiry activity that relates life science content to energy resources can be accessed at the URL below. In the activity, students will investigate how changes in the DNA sequence for cell wall formation can result in plants with higher levels of cellulose. More cellulose, in turn, increases the amount of ethanol that can be produced from the plants. The activity involves many areas of life science, including cell wall structure and function, DNA and genetics, evolution, technology, and science and society. <http://www1.eere.energy.gov/education/lessonplans/plans.aspx?id=219>

## Real-World Connection

With the Smithsonian module at the URL below, students can use a variety of activities, including role play and debate, to investigate how to achieve a balance between human uses of resources and the need to conserve habitats for wildlife. <http://nationalzoo.si.edu/education/conservationcentral/pdfs/Module%205.pdf>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 25.3 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 25.3 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is a natural resource?
2. List two cons of using fossil fuels for energy.
3. Describe three renewable energy resources.
4. Identify ways you could conserve natural resources in your own life.
5. New soil is always being formed, yet soil is considered to be a nonrenewable resource. Explain why.
6. Compare and contrast renewable and nonrenewable natural resources.

## Lesson Quiz

Check students' mastery of the lesson with Lesson 25.3 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

Biodiversity is another important natural resource.

- What is biodiversity?
- Why is biodiversity considered to be a natural resource?

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## 25.4 Biodiversity and Extinction

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### Key Concepts

- Definition of biodiversity
- Benefits of biodiversity
- Habitat loss and the sixth mass extinction
- Protecting biodiversity

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### Standards

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### Lesson Objectives

- Define biodiversity.
- List benefits of biodiversity to people and ecosystems.
- Describe the sixth mass extinction, and identify its chief causes.
- Identify ways individuals can protect biodiversity.

---

### Lesson Vocabulary

- biodiversity: variation in living things, often measured by the number of different species
- exotic species: non-native species introduced into a new habitat where it may become invasive and threaten native species
- habitat loss: disturbance or destruction of natural habitats, usually due to human actions such as clearing land for farming
- sixth mass extinction: current rapid rate of species extinctions that is due mainly to human destruction of habitats

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### Teaching Strategies

#### Introducing the Lesson

Introduce biodiversity, its importance, and the threat of extinction by showing the class the short video clip at this URL: <http://www.pbs.org/wnet/nature/the-loneliest-animals-web-exclusive-video-the-importance-of-biodiversity/4942/>

## Activity

Help students gain an appreciation for the economic benefits of the tropical rainforest biome. Set up the classroom activity described at the URL below. Students will move from station to station, observing samples of products from the tropical rainforest. At each station, they will record the name of the product, write a description of it, and make a sketch of the product. For homework, have students prepare an advertisement for the rainforest and its products. [http://www.accessexcellence.org/AE/AEC/AEF/1994/milani\\_rain.php](http://www.accessexcellence.org/AE/AEC/AEF/1994/milani_rain.php)

## Building Science Skills

With the Smithsonian module at the following URL, students can explore the effects of habitat fragmentation on temperate forest mammals. The module includes several activities, including a family learning activity. <http://nationalzoo.si.edu/education/conservationcentral/pdfs/Module%203.pdf>

## Discussion

Use the interesting case study at the URLs below to help students appreciate the dangers of exotic species. Students will read an article and be able to analyze and summarize the relationship of the Pacific Tree frog population to the populations of nonnative trout. Then they will discuss the issue as a class. The first URL is a lesson plan for using the article at the second URL. The third URL is a graphic organizer for the lesson. <http://www.naturalinquirer.org/UserFiles/File/KnockedOutLP.pdf> [http://www.naturalinquirer.org/modules.php?name=NaturalInquirer&op=download&article\\_id=65&type=pdf\\_eng](http://www.naturalinquirer.org/modules.php?name=NaturalInquirer&op=download&article_id=65&type=pdf_eng) [http://www.naturalinquirer.org/UserFiles/File/GraphicOrganizerKnockedOutbyTrout\(1\).pdf](http://www.naturalinquirer.org/UserFiles/File/GraphicOrganizerKnockedOutbyTrout(1).pdf)

## Differentiated Instruction

Provide students with several cloze prompts to complete as they read the lesson. The cloze prompts should require students to fill in blanks with important information from the lesson. Use prompts such as these [possible answers in brackets]:

1. Biodiversity refers to [the variety of life and its processes].
2. Economic benefits of biodiversity include [food and other products, warnings of toxins in the environment, and inspiration for technology].
3. Ecosystem services of biodiversity include [adding oxygen to the air, purifying water, and controlling insect pests].

## Enrichment

Challenge interested students to do the project at the following URL either as a science fair project or for enrichment. In the project, each student will take on the role of a wildlife biologist by examining the biodiversity of insects in his or her own backyard, using a homemade bug vacuum. Ask the students to report back to the class on the results of the project. [http://www.sciencebuddies.org/science-fair-projects/project\\_ideas/EnvSci\\_p045.shtml](http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p045.shtml)

## Science Inquiry

Have the class do the simulation activity at the following URL. Students will simulate possible effects of an introduced species on populations of native species. In the simulation, the introduced species has a broad niche, and all the native species have very narrow niches. Students will observe that the introduced species quickly outcompetes the native species. [http://www.accessexcellence.org/AE/AEC/AEF/1995/warehime\\_today.php](http://www.accessexcellence.org/AE/AEC/AEF/1995/warehime_today.php)

### Real-World Connection

Use the real-world case study at the URL below to help students understand how habitat change threatens species. The case study will also help them appreciate the complexity of issues surrounding the protection of endangered species. First, students will read an article about the endangered Channel Island fox. Then, they will create and use food webs to better understand the reasons for the foxes' decline. <http://www.mysciencebox.org/foxes>

### Real-World Connection

Students can use video segments and online maps to investigate another real-world example of endangered species at the following URL. In this case, the species are the horseshoe crab and a small migratory bird called the red knot. <http://www.pbslearningmedia.org/resource/bf10.sci.lv.ls.lpendang/endangered-relationships/>

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## Reinforce and Review

### Lesson Worksheets

Copy and distribute the Lesson 25.4 worksheets in CK-12 MS Life Science Workbook. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

### Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 25.4 in CK-12 MS Life Science Flexbook. Answers are provided below.

1. What is biodiversity?
2. Identify some of the direct benefits of biodiversity to human beings.
3. Describe two ecosystem services provided by biodiversity.
4. Describe one specific change you could make in your life to help protect biodiversity.
5. Explain causes and effects of habitat loss.

### Lesson Quiz

Check students' mastery of the lesson with Lesson 25.4 Quiz in CK-12 MS Life Science Assessments.

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## Points to Consider

The human species has been incredibly successful. In a relatively short period of time, it has colonized almost all of Earth's terrestrial habitats. Unfortunately, human beings have also impacted Earth, its climate, and its environment. Human actions threaten Earth's valuable biodiversity.

- What do you think Earth's future may hold?
- Do you think people will take steps to save Earth for future generations before it's too late?