Chapter 33 Organizer

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 33.1 **Innate Behavior** National Science Education Standards UCP.2-4; A.1, A.2; C.3, C.6; F.4; G.1, G.2 (1 session)	1. **Distinguish** among the types of innate behavior. 2. **Demonstrate,** by example, the adaptive value of innate behavior.	**MiniLab 33-1:** Testing an Isopod's Response to Light, p. 890 **Problem-Solving Lab 33-1,** p. 897 **Investigate BioLab:** Behavior of a Snail, p. 904 **BioTechnology:** Tracking Sea Turtles, p. 906
Section 33.2 **Learned Behavior** National Science Education Standards UCP.2, UCP.3; A.1, A.2; C.6; E.1, E.2; F.4, F.6; G.1-3 (2 sessions)	3. **Distinguish** among types of learned behavior. 4. **Demonstrate,** by example, types of learned behavior.	**MiniLab 33-2:** Solving a Puzzle, p. 900 **Problem-Solving Lab 33-2,** p. 902

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab

p. 904 snails, dropper, spring water, plastic petri dish, scissors, stereomicroscope, pencil, rubber band, masking tape

MiniLabs

p. 890 isopods (5), plastic petri dish, black paper, paper towel, water, transparent tape, paper, pencil
p. 900 paper puzzle, clock with second hand, paper, pencil

Alternative Lab

p. 894 terrarium with cover, sand, crickets (1 female, 5 male), dry oatmeal, apple slices, cellulose sponge, matchbox (4), jar with lid (5), nail polish (4 colors)

Quick Demos

p. 891 assorted animals
p. 891 plexiglass sheet, paper
p. 901 none

Key to Teaching Strategies

- L1 Level 1 activities should be appropriate for students with learning difficulties.
- L2 Level 2 activities should be within the ability range of all students.
- L3 Level 3 activities are designed for above-average students.
- ELL ELL activities should be within the ability range of English Language Learners.
- COOP LEARN Cooperative Learning activities are designed for small group work.
- P These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Animal Behavior

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 33.1 **Innate Behavior**	**Reinforcement and Study Guide,** pp. 145-146 L2 **Concept Mapping,** p. 33 L3 ELL **Critical Thinking/Problem Solving,** p. 33 L3 **BioLab and MiniLab Worksheets,** p. 147 L2 **Laboratory Manual,** pp. 239-242 L2 **Content Mastery,** pp. 161-162, 164 L1	**Section Focus Transparency 79** L1 ELL
Section 33.2 **Learned Behavior**	**Reinforcement and Study Guide,** pp. 147-148 L2 **Critical Thinking/Problem Solving,** p. 33 L3 **BioLab and MiniLab Worksheets,** pp. 148-150 L2 **Laboratory Manual,** pp. 243-246 L2 **Content Mastery,** pp. 161, 163-164 L1	**Section Focus Transparency 80** L1 ELL **Basic Concepts Transparency 60** L2 ELL **Reteaching Skills Transparency 48** L1 ELL

Assessment Resources

Chapter Assessment, pp. 193-198
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 33 quiz

Additional Resources

Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe
To order the following products, call Glencoe at 1-800-334-7344:
CD-ROM
Mammals: A Multimedia Encyclopedia
Videodisc
STV: Animals

Products Available From National Geographic Society
To order the following products, call National Geographic Society at 1-800-368-2728:
Book
National Geographic Book of Mammals

Videos
Predators of North America
Strange Creatures of the Night

Index to National Geographic Magazine
The following articles may be used for research relating to this chapter:
"Animals at Play," by Stuart L. Brown, December 1994.
"Secrets of Animal Navigation," by Michael E. Long, June 1991.

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life
CD-ROM ELL
Video: *Bird Courtship*
Video: *Territorial Behavior*
Video: *Salmon Migration*
Exploration: *Learned Behavior*
Video: *Elephant Behavior*

Videodisc Program
Bird Courtship
Territorial Behavior
Salmon Migration

Chapter 33

Getting Started Demo

Ask students to bring in a caged pet. Have the class list behaviors of the pet that they think are learned and those that are not learned. L2

Theme Development

Students will examine the theme of **unity within diversity** as they consider the kinds of behaviors animals have in common and behaviors that are unique to a species. The theme of **evolution** is important to the study of behavior because of the adaptive value of behavior and the fact that behavior, just like physical features of animals, evolves.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Question Segment

Response Segment

Chapter

33 Animal Behavior

What You'll Learn

- You will distinguish between innate and learned behavior.
- You will identify the adaptive value of specific types of behavior.

Why It's Important

Animals have patterns of behavior that help them survive and reproduce. Some of these behavior patterns are inherited and some are learned. You will recognize that humans, like other animals, have both types of behavior, and that these behavior patterns enable you to survive as well.

Getting Started

Animal Behavior

Observe the behavior of a small animal for one minute. *How does the observed behavior of the animal help it to survive?*

interNET CONNECTION To find out more about animal behavior, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Prairie dogs bark to warn others of approaching predators. Vultures soar high above the prairie. Some animal behavior is inherited and is performed correctly right away. Some behavior is learned through a lifetime of practice.

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Portfolio, pp. 890, 900; Quick Demo, pp. 891, 901; Meeting Individual Needs, p. 901; Tech Prep, p. 901

Visual-Spatial Biology Journal, p. 891; Quick Demo, p. 891; Project, p. 893; Extension, p. 897

Interpersonal Display, p. 894; Project, p. 899; Reteach, p. 903

Intrapersonal Meeting Individual Needs, p. 891

Linguistic Tech Prep, p. 892

Auditory-Musical Enrichment, p. 893; Biology Journal, p. 898

Section

33.1 Innate Behavior

Have you ever watched a bird feed its young? Nestlings greet a parent returning to the nest with cries and open beaks. Parent birds practically stuff the food down their offsprings' throats, then fly off to find more food. Why do baby birds open their beaks wide? Why do parent birds respond to open beaks by feeding their offspring? These actions are examples of behavior that appears in birds without being taught or learned. Animals exhibit many kinds of behavior in nature, both inherited and learned.

Cedar waxwings and their nestlings (inset)

SECTION PREVIEW

Objectives

Distinguish among the types of innate behavior.

Demonstrate, by example, the adaptive value of innate behavior.

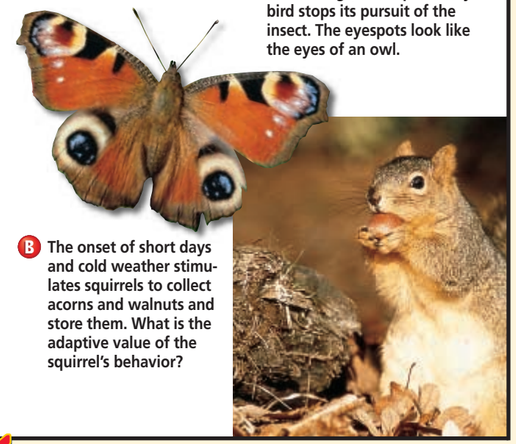
Vocabulary

behavior
innate behavior
reflex
fight-or-flight response
instinct
courtship behavior
territory
aggressive behavior
dominance hierarchy
circadian rhythm
migration
hibernation
estivation

What Is Behavior?

A peacock displaying his colorful tail, a whale spending the winter months in the ocean off the coast of southern California, and a lizard seeking shade from the hot desert sun are all examples of animal behavior. **Behavior** is anything an animal does in response to a stimulus in its environment. The presence of a pea-hen stimulates a peacock to open its tail feathers and strut. Environmental cues, such as a change in daylength, might be the stimulus that causes the whale to leave its summertime arctic habitat. Heat stimulates the lizard to seek shade. The illustrations in ***Figure 33.1*** show two examples of stimuli that affect animal behavior.

Figure 33.1
Animals exhibit a variety of behavioral responses.



A **This butterfly exposes eyespots on its wings, and a predatory bird stops its pursuit of the insect. The eyespots look like the eyes of an owl.**

B **The onset of short days and cold weather stimulates squirrels to collect acorns and walnuts and store them. What is the adaptive value of the squirrel's behavior?**

Assessment Planner

Portfolio Assessment
Portfolio, TWE, pp. 890, 900
Assessment, TWE, p. 897
MiniLab, TWE, p. 900

Performance Assessment
Assessment, TWE, pp. 891, 899
Alternative Lab, TWE, pp. 894-895
Problem-Solving Lab, TWE, p. 902
BioLab, TWE, pp. 904-905
BioLab, SE, pp. 904-905
MiniLab, SE, pp. 890, 900

Knowledge Assessment
Section Assessment, SE, pp. 897, 903
Chapter Assessment, SE, pp. 907-909
MiniLab, TWE, p. 890

Skill Assessment
Problem-Solving Lab, TWE, p. 896

Prepare

Key Concepts

Response to a stimulus is presented with examples of inherited behavior. Simple reflexes are considered along with more complex behavior patterns.

Planning

- Gather isopods, lamps, and petri dishes for MiniLab 33-1.
- Purchase pieces of plexiglass and gather a variety of live animals for the Quick Demos.
- Obtain a terrarium and materials for the Alternative Lab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 79** on the overhead projector and have students answer the accompanying questions. L1 ELL


Transparency 79 Behaving to Survive

SECTION FOCUS
Use with Chapter 33, Section 33.1

1. How do the actions of the geese help the species to survive?
2. Do you think the survival behavior of the geese is learned? Explain.

BIOLOGY: The Dynamics of Life — SECTION FOCUS TRANSPARENCIES

Resource Manager

Section Focus Transparency 79 and Master L1 ELL

2 Teach

MiniLab 33-1

Purpose
Students will observe the innate response of an isopod to light.

Process Skills
experiment, collect data, analyze information, draw a conclusion

Teaching Strategies
- Isopods may be collected locally or purchased from biological supply houses.
- Use plastic or glass petri dishes for chambers or collect empty plastic food cartons. Cardboard boxes such as shoe boxes will also work well. Use black construction paper to block out light.
- Tape the toweling edges prior to moistening.
- If there is a problem of getting all isopods aligned at the center of the dish when first starting, use the species *Armadillidium* (available from supply houses). This species curls up into a ball when touched. Thus, curled up isopods can all be placed at the center at the same time.

Expected Results
Isopods will move toward low light.

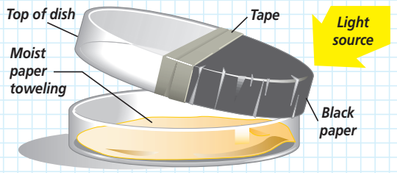
Analysis
1. dark areas; majority of isopods were found under dark paper side
2. Explanations may vary, but the behavior is innate. This type of behavior would not have been learned during the experiment because isopods have this behavior as soon as they hatch and it may not be under their conscious control.
3. Isopods must remain moist to survive. Dark areas in nature are more likely to be moist than light areas. Through natural selection, those isopods that innately moved toward dark areas survived and passed this genetic trait on to their offspring.
4. Students' bar graphs should depict the data they collected.

MiniLab 33-1 Experimenting

Testing an Isopod's Response to Light Isopods, the pill bugs and sow bugs, are common arthropods on sidewalks or patios. They are actually land crustaceans and respire through gill-like organs that must be kept moist at all times.

Procedure

1. Copy the data table.
2. Prepare a plastic dish using the diagram as a guide. Moisten the paper toweling.



3. Place six isopods in the center of the dish and add the cover. Place the dish near a lamp or next to a classroom window with light. Have the light strike the dish as shown in the diagram. **CAUTION:** ***Treat isopods gently.***
4. Wait five minutes and observe the dish. Count and record in your data table the number of isopods on the dark or light side. This is your "five minute observation."
5. Repeat step 4 three more times, waiting five minutes before each observation.

Data Table

Observation in minutes	Number of isopods present	
	Light side	Dark side
5		
10		
15		
20		
25		

Analysis
1. Do isopods tend to move toward light or dark areas? Support your answer with specific numbers from your data.
2. Might the behavior of isopods toward light or darkness be innate or learned? Explain your answer.
3. What might be the adaptive advantage for the observed isopod behavior and their response to light? Explain how natural selection may have influenced this isopod behavior.
4. Prepare a bar graph that depicts your data.

Animals carry on many activities—such as getting food, avoiding predators, caring for young, finding shelter, and attracting mates—that enable them to survive. These behavior patterns, therefore, have adaptive value. For example, a parent gull that is not incubating eggs or caring for chicks joins a noisy flock of gulls to dive for fishes. If the parent cannot catch a lot of fishes, not only will it die, but its chicks will not survive either. Therefore, this feeding behavior has adaptive value for the gull.

Inherited Behavior

Inheritance plays an important role in the ways animals behave. You don't expect a duck to tunnel underground or a mouse to fly. Yet, why does a mouse run away when a cat appears? Why does a mallard duck fly south for the winter? These behavior patterns are genetically programmed. An animal's genetic makeup determines how that animal reacts to certain stimuli.

Natural selection favors certain behaviors

Often, a behavior exhibited by an animal species is the result of natural selection. The variability of behavior among individuals affects their ability to survive and reproduce. Individuals with behavior that makes them more successful at surviving and reproducing will produce more offspring. These offspring will inherit the genetic basis for the successful behavior. Individuals without the behavior will die or fail to reproduce. You can observe the behavior of isopods in the *MiniLab* on this page.

Inherited behavior of animals is called **innate behavior** (ihn AYT). A toad captures prey by flipping out its sticky tongue. To capture prey, a toad must first be able to detect and follow its movement. Toads have "insect detector" cells in the retinas of their eyes. As an insect moves across a toad's line of sight, the "insect detector" cells signal the brain of the prey's changing position, thus releasing an innate response; the toad's tongue flips out. Toads capture prey through an innate behavior known as a fixed action pattern, ***Figure 33.2.***

Genes form the basis of behavior

Through experiments, scientists have found that an animal's hormonal balance and its nervous system—especially the sense organs responsible for sight, touch, sound, or odor identification—affect how sensitive the individual is to certain stimuli. Because genes control the production of an animal's hormones and development of its nervous system, it's logical to conclude that genes indirectly control behavior. Innate behavior includes both automatic responses and instinctive behaviors. You can observe the response of animals to certain stimuli in the *BioLab* at the end of this chapter.

Figure 33.2
A toad can starve even though it is surrounded by dead insects because it cannot recognize non-moving animals as prey.

Automatic Responses

What happens if something quickly passes in front of your eyes or if something is thrown at your face? Your first reaction is to blink and jerk back your head. Even if a protective clear shield is placed in front of you, you can't stop yourself from behaving this way when the object is thrown. This reaction is an example of the simplest form of innate behavior, called a reflex. A **reflex** (REE fleks) is a simple, automatic response that involves no conscious control. ***Figure 33.3*** shows an example of a reflex.

The adaptive value of another automatic response is obvious. Think about a time when you were suddenly scared. Immediately, your heart began to beat faster. Your skin got cold and clammy, your respiration increased, and maybe you trembled. You were having a **fight-or-flight response.** A fight-or-flight response mobilizes the body for greater activity. Your body is being prepared to either fight or run from the danger. A fight-or-flight response is automatic and controlled by hormones.

Figure 33.3
Reflexes have survival value for animals. When you accidentally touch a hot stove, you jerk your hand away from the hot surface. The movement saves your body from serious injury.

Assessment

Knowledge Ask students to describe the equipment and experimental procedure needed to test the hypothesis that isopods prefer dry rather than moist conditions. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L2

Portfolio

Design an Experiment

Kinesthetic Ask students to hypothesize how different animals will respond to a loud noise. Have students design and carry out experiments and write their observations in their portfolios. Ask them to speculate whether the behavior they observed is innate. L2 P

Meeting Individual Needs

Gifted

Intrapersonal Ask students to do research to determine how animal sounds are studied electronically. Ask students to present an illustrated report to the class and devise a way to study the sounds made by a local animal. L3

Biology Journal

Observing Bird Behavior

Visual-Spatial Ask students to observe local birds for one week and record their observations in their journals. Ask them to speculate about which behaviors are instinctive. Have them compare their observations with those of other students. Elicit whether students classified similar behaviors in the same way. L2

Quick Demo

Visual-Spatial Have a variety of animals in class. Expose each animal to a single stimulus, such as a bright light. Have students observe their varied responses. Ask students to speculate about the survival value of each animal's response to that stimulus.

Quick Demo

Kinesthetic Have students examine the blink response by asking them to hold a large piece of plexiglass in front of their faces and try to keep their eyes open when a partner gently tosses a crumpled piece of notebook paper at the glass. L1 ELL

Assessment

Performance Have students design experiments to determine the preferences of mealworms for light or dark, damp or dry, and smooth or rough surfaces. Have students obtain approval for their designs and then conduct their experiments. Have students conduct experiments on both the larval stage and the adult beetle to determine if preferences differ at each stage. L2

Resource Manager

BioLab and MiniLab Worksheets, p. 147 L2

TechPrep

Animal Psychology

Linguistic Ask students to interview an animal psychologist and report about what he or she does, the kinds of problems pet owners report, and the kinds of treatments provided. Have students include a complete transcript of the interview in their portfolios. L2 P

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Bird Courtship,* Disc 4
Video: *Territorial Behavior,* Disc 4

VIDEODISC
Biology: The Dynamics of Life
Bird Courtship (Ch. 24)
Disc 2, Side 1, 31 sec.

Territorial Behavior (Ch. 25)
Disc 2, Side 1, 1 min. 17 sec.

Resource Manager

Laboratory Manual, pp. 239-242 L2

Instinctive Behavior

Compare the fixed action pattern of a toad capturing prey with a fight-or-flight response. Both are quick, automatic responses to stimuli. But some behaviors take a longer time because they involve more complex actions. An **instinct** (IHN stingt) is a complex pattern of innate behavior. Instinctive behavior patterns may have several parts and may take weeks to complete. Instinctive behavior begins when the animal recognizes a stimulus and continues until all parts of the behavior have been performed.

WORD Origin
instinct
From the Latin word *instinctus*, meaning "impulse." An instinct is a complex pattern of innate behavior.

As shown in ***Figure 33.4,*** greylag geese instinctively retrieve eggs that have rolled from the nest and will go through the motions of egg retrieval even when the eggs are taken away. You can see that survival of the young may be dependent on this behavior.

Figure 33.4
The female greylag goose instinctively retrieves an egg that has rolled out of the nest by arching her neck around the stray egg and moving it like a hockey player advancing a puck. The female goose will retrieve many objects outside the nest, including baseballs and tin cans.

Courtship behavior ensures reproduction

Much of an animal's courtship behavior is instinctive. **Courtship behavior** is the behavior that males and females of a species carry out before mating. Like other instinctive behaviors, courtship has evolved through natural selection. Imagine what would happen to the survival of a species if members were unable to recognize other members of that same species. Individuals often can recognize one another by the behavior patterns each performs. In courtship, behavior ensures that members of the same species find each other and mate. Obviously, such behavior has an adaptive value for the species. Different species of fireflies, for example, can be seen at dusk flashing distinct light patterns. However, female fireflies of one species respond only to those males exhibiting the species-correct flashing pattern.

Some courtship behaviors help prevent females from killing males before they have had the opportunity to mate. For example, in some spiders, the male is smaller than the female and risks the chance of being eaten if he approaches her. Before mating, the male in some species presents the female with a nuptial gift, an insect wrapped in a silk web. While the female is unwrapping and eating the insect, the male is able to mate with her without being attacked. After mating, however, the male may be eaten by the female anyway.

In some species, nuptial gifts play an important role in allowing the female to exercise a choice as to which male to choose for a mating partner. The hanging fly, shown in ***Figure 33.5,*** is such a species.

Territoriality reduces competition

You may have seen a chipmunk chase another chipmunk away from seeds on the ground under a bird feeder. The chipmunk was defending its territory. **A territory** is a physical space an animal defends against other members of its species. It may contain the animal's breeding area, feeding area, and potential mates, or all three.

Animals that have territories will defend their space by driving away other individuals of the same species. For example, a male sea lion patrols the area of beach where his harem of female sea lions rests. He does not bother a neighboring male that has a harem of his own because both have marked their territories, and each respects the common boundaries. But if an unattached, young male tries to enter the sea lion's territory, the owner of the territory will attack and drive the intruder away from his harem.

Although it may not appear so, setting up territories actually reduces conflicts, controls population growth, and provides for efficient use of environmental resources. When animals space themselves out, they don't compete for the same resources within a limited space. This behavior improves the chances of survival of the young, and, therefore, survival of the species. If the male has selected an appropriate site and the young survive, they may inherit his ability to select an appropriate territory. Therefore, territorial behavior has survival value, not only for individuals, but also for the species. The male stickleback shown in ***Figure 33.6*** is another animal that exhibits territoriality, especially during breeding season.

Recall that pheromones are chemicals that communicate information among individuals of the same species. Many animals produce pheromones to mark territorial boundaries. For example, wolf urine contains pheromones that warn other wolves to stay away. The male pronghorn antelope uses a pheromone secreted from facial glands. One advantage of using pheromones is that they work both day and night,

Figure 33.5
Female hanging flies instinctively favor the male that supplies the largest nuptial gift—in this case, a moth. The amount of sperm the female will accept from the male is determined by the size of the gift.

Figure 33.6
The male three-spined stickleback displays a red belly to other breeding males near his territory. The male instinctively responds to other red-bellied males by attacking and driving them away.

Visual Learning

Figure 33.5 What adaptive value does this behavior have? *The behavior helps to ensure that all offspring can be provided for.*

Enrichment

Auditory-Musical Crickets chirp as part of their courtship and territorial behaviors. The number of chirps in a specific length of time decreases as the temperature gets colder. Have students set up a means for observing this behavior. Crickets are available in pet shops and from biological supply companies. L3

Reinforcement

Ask students to brainstorm answers to the following questions: How would animals be different if there were no inherited behaviors? *Many animals would not survive long enough to reproduce, resulting in the extinction of species.* If humans relied on instinctive behavior, what kinds of instinctive behavior patterns might have evolved? *those essential to survival, such as feeding and reproductive strategies*

Resource Manager

Concept Mapping, p. 33 L3 ELL

Internet Address Book

internet CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

PROJECT

Pheromone Studies

Visual-Spatial Have students observe how pheromones influence behavior by carrying out the following activity. Place three snails of one species on one side of a pan, and three snails of another species on the opposite side. Allow the snails to move about on their respective sides of the pan for about 10 minutes and then remove the snails from the pan. Immediately place all the snails back in the pan at the center of the pan. Observe which way each snail moves. Clean the pan with warm, soapy water. Repeat the process three times and record your observations. Write a summary of your observations that includes a conclusion about why the snails moved as they did. L2 ELL COOP LEARN

Visual Learning

Figure 33.7 Have students examine Figure 33.7 and explain how symbolic behavior contributes to survival.

Display

Interpersonal Ask a group of students to make a photo collage of aggressive behaviors of pets and other local animals. Have them post their display on the classroom bulletin board. L2 ELL COOP LEARN

Figure 33.7
In many species, such as bighorn sheep, individuals have innate inhibitions that make them fight in relatively harmless ways among themselves.

and whether or not the animal that made the mark is present.

Aggressive behavior threatens other animals

Animals occasionally engage in aggression. **Aggressive behavior** is used to intimidate another animal of the same species. Animals fight or threaten one another in order to defend their young, their territory, or a resource such as food. Aggressive behaviors, such as bird calling, teeth baring, or growling, deliver the message to others of the same species to keep away.

When a male gorilla is threatened by another male moving into his territory, for example, he does not kill the invader. Animals of the same species rarely fight to the death. The fights are usually symbolic, as shown in ***Figure 33.7.*** Male gorillas do not usually even injure one another. Why does aggressive behavior rarely result in serious injury? One answer is that the defeated individual shows signs of submission to the victor. These signs inhibit further aggressive actions by the victor. Continued fighting might result in serious injury for the victor; thus, its best interests are served by stopping the fight.

Submission leads to dominance hierarchies

Do you have an older or younger sibling? Who wins when you argue? In animals, it is usually the oldest or strongest that wins the argument. But what happens when several individuals are involved in the argument? Sometimes, aggressive behavior among several individuals results in a grouping in which there are different levels of dominant and submissive animals. A **dominance hierarchy** (DAHM uh nunts • HI rar kee) is a form of social ranking within a group in which some individuals are more subordinate than others. Usually, one animal is the top-ranking, dominant individual. This animal might lead

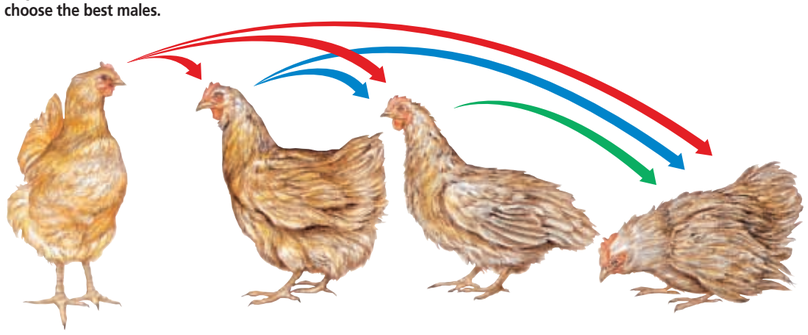


Figure 33.8
A dominance hierarchy often prevents continuous fighting because submissive birds give way peacefully in confrontations. The hierarchy also may provide a way for females to choose the best males.

Figure 33.9
A variety of animals respond to the urge to migrate.

A Canadian and Alaskan caribou migrate from their winter homes in the taiga forests to the tundra for the summer.

B Both the freshwater eel and all species of salmon migrate to their spawning grounds.

C Adult monarch butterflies fly southward where they roost. In the spring, their young fly back north.

others to food, water, and shelter. A dominant male often sires most or all of the offspring. There might be several levels in the hierarchy, with individuals in each level subordinate to the one above. The ability to form a dominance hierarchy is innate, but the position each animal assumes may be learned.

The term *pecking order* comes from a dominance hierarchy that is formed by chickens, illustrated in ***Figure 33.8.*** The top-ranking chicken can peck any other chicken. The chicken lowest in the hierarchy is pecked at by all the other chickens in the group.

Behavior resulting from internal and external cues

Some instinctive behavior is exhibited in animals in response to internal, biological rhythms. Behavior based on a 24-hour day/night cycle is one example. Many animals, humans included, sleep at night and are awake during the day. Other animals, such as owls, reverse this pattern and are awake at night. A 24-hour cycle of behavior is called a **circadian rhythm** (sur KAYD ee uhn). Most animals come close to this 24-hour cycle of sleeping and wakefulness. Experiments have shown that in laboratory settings with no windows to show night and day, animals continue to behave on a 24-hour cycle.

Rhythms also can occur on a yearly or seasonal cycle. **Migration,** for example, occurs on a seasonal cycle. Migration is the instinctive, seasonal movement of animals, shown in ***Figure 33.9.*** In the United States, about two-thirds of bird species fly south in the fall to areas such as South America where food is available during the winter. The birds fly north in the spring to areas where they breed during the summer. Whales migrate seasonally, as well. Change in day length is thought to

Enrichment

Ask a group of students to make a trip to a local zoo to observe and photograph pecking orders of animals, and report back to the class. L3 ELL COOP LEARN

Visual Learning

Figure 33.9 After studying Figure 33.9, have students explain how migration can contribute to survival.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Salmon Migration*
Disc 4

VIDEODISC
Biology: The Dynamics of Life
Salmon Migration (Ch. 26)
Disc 2, Side 1, 28 sec.

The Infinite Voyage *The Living Clock Changing Circadian Rhythms Through Altering DNA* (Ch. 5), 6 min.

How Living Things Convert Light into Time (Ch. 6), 5 min. 30 sec.

Alternative Lab

Cricket Hierarchies

Purpose
Students will observe crickets setting up a dominance hierarchy.

Materials
glass terrarium or aquarium tank with cover, sand, 1 female and 5 male field crickets, dry oatmeal in a jar lid, apple slices, clean sponge pieces soaked in water, 4 matchboxes, 5 jars with lids, 4 different colors of nail polish

Procedure
Give students the following directions.

1. Set up a terrarium with about 2 cm of sand in the bottom and numbered matchboxes in all 4 corners.
2. Place different colored spots of nail polish on the thoraxes of four male crickets. One male will not need polish. The female can be identified by her long ovipositor at the end of her abdomen.
3. Keep the five crickets in separate jars for at least one day prior to beginning the experiment.
4. Place four males in the terrarium and observe and record their behavior for 15 minutes.
5. Examine the terrarium for about 10 minutes each day for 5 days. Note which cricket becomes dominant and the behavior it exhibits.

Expected Results
One cricket will become dominant and the others will avoid him.

Analysis

1. How could you tell that your crickets set up a dominance hierarchy? *One cricket chirped more, was initially more aggressive, and later others avoided him.*
2. Describe the differences in behavior of the crickets before and after the hierarchy was established. *Before: much aggression and chirping; after: other crickets avoided the dominant male.*

Assessment

Performance Ask students to hypothesize how the crickets will respond to the female and then introduce her to the terrarium. *The dominant male may mate with the female.* Use the Performance Task Assessment List for Formulating a Hypothesis in **PASC,** p. 21. L2

Problem-Solving Lab 33-1

Purpose

Students will determine that hibernation in squirrels is controlled by an internal annual biological clock.

Process Skills

think critically, analyze information, identify and control variables, design an experiment, interpret scientific illustrations

Teaching Strategies

- Point out that not all months of the year are listed.
- Remind students that the dark bands correspond to periods of hibernation.
- Discuss human circadian patterns as an introduction to periods of hibernation.
- Help students determine the approximately annual cycle of behavior by noting the peaks of body weight and the time lapse between these peaks.

Thinking Critically

1. Squirrels spend about 120 days in hibernation and close to 200 days out of hibernation.
2. They were controlling variables by eliminating them from the experiment. Outside stimuli could provide clues as to when it might be time to hibernate.
3. to show that temperature was not influencing start of hibernation; changing length of light time to more or less than 12 hours per day, altering food selection
4. Place newborn squirrels into identical experimental chambers as those used in the other experiments and observe if squirrels hibernate at the proper time of the year.

stimulate the onset of migration in the same way that it controls the flowering of plants. You can find out how migrating turtles are tracked in the *BioTechnology* at the end of this chapter.

Migration calls for remarkable strength and endurance. The Arctic tern migrates between the Arctic Circle and the Antarctic, a one-way flight of almost 18 000 km.

Animals navigate in a variety of ways. Some use the positions of the sun and stars to navigate. They may use geographic clues, such as mountain ranges. Some bird species seem to be guided by Earth's magnetic field. You might think of this as being guided by an internal compass.

Biological rhythms are clearly governed by a combination of internal and external cues—that is, by both innate and learned behavior. Animals that migrate might be responding to colder temperatures and shorter days, as well as to hormones. Young animals may learn when and where to migrate by following their parents. You can easily see why animals migrate from a cold place to a warmer place, yet most animals do not migrate. How animals cope with winter is another example of instinctive behavior.

You know that many animals store food in burrows and nests. But other animals survive the winter by undergoing physiological changes that reduce their need for energy. Many mammals, some birds, and a few other types of animals go into a deep sleep during the cold winter months. Other animals experience hibernation. **Hibernation** (hi bur NAY shun) is a state in which the body temperature drops substantially, oxygen consumption decreases, and breathing rates decline to a few breaths per minute. Hibernation conserves energy. Animals that hibernate typically eat vast amounts of food to build up body fat before entering hibernation. This fat fuels the animal's body while it is in this state. The golden-mantled ground squirrel shown in ***Figure 33.10*** is an example of an animal that hibernates. You can find out more about hibernation in the *Problem-Solving Lab* on the next page.

What happens to animals that live year-round in hot environments? Some of these animals respond in a way that is similar to hibernation. **Estivation** (es tuh VAY shun) is a state of reduced metabolism that occurs in animals living in conditions of intense heat. Desert animals appear to estivate sometimes in response to lack of food or periods of drought. However, Australian long-necked turtles, shown in ***Figure 33.11***, will estivate even when they are kept in a laboratory with constant food and water. Clearly, estivation is an innate behavior that depends on both internal and external cues.

Figure 33.10
The golden-mantled ground squirrel has a normal body temperature of around 37°C. When the day length shortens in the fall, the ground squirrel's temperature drops to 2°C, and it goes into hibernation.

Figure 33.11
Australian long-necked turtles are among the reptiles and amphibians that respond to hot and dry summer conditions by estivating.

Assessment

Skill Have students draw graphs that would illustrate the pattern of hibernation for squirrels that were born in the Andes Mountains of South America and then brought to the United States for experimentation to determine their year-long rhythms. Use the Performance Task Assessment List for Graph from Data in **PASC,** p. 39. L3

Resource Manager

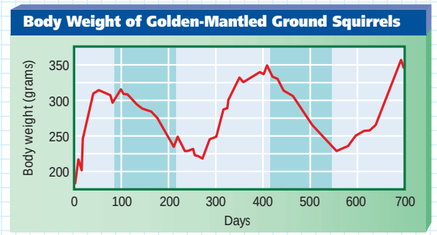
Critical Thinking/Problem Solving, p. 33 L3
Reinforcement and Study Guide, pp. 145-146 L2
Content Mastery, p. 162 L1

Problem-Solving Lab 33-1 Designing an Experiment

Is hibernation an innate or learned behavior? Circadian rhythms occur on an almost 24-hour cycle in certain organisms. The word circadian comes from Latin, *circa* (about) and *dies* (day). Scientists have even discovered rhythms that last almost a year.

Analysis

Ground squirrels were placed in a room free from all outside stimuli. The room contained food and water, was kept at a temperature of 22°C and a light remained on for 12 hours each day. Body weight was measured and recorded weekly. The graph shows the results of the experiment. The dark bands correspond to times when the squirrels were in hibernation.



Thinking Critically

1. Describe the cyclic pattern of activity of these squirrels.
2. Why did scientists keep temperature, food and water, and light constant during the experiment? Explain why scientists kept the squirrels free from all outside stimuli.
3. Scientists repeated the experiment using different temperatures. Why is this appropriate experimental procedure? What other variables could have been tested?
4. Suggest an experiment that supports the conclusion that this pattern of hibernation is genetic and not learned.

Section Assessment

Understanding Main Ideas
1. What is behavior?
2. How is a reflex different from instinct?
3. Explain by example two types of innate behavior.
4. Explain behaviors that reduce competition.

Thinking Critically
5. How is innate behavior an advantage to a species in which the young normally hatch after the mother has left?

Skill Review
6. **Designing an Experiment** Design an experiment to test what stimulus causes an earthworm to return to its burrow. For more help, refer to *Practicing Scientific Methods* in the **Skill Handbook.**

Section Assessment

1. Behavior is anything an animal does in response to a stimulus in its environment.
2. A reflex is a simple physical response to a stimulus. An instinct is a complex pattern of innate behavior.
3. Courtship rituals in birds and migration in salmon have innate behavior components.
4. dominance hierarchy; symbolic aggressive behavior
5. The young will instinctively find food and shelter and avoid predators.
6. Determine which stimuli cause an earthworm to move: light, heat, cold, touch, and water; time how long it takes the worm to move a specific distance under each condition.

3 Assess

Check for Understanding

Ask students to prepare a concept map using all the vocabulary words in this section. L2

Reteach

Have students make a table that lists types of innate behaviors down the left side. Across the top, have them write the following heads: Definition, Example, Outcome of behavior, Survival value. Have them fill in the table. L1

Extension

Visual-Spatial Ask students to go to a nearby zoo. As they observe animals, have them note innate behaviors and explain their survival value. L3

Assessment

Portfolio Have students list five major groups (phylum or class) of animals they have studied. For each phylum or class, ask them to identify one innate behavior and explain its adaptive value. L2 P

4 Close

Discussion

Male katydids sing to attract females. In Panamanian forests where bats are common, male katydids on plants shake their bodies vigorously to attract females. The females detect the shaking of the plant and respond to the male. The bats cannot detect the shaking. Ask students to explain the behavior of the male katydids.

Section 33.2

Prepare

Key Concepts

Students will study various types of learned behavior. They will learn about the adaptive value of habituation, imprinting, trial-and-error learning, conditioning, insight, and communication.

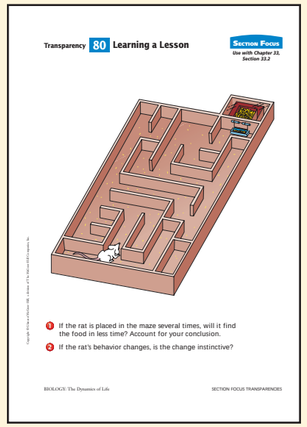
Planning

- Prepare puzzle pieces for MiniLab 33-2.
- Gather tie shoes for the Quick Demo.
- Purchase snails and gather binocular microscopes, spring water, droppers, small dishes, and scissors for the BioLab. Prepare probes from tape, rubber bands, and pencils.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 80** on the overhead projector and have students answer the accompanying questions. L1 ELL


Transparency 80 Learning a Lesson

Section Focus

Use with Chapter 33, Section 33.2

1. If the rat is placed in the maze several times, will it find the food in less time? Account for your conclusion.
2. If the rat's behavior changes, is the change instinctive?

BIOLOGY: The Dynamics of Life — SECTION FOCUS TRANSPARENCIES

SECTION PREVIEW

Objectives

Distinguish among types of learned behavior.

Demonstrate, by example, types of learned behavior.

Vocabulary

habituation
imprinting
trial-and-error learning
motivation
conditioning
insight
communication
language

Section

33.2 Learned Behavior

You were born knowing how to cry, but were you born knowing how to tie your shoes or read? Behavior controlled by instinct, as you now know, occurs automatically. However, some behavior is the direct result of the previous experiences of an animal. A dog that has picked a poisonous frog up in its mouth will never do so again. You may know how to play a musical instrument after a few months or it may take several years. These behaviors are a result of learning.

Both the teen and the dog are exhibiting learned behavior.

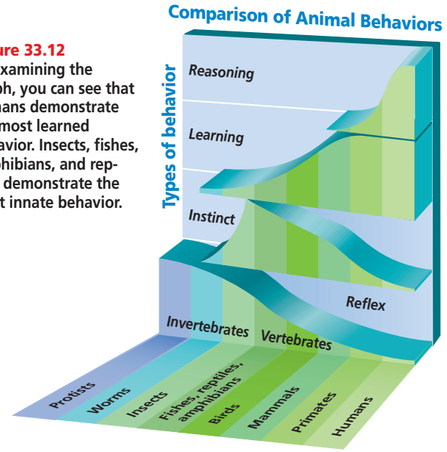


Figure 33.12
By examining the graph, you can see that humans demonstrate the most learned behavior. Insects, fishes, amphibians, and reptiles demonstrate the most innate behavior.

What Is Learned Behavior?

Learning, or learned behavior, takes place when behavior changes through practice or experience. The more complex an animal's brain, the more elaborate the patterns of its learned behavior. As you can see in ***Figure 33.12,*** innate types of behavior are more common in invertebrates, and learned types of behavior are more common in vertebrates. In humans, many behaviors are learned. Reading, writing, and playing a sport are all learned.

Learning has survival value for all animals in changing environments because it permits behavior to change in response to varied conditions. Learning allows an animal to adapt to change, an ability that is especially important for animals with long life spans. The longer that an animal lives, the greater the chance that its environment will change and that it will encounter unfamiliar situations.

Kinds of Learned Behavior

Just as there are several types of innate behavior, there are several types of learned behavior. Some learned behavior is simple and some is complex. Which group of animals do you think carries out the most-complex type of learned behavior?

Habituation: A simple form of learning

Horses normally shy away from an object that suddenly appears from the trees or bushes, yet after a while they disregard noisy cars that speed by the pasture honking their horns. This lack of response is called habituation. **Habituation** (huh BIT yew ay shun) illustrated in ***Figure 33.13,*** occurs when an animal is repeatedly given a stimulus that is not associated with any punishment or reward. An animal has become habituated to a stimulus when it finally ceases to respond to the stimulus.

Imprinting: A permanent attachment

Have you ever seen young ducklings following their mother? This behavior is the result of imprinting. **Imprinting** is a form of learning in which an animal, at a specific critical time of its life, forms a social attachment to another object. Many kinds of birds and mammals do not innately know how to recognize members of their own species. Instead, they learn to make this distinction early in life. Imprinting takes place only during a specific period of time in the animal's life and is usually irreversible. For example, birds that leave the nest immediately after hatching, such as geese, imprint on their mother. They learn to recognize and follow her within a day of hatching.

In birds such as ducks, imprinting takes place during the first day or two after hatching. A duckling rapidly learns to recognize and follow the first conspicuous moving object it sees. Normally, that object is the duckling's mother. Learning to recognize their mother and follow her ensures that food and protection will always be nearby.

Learning by trial and error

Do you remember when you first learned how to ride a bicycle? You probably tried many times before being able to successfully complete the task. Nest building, like riding a bicycle, may be a learning experience. The first time a jackdaw builds

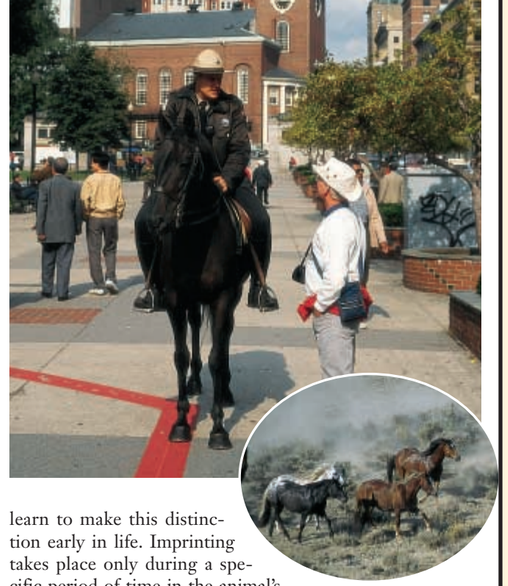


Figure 33.13
Habituation is a loss of sensitivity to certain stimuli. Young horses often are afraid of cars and noisy streets. Gradually, they become habituated to the city and ignore normal sights and sounds.

2 Teach

Visual Learning

Figure 33.13 Ask students to explain how each of the horses may become habituated to different stimuli.

The BioLab at the end of the chapter can be used at this point in the lesson.

INVESTIGATE BioLab

Reinforcement

Show students photos of mother animals and their young. Ask if they know how a mother is able to identify her own young and vice versa. Ask them to explain why imprinting would be important for animals in herds.

Assessment

Performance Ask students to spend a week learning to juggle three tennis balls. Provide them with a set of instructions. Encourage them to practice every day. Ask them to make an entry in their journals each day describing their experience. At the end of the week, have students demonstrate what they have learned.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Learned Behavior*
Disc 4

BIOLOGY JOURNAL

Whale Communication

Auditory-Musical Certain whales are known for their melodious songs. Play a recording of whale songs to the class. Ask students to describe in their journals the songs of the whales. Provide library resources and ask them to figure out whether the sounds the whales make are innate or learned. L2

Resource Manager

Section Focus Transparency 80 and Master L1 ELL
Reteaching Skills Transparency 48 and Master L1 ELL

PROJECT

Imprinting

Interpersonal Konrad Z. Lorenz has been called the "father of ethology." During the 1930s, he studied the behavior of birds and developed a theory of animal behavior that stressed its inherited aspects. Ask a group of students to present a skit about the work of Konrad Lorenz. L2 COOP LEARN

MiniLab 33-2

Purpose
Students will conduct an experiment to test the nature of trial-and-error learning.

Process Skills
interpret data, think critically, collect data, draw a conclusion

Teaching Strategies
- Have students work in teams of two. One can be the time keeper while the other does the puzzle. The time keeper should not watch the student doing the assembly but should be told when the assembler begins and completes the puzzle.
- Prepare puzzle pieces in advance and place on card stock. Save puzzle pieces in plastic bags for students in later classes.
- Enlarge puzzle pieces shown here to approximately twice their size for your students.

Expected Results
Student times needed to complete the puzzle will decline with each trial.

Analysis
1. times decreased
2. No, the ability to work the puzzle was an example of learned behavior.
3. Yes, because the time it took to do the puzzle decreased as learning took place.
4. Student answers may vary. Imprinting and conditioning were not involved with this type of learning. Trial-and-error learning was operating with the initial solving of the puzzle, but later trials may have relied upon insight.

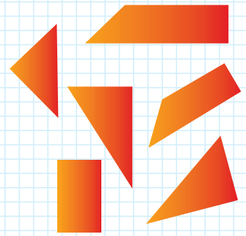
Assessment

Portfolio Have students describe how the experiment could be modified to introduce the aspect of motivation in solving the puzzle. Use the Performance Task Assessment List for Assessing a Whole Experiment and Planning the Next Experiment in **PASC,** p. 33. L2 P

MiniLab 33-2 Experimenting

Solving a Puzzle You are given a bunch of keys and asked to open a door. How do you go about finding the right key? Several attempts are needed and then finally the door opens. The next time you are asked to perform the same task, can you go directly to the correct key? Chances are, you can. You have learned how to solve this problem.

Procedure
1. Copy the data table below.
2. Obtain a paper puzzle from your teacher.
3. Time how long it takes you to assemble the puzzle pieces into a perfect square.
4. Record the time it took and call this trial 1.
5. Disassemble the square and mix the pieces.
6. Repeat step 3 for four more trials.



Data Table

Trial	Time needed to complete square puzzle
1	
2	
3	
4	
5	

Analysis
1. Using your data, explain how the time needed to complete the puzzle changed from trial 1 to trial 5.
2. Was the final completion of the puzzle an example of innate behavior? Explain your answer.
3. Was the final completion of the puzzle an example of learned behavior? Explain your answer.
4. Analyze your behavior when solving the puzzle as to the role that imprinting, trial and error, conditioning, and insight may have played in improving your trial times.

a nest, it uses grass, bits of glass, stones, empty cans, old light bulbs, and anything else it can find. With experience, the bird finds that grasses and twigs make a better nest than do light bulbs. The jackdaw has used **trial-and-error** learning in which an animal receives a reward for making a particular response. When an animal tries one solution and then another in the course of obtaining a reward, in this case a suitable nest, it is learning by trial and error. Find out for yourself how trial and error learning works in the *MiniLab* on this page.

Learning happens more quickly if there is a reason to learn or be successful. **Motivation,** an internal need that causes an animal to act, is necessary for learning to take place. In most animals, motivation often involves satisfying a physical need, such as hunger or thirst. If an animal isn't motivated, it won't learn. Animals that aren't hungry won't respond to a food reward. Mice living in a barn, shown in ***Figure 33.14,*** discover that they can eat all the grain they like if they first chew through the container in which the grain is stored.

Figure 33.14
Mice soon learn where grain is stored in a barn and are motivated by hunger to chew through the storage containers.

Portfolio

Rodent Behavior

Kinesthetic Have students construct a simple maze for small rodents such as mice and gerbils. Students should determine how many trials it takes for each type of rodent to learn the maze. Ask students to write a report on rodent learning for their portfolios. L2 P COOP LEARN

Resource Manager

BioLab and MiniLab Worksheets, p. 148 L2

Figure 33.15
In 1900, Ivan Pavlov, a Russian biologist, first demonstrated conditioning in dogs.

A Pavlov noted that dogs salivate when they smell food. Responding to the smell of food is a reflex, an example of innate behavior.

B By ringing a bell each time he presented food to a dog, Pavlov established an association between the food and the ringing bell.

C Eventually, the dog salivated at the sound of the bell alone. The dog had been conditioned to respond to a stimulus that it did not normally associate with food.

Conditioning: Learning by association

When you first got a new kitten, it would meow as soon as it smelled the aroma of cat food in the can you were opening. After a few weeks, the sound of the can opener alone attracted your kitten, causing it to meow. Your kitten had become conditioned to respond to a stimulus other than the smell of food. **Conditioning** is learning by association. A well-known example of an early experiment in conditioning is illustrated in ***Figure 33.15.***

Insight: The most complex type of learning

In a classic study of animal behavior, a chimpanzee was given two bamboo poles, neither of which was long enough to reach some fruit placed outside its cage. By connecting the two tapering short pieces to make one longer pole, the chimpanzee learned to solve the problem of how to reach the fruit. This type of learning is called insight. **Insight** is learning in which an animal uses previous experience to respond to a new situation.

Much of human learning is based on insight. When you were a baby, you learned a great deal by trial and error. As you grew older, you relied more on insight. Solving math problems is a daily instance of using insight. Probably your first experience with mathematics was when you learned to count. Based on your concept of numbers, you then learned to add, subtract, multiply, and divide. Years later, you continue to solve problems in mathematics based on your past experiences. When you encounter a problem you have never experienced before, you solve the problem through insight.

Meeting Individual Needs

Gifted

Kinesthetic Ask students to conduct an experiment to see whether ants learn. They should set food sources farther and farther away from an ant's nest at regular intervals. Ask students to determine whether the ants learn to anticipate where food will be. Have students record their observations. L3

Resource Manager

Laboratory Manual, pp. 243-246 L2
Basic Concepts Transparency 60 and Master L2 ELL
Reinforcement and Study Guide, pp. 147-148 L2
Content Mastery, pp. 161, 163-164 L1

Quick Demo

Kinesthetic Explain to students that doing something by habit has value because you don't waste time relearning the procedure each time you perform it. Ask students to write a set of directions for tying shoes. They should not tie or even look at shoes or laces as they write. Have them trade papers and then try to follow exactly the directions to tie one shoe. Ask them why it was difficult to describe how to tie a shoe. L1

TechPrep

Imprinting on a Puppet

Kinesthetic Explain to students that biologists raising endangered birds in captivity often use hand puppets in the shape of the adult birds' heads to feed young birds in order to prevent the young from imprinting on humans. Have students do research to determine what birds might be raised in this way and have them construct a feeding puppet that would be suited for feeding the young of a particular species. L2

Glencoe Technology

CD-ROM
Biology: The Dynamics of Life
Video: *Elephant Behavior*
Disc 1

Problem-Solving Lab 33-2

Purpose

Students will determine that the song of certain bird species is partially innate but mostly learned behavior.

Process Skills

analyze information, apply concepts, think critically, interpret scientific illustrations

Teaching Strategies

- Advise students that the term "wild" refers to the sparrow raised in its natural surroundings.
- Units along the left axis are kilocycles per second. Units along the bottom axis are in seconds of time.

Expected Results

Students will recognize that a small portion of the sparrow's song is innate, but the major portion of the song must be learned.

Analysis

1. Segment A is similar in both songs. Segments B and C are quite different.
2. Segment A appears to be innate; it would be impossible for the bird raised in isolation to have learned the first part of the song. Segments B and C must be learned, because the bird raised in isolation cannot match these segments of the wild bird's song.
3. The majority of the bird's song appears to be learned because segments B and C are longer than segment A.
4. The bird will learn the correct sparrow song.

Assessment

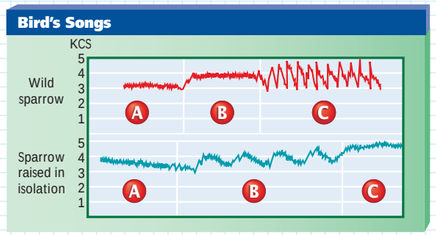
Performance Have students design an experiment to test the hypothesis that birds raised in isolation will learn their proper song from a recording only immediately after hatching. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L2

Problem-Solving Lab 33-2 Interpreting Data

Do birds learn how to sing? Do birds learn how to sing, or is this innate behavior? Most experimental evidence points to the fact that singing may be a combination of the two types of behavior, but in certain species, learning is critical in order to sing the species song correctly.

Analysis

Bird sound spectrograms allow scientists to record and visually study the song patterns of birds. Using this tool, they recorded spectrograms for white-crowned sparrows. The top spectrogram is that of a wild white-crowned sparrow. The bottom spectrogram is that of a white-crowned sparrow hatched and raised in total isolation from all other birds. Segments of the song have been identified with the letters A-C.



Thinking Critically

1. In general, how do the two spectrograms compare?
2. Which segment of the sparrow's song may be innate? Learned? Explain your answers.
3. Does it appear that the majority of the sparrow's song is learned or innate? Explain your answer.
4. In a different experiment, a recording of white-crowned sparrow song was repeatedly played for a young bird raised in isolation. If bird song is mainly learned, predict the outcome of the experiment.

The Role of Communication

When you think about the interactions that happen among animals as a result of their behavior, you realize that some sort of communication has taken place. **Communication** is an exchange of information that results in a change of behavior. Black-headed gulls visually communicate their availability for mating with instinctive courtship behavior. The pat on the head from a dog's owner after the dog retrieves a stick signals a job well done.

Most animals communicate

Animals have several channels of communication open to them. They signal each other by sounds, sights, touches, or smells. Sounds radiate in all directions and can be heard a long way off. The sounds of the humpback whale can be heard 1200 km away. Sounds such as songs, roars, and calls communicate a lot of information quickly. For example, the song of a male cricket tells his sex, his location, his social status, and, because communication by sound is usually species specific, his species.

Signals that involve odors may be broadcast widely and carry a general message. Ants, shown in ***Figure 33.16,*** leave odor trails that are followed by other members of their nest. Some odors may also be species specific. As you know, pheromones, such as those of moths, may be used to attract mates. Because only small amounts of pheromones are needed, other animals, especially predators, may be unable to detect the odor.

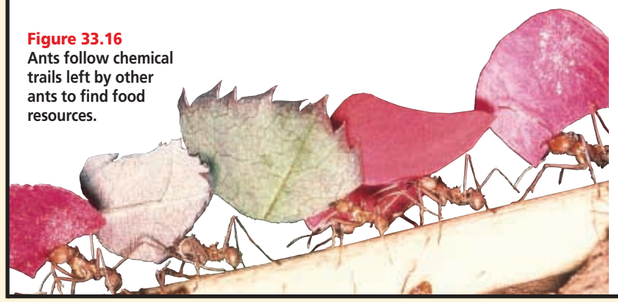


Figure 33.16
Ants follow chemical trails left by other ants to find food resources.

Using both innate and learned behavior

Some communication is a combination of both innate and learned behavior. In some species of songbirds, as shown in ***Figure 33.17,*** males automatically sing when they reach sexual maturity. Their songs are specific to their species, and singing is innate behavior. Yet members of the same species that live in different regions learn different variations of the song. They learn to sing with a regional dialect. In other species, birds raised in isolation never learn to sing their species song. Find out more about the songs birds sing in the *Problem-Solving Lab* on the facing page.

Figure 33.17
The Indigo bunting sings a high-pitched series of notes that descend the scale, then ascend again at the end of the song.

Some animals use language

Language, the use of symbols to represent ideas, is present primarily in animals with complex nervous systems, memory, and insight. Humans, with the help of spoken and written language, can benefit from what other people and cultures have learned and don't have to experience everything for themselves. We can use accumulated knowledge as a basis on which to build new knowledge, illustrated in ***Figure 33.18.***

Figure 33.18
English and other languages are made up of words that have specific meanings. An amazing number of meanings can be communicated using words of any human language.

Section Assessment

Understanding Main Ideas

1. What is the difference between imprinting and other types of learned behavior?
2. How does learning have survival value in a changing environment? Explain your answer by using an example from your daily life.
3. Explain by example the difference between trial-and-error learning and conditioning.
4. What is the difference between communication and language?

Thinking Critically

5. How would a cat respond if the mice in a barn no longer entered at the usual places?

Skill Review

6. **Observing and Inferring** Two dog trainers teach dogs to do tricks. One trainer gives her dog a food treat whenever the dog correctly performs the trick. The other trainer does not use treats. Which trainer will be more successful at dog training? Why? For more help, refer to *Thinking Critically* in the **Skill Handbook.**

Cultural Diversity

Bertram Fraser-Reid

Discuss with students the important contributions of African American organic chemist, Bertram O. Fraser-Reid. His most important work involved synthesizing artificial insect pheromones as substitutes for dangerous insecticides. In Canada, the western pine beetle causes billions of dollars of damage to trees each year. Fraser-Reid reasoned that if he released artificial pheromones of female pine beetles in a part of the forest that contained no females, it might attract male pine beetles to the spot, thus preventing them from mating. Fraser-Reid's initial research laid the groundwork for future studies.

Section Assessment

1. Imprinting can take place only during a specific time during an animal's life. Other learned behaviors may develop later.
2. The behavior can be modified to deal with a changing environment.
3. You learn to ride a bicycle by trial-and-error learning; an animal may be conditioned to the sound of a can opener.
4. Communication is an exchange of information that results in a change of behavior, whereas language is the use of symbols to represent ideas.
5. The cat might wait at the usual places for a while; after not having any success finding mice, the cat would look for new places mice might enter.
6. The dog will be more easily trained if it is rewarded when it responds correctly.

3 Assess

Check for Understanding

Write a list of behaviors on the chalkboard. Ask students to identify each as innate or learned. L1

Reteach

Interpersonal Have students play animal behavior charades. Write a number of behaviors on slips of paper. Have students draw a slip and act out the behavior. Class members will try to guess the name of the behavior and whether it is innate or learned. L2 ELL COOP LEARN

Extension

TECH PREP

Ask students to accompany a wildlife specialist, a fishery biologist, or a veterinarian on the job for a day. Have them report how the knowledge of animal behavior is important to being able to carry out that particular job. L2

Assessment

Portfolio Ask students to select a local wild animal species to observe for a period of time. Students should look for and record examples of feeding behavior, movement, communication, and social interactions. They should try to categorize the behaviors as innate, learned, or a combination of both. L3 P

4 Close

Audiovisual

Show a film about animal behavior. Interesting films about dolphins, baboons, cats, honeybees, and penguins are available from National Geographic Society at your local library.

INVESTIGATE BioLab

Time Allotment
One class period

Process Skills
collect data, experiment, hypothesize, define operationally, observe and infer, conclude, think critically, use numbers

Preparation

- No special housing or food are needed if snails are used almost immediately upon arrival from a supply house.

Procedure

Teaching Strategies
- Small disposable plastic petri dishes (60 mm diameter × 15 mm deep) or Syracuse watch glasses are ideal.
- Allow students to prepare the probe. Substitute wooden match or Q-tip for the pencil portion of the probe. Simply snip a rubber band in half to obtain the needed section.
- Have students work in small groups of three or four.

Troubleshooting
- Students must be able to tell front and rear ends. They are easy to tell apart macroscopically. Review the differences with students.
- Students must be cautioned about not striking the snail too hard with the rubber band probe.
- Some stimulations will result in no response. Students should record exactly what they observe. Habituation will be difficult to achieve, if at all. Students will tire before the snail does.

INVESTIGATE BioLab

Behavior of a Snail

Land snails are members of the mollusk class Gastropoda. Land snails live on or near the ground, feed on decaying organic matter, and breathe with gills or, in some cases, with a simple lung. Land snails sense their environment with a pair of antennae and eyes. Snails are excellent organisms for behavioral studies because they show a variety of consistent responses to certain stimuli.

Preparation

Problem
How can you test the behavior of snails to touch stimuli?

Objectives
In this BioLab you will:
- **Test** the response of snails to touch.
- **Measure** the time needed for habituation to occur after repeated touch stimuli.

Materials
snails
dropper
spring water
small dish
scissors
dissecting microscope
probe constructed from tape, rubber band, and pencil

Safety Precautions
Always wear goggles in the lab. Wash your hands both before and after handling any animals. Use caution when working with live animals.

Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

Procedure

A land snail

1. Copy the data table.
2. Prepare a stimulator probe by taping a small piece of a cut rubber band to the tip of a pencil.
3. Cover the bottom of a small dish with spring water.
4. Obtain a snail from your teacher and place it in the dish.
5. Use a dissecting microscope to examine and locate its head. Its head has two antennae that it can extend and retract.
6. Place the dish on your desk.
7. Lightly touch the snail's anterior end using the end of the rubber band probe. Note if it responds (yes or no), and record the direction the snail moves. Consider this trial 1.
8. Repeat step 7 for four more trials.
9. Lightly touch the snail's posterior end using the rubber band probe. Record your observations and conduct a total of five trials.
10. Repeat step 9, touching the middle of the snail's body.
11. Test the snail's ability to become habituated from stimulation to its anterior end.
    a. Continue to touch the snail's anterior end with the probe every 10 seconds until habituation occurs. Continue testing for a reasonable length of time if habituation does not occur.
    b. Count and record the number of stimulations needed for habituation.

Data Table

Body area	Response to touch		
Trial	Anterior	Posterior	Middle
1			
2			
3			
4			
5			
Habituation studies			
Rate of stimulation	Number of stimulations needed to reach habituation		

Analyze and Conclude

1. **Hypothesizing** Are the responses shown by snails to touch learned or innate? Explain your answer.
2. **Observing** Describe the direction that a snail moves when its anterior and posterior ends are stimulated. Does one end appear to be more sensitive than the other? Is the middle sensitive to touch? Is the speed of response slow or rapid?
3. **Hypothesizing** Explain how the behavior of responding to touch may be an adaptation for survival.
4. **Experimenting** Why did you perform several trials for each experiment involving stimulation of the anterior, posterior, and middle of the snail?
5. **Defining Operationally** Define the term habituation.
6. **Concluding** Explain how your data may be used to support the observation that snails are not easily habituated to touch. Use actual data to support your answer.
7. **Predicting** How might this lack of habituation serve as an adaptation for survival?

Going Further
Experimentation Form a hypothesis regarding snail behavior when given a choice between light and dark conditions. Design and carry out an experiment to test your hypothesis.

internet CONNECTION To find out more about animal behavior, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Data and Observations
Both ends are sensitive to touch. Students may detect no response when performing a specific trial. Habituation will usually not occur.

Assessment
Performance Ask students to plan an experiment that could be used to test a snail's response to rapid changes in light intensity. Use the Performance Task Assessment List for Designing an Experiment in **PASC**, p. 23. L2

Going Further
Snails can also respond by withdrawing into their shells. Have students determine under what conditions snails withdraw rather than move away. L1 ELL

INVESTIGATE BioLab

Analyze and Conclude

1. Student answers may vary. These responses are innate because the animals lack a large enough brain to learn behavior; they do not have the opportunity to learn correct behavior because the first time they do not respond correctly, they may be eaten by a predator.
2. The snail moves backward when the anterior end is touched. The snail moves forward when the posterior end is touched. The anterior appears to be more sensitive to touch. The middle is less sensitive to touch.
3. The snail will move away from predators rapidly.
4. Student answers will vary; good experimental technique, failure to make contact with probe, etc.
5. Habituation is the lack of a response after repeated stimulation.
6. Snails continued to respond after several minutes of stimulation to their anterior ends.
7. Continued stimulation from a predator would bring about continued response of moving away from that predator.

Resource Manager
BioLab and MiniLab Worksheets, pp. 149-150 L2

BIO Technology

Purpose

Students become familiar with tagging and with satellite telemetry as methods of tracking animal migrations.

Background

Four species of sea turtles found along the U.S. coast are on the endangered species list: Kemp's ridley, hawksbill, Florida green, and leatherback. A fifth species, the loggerhead, is threatened.

The Florida green turtle nests from June to October, and a female will nest every two to four years. During a nesting year, the female will lay clutches of about 115 eggs at 12-day intervals.

Teaching Strategies

- Have students locate the Caribbean Sea on a map. Point out that satellite tracking is especially useful for following the movements of animals that travel large distances.
- Go over with students the definition of the word telemetry. Telemetry is the science of transmitting data over a distance via radio waves. It comes from the Greek words *tele*, meaning "distance," and *metron*, meaning "measure."

Investigating the Technology

Students are likely to hypothesize that these areas are green turtle feeding grounds. The hypothesis could be tested by going to the area to see if turtles are feeding there, or by sampling the area for the presence of organisms on which the turtles are known to feed.

BIO Technology

Tracking Sea Turtles

The Florida green turtle (Chelonia mydas mydas) *is an endangered species that nests on sandy beaches. It is found in temperate and tropical waters, including the southeastern coast of the United States. Like other sea turtles, the Florida green turtle spends virtually all of its life at sea; however, adult females visit beaches several times a year to lay their eggs.*

Studying sea turtles presents a challenge because they spend so little time on land. Research is most easily conducted on the beach, where the nesting behavior of the females can be directly observed. These observations have provided important information about how to protect the nesting sites from human disturbance or predation. But more information about the Florida green turtle is needed because protecting an endangered species requires knowing what environmental factors are crucial to its survival.

Tagging To study these animals, researchers affix a small metal tag onto the flipper of a captured turtle. The tag is etched with an identification number. If the animal is captured again, the date and location are shared with other turtle researchers. But even when a tagged turtle is recaptured, the route the animal took to move from one location to another remains unknown.

Satellite tracking Recent improvements in satellite telemetry are making it possible for researchers to keep much better track of individual turtles as they swim from place to place. A transmitter the size of a small, portable cassette player is attached to the shell behind the turtle's neck. The battery-powered transmitter will work for six to ten months before it falls off. When the turtle comes to the surface to breathe, the transmitter broadcasts data in the form of a digital signal to an orbiting communications satellite. The satellite transmits the data to a receiving station on Earth.

The digital signal contains information about the turtle's latitude and longitude, the number of dives it made in the past 24 hours, the length of its most recent dive, and the temperature of the water. By plotting the location of data transmissions on a map, researchers can track the direction and speed in which the animal is moving.

Problems with satellite tracking Sometimes a transmitter stops working after just a few weeks, and there are problems with the data itself. Increasingly accurate information will become available as the technology improves and as more turtles are included in satellite tracking efforts.

Investigating the Technology

Thinking Critically Telemetry data from a Florida green turtle indicate the animal has spent the past several days in an offshore location characterized by coral reefs and seagrass meadows. Past telemetry data from other green turtles indicate that these animals periodically interrupt their travels to stop at this location and at other coral reefs and seagrass meadows. Form a hypothesis that could explain this behavior. How could you test your hypothesis?

internet CONNECTION To find out more about sea turtle migration, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Florida green turtle

Going Further

Invite students to learn more about the life cycle of the Florida green turtle, or to find out what other species of animals are currently being tracked via satellite telemetry.

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Tracking Equipment

Chapter 33 Assessment

Summary

Section 33.1 Innate Behavior

Main Ideas

- Behavior is anything an animal does in response to a stimulus. Many behaviors have adaptive value and are shaped by natural selection.
- Innate behavior is inherited. Innate behaviors include automatic responses and instincts. Automatic responses include reflexes and fight-or-flight responses.
- An instinct is a complex pattern of innate behaviors.
- Behaviors such as courtship rituals, displays of aggressive behavior, territoriality, dominance hierarchies, hibernation, and migration are all forms of instinctive behavior.

Vocabulary

aggressive behavior (p. 894)
behavior (p. 889)
circadian rhythm (p. 895)
courtship behavior (p. 892)
dominance hierarchy (p. 894)
estivation (p. 896)
fight-or-flight response (p. 891)
hibernation (p. 896)
innate behavior (p. 890)
instinct (p. 892)
migration (p. 895)
reflex (p. 891)
territory (p. 893)

Section 33.2 Learned Behavior

Main Ideas

- Learning takes place when behavior changes through practice or experience. Learned behavior has adaptive value.
- Learning includes habituation, imprinting, trial and error, and conditioning. The most complex type of learning is learning by insight.
- Some animals use language, whereas most communicate by either visual, auditory, or chemical signals.

Vocabulary

communication (p. 902)
conditioning (p. 901)
habituation (p. 899)
imprinting (p. 899)
insight (p. 901)
language (p. 903)
motivation (p. 900)
trial-and-error learning (p. 900)

Understanding Main Ideas

1. Your adult dog is chewing on a bone when a puppy approaches. Your dog growls at the puppy. What type of behavior is your dog exhibiting?
   a. conditioning **c.** habituation
   b. aggressive behavior **d.** fighting
2. A change in temperature or the presence of a female may be the _____ that results in a change in an animal's behavior.
   a. response **c.** stimulus
   b. reflex **d.** rhythm
3. Animals with behavior that makes them more successful at surviving and reproducing will produce more _____.
   a. offspring **c.** territory
   b. aggression **d.** eggs
4. All inherited behavior of animals is _____ behavior.
   a. instinctive **c.** conditioned
   b. learned **d.** innate
5. When a toad flips out its sticky tongue to catch an insect flying past, it is exhibiting _____.
   a. learned behavior **c.** territoriality
   b. courtship behavior **d.** innate behavior

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 33: *Animal Behavior*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 193-198
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 33 quiz

Chapter 33 Assessment

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW

All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.

Understanding Main Ideas

1. b
2. c
3. a
4. d
5. d

6. c
7. c
8. d
9. c
10. b
11. insight
12. attract
13. visual
14. instinctive
15. motivation
16. Hibernation
17. aggressive
18. language
19. courtship
20. territorial

Applying Main Ideas

21. A dominance hierarchy would reduce aggression at common feeding sites.
22. No, most likely they would already have imprinted on their own mother by the time they are five days old.
23. Ivan Pavlov observed dogs' natural behavior when food was presented. He hypothesized that the dogs could be conditioned to respond to the sound of a bell as if it were food. He designed an experiment to test his hypothesis. He rang a bell each time he fed the dog, then again when the dog smelled food. Finally, when he rang the bell with no food stimulus, the dog salivated. He concluded that the dog had been conditioned to respond to a stimulus that it did not normally associate with food.

6. What type of behavior is shown in this diagram?

a. conditioning
b. imprinting
c. instinctive
d. habituation

7. Caribou are _____ when they move from their winter homes in the forests to the tundra for the summer.
a. hibernating **c.** migrating
b. imprinting **d.** learning

8. Of these, which is NOT an example of instinctive behavior resulting from internal or external cues?
a. circadian rhythm **c.** hibernation
b. migration **d.** habituation

9. Establishing _____ reduces the need for aggressive behavior among members of the same species.
a. reflexes **c.** territories
b. conditioning **d.** habituation

10. Your cat exhibits _____ when it runs for its food dish upon hearing the sound of the can opener.
a. insight **c.** habituation
b. conditioning **d.** imprinting

11. You use _____ when you solve a math problem that you have never seen before.

12. Male moths use pheromones to _____ female moths.

13. Black-headed sea gulls use _____ cues as a means of communicating their availability for mating.

14. The ability to form a dominance hierarchy is an example of a(n) _____ behavior pattern because it is inherited.

15. When a mouse is learning to go through a maze, the food reward at the end of the maze is _____ because it is based on a need the animal has.

16. _____ is different from deep sleep because an animal exhibiting this behavior has a lowered body temperature.

17. The bighorn sheep below are demonstrating _____ behavior.


18. When a chimpanzee learns to use a computer, it is learning _____ because it is using symbols that represent ideas.

19. Certain ground-dwelling birds stamp their feet and fluff their feathers repeatedly at a certain time of the year. This may be _____ behavior if potential mates are attracted to this display.

20. If your dog continually chases other dogs away from your front yard, your dog may be exhibiting _____ behavior because it has also marked certain areas of the yard with urine.

Test-Taking Tip

Use Roots to Learn
The root of a word can help you group words together as you learn them. If you learn that *trans-* means *across,* as in *transfer,* you might then remember the meaning of words like *transgenic, translocation,* and *transpiration.*

Applying Main Ideas

21. What would be the advantage of a dominance hierarchy in members of a species that are not defending a territory?

22. If you found a nest of five-day-old goslings, would they imprint on you and follow you home? Explain.

23. Explain how Ivan Pavlov used the methods of science to study conditioning behavior.

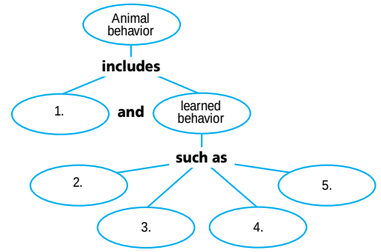
24. By accident, a gull drops a snail on the road. The snail's shell breaks, and the gull eats the snail. The gull continues to drop mollusks on the road. What type of behavior is this?

Thinking Critically

25. **Comparing and Contrasting** Ducklings display an alarm reaction when a model of a hawk is flown over their heads, and no alarm reaction when a model of a goose is flown over their heads. After several days, neither model causes any reaction. Compare the effects of the two models during the first two days with the effects of the same models two weeks later.

26. **Recognizing Cause and Effect** When Charles Darwin visited the Galapagos Islands in 1835, he was amazed that the animals would allow him to touch them. Why were they not afraid?

27. **Concept Mapping** Complete the concept map by using the following vocabulary terms: innate behavior, imprinting, habituation, conditioning, insight.

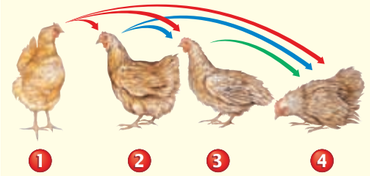


CD-ROM

For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

Chickens that show submission find themselves at lower levels in the barnyard pecking order.



Interpreting Scientific Illustrations Use the diagram above to answer the following questions.

1. Which chicken is dominant?
a. 1 **c.** 3
b. 2 **d.** 4

2. Which chicken or chickens would chicken number 4 peck?
a. only 3 **c.** 1, 2, and 3
b. only 2 and 3 **d.** none

3. Which chickens could be described as submissive?
a. only 2, 3, and 4 **c.** only 4
b. only 3 and 4 **d.** only 1

4. What type of behavior is illustrated in the diagram?
a. learned behavior
b. courtship behavior
c. instinctive behavior
d. reflex behavior

5. **Creating a Model** Under crowded conditions, mice form dominance hierarchies. Create a model showing six mice that have set up a dominance hierarchy in a small cage. Write a caption that explains what is happening.

24. learned behavior

Thinking Critically

25. They show alarm with the hawk model, but not with the goose because a hawk is a potential predator of the duckling, and the goose is not. This is instinctive behavior. When there are no dangerous results, the ducklings become habituated to the hawk model.
26. They had learned not to fear large animals because there were no large predators on the islands.
27. 1. Innate behavior; 2. Imprinting; 3. Insight; 4. Habituation; 5. Conditioning

Assessing Knowledge & Skills

1. a
2. d
3. a
4. c
5. Make sure that the mice are exhibiting threatening or aggressive posture from one to another and that the order of the dominance hierarchy is clear.

Internet Address Book

internNET CONNECTION

Note Internet addresses that you find useful in the space below for quick reference.

National Science Education Standards: UCP.1, UCP.2, UCP.3, UPC.4, UCP.5, C.3, C.4, C.5, C.6

Prepare

Purpose

This BioDigest can be used as an introduction to or as an overview of the vertebrate classes. You may wish to use this unit summary to teach about vertebrates in place of the chapters in the Vertebrates unit.

Key Concepts

Students will study vertebrates by comparing and contrasting the features of fishes, amphibians, reptiles, birds, and mammals. Students learn that there are three classes of fishes as compared with one class each of amphibians, reptiles, birds, and mammals. Students will trace the evolution of vertebrates and identify the similar traits that are found within all seven vertebrate classes. Students will see differences in form that correspond to adaptations to different habitats as vertebrate ancestors moved from life in the water to life on land.

1 Focus

Bellringer

Collect pictures of many different kinds of vertebrates and place them on the bulletin board. Number each picture. As students enter the classroom, have them take a sheet of notebook paper and list the names of the numbered animals. Ask students what all these animals have in common. They should be able to list some vertebrate characteristics, such as having a backbone. L1

For a **preview** of the vertebrate unit, study this BioDigest before you read the chapters. After you have studied the vertebrate chapters, you can use the BioDigest to **review** the unit.

Vertebrates

Like all chordates, vertebrates have a notochord, gill slits, a dorsal hollow nerve cord, and muscle blocks. However, in vertebrates the notochord is replaced during development by a backbone. All vertebrates are bilaterally symmetrical, coelomate animals that have an endoskeleton, a closed circulatory system, an efficient respiratory system, and a complex brain and nervous system.

Fishes

All fishes are ectotherms, animals with body temperatures dependent upon the temperature of their surroundings. Fishes have two-chambered hearts and breathe through gills. Fishes are grouped into three different classes.

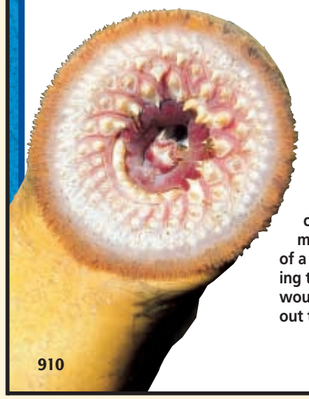
Jawless Fishes

Lampreys and hagfishes are jawless fishes. Jawless fishes have endoskeletons made of cartilage, like sharks and rays, but they do not have jaws.

Cartilaginous Fishes

Sharks, skates, and rays are cartilaginous fishes. Fossil evidence shows that jaws first evolved in these fishes. Cartilaginous fishes have endoskeletons made of cartilage, paired fins, and a lateral line system that enables them to detect movement and vibrations in water.

Cartilaginous fishes such as this whitetip reef shark are more dense than water. Sharks will sink if they stop swimming.



Lacking jaws, this sea lamprey obtains food by clamping its round mouth onto the side of a fish, using its rasping tongue to make a wound, then sucking out the prey's blood.

Vital Statistics

Fishes
Size ranges: Largest: Whale shark, length, 15 m; smallest: Dwarf goby, length, 1 cm.
Distribution: Freshwater, saltwater, and estuarine habitats worldwide.
Unusual adaptations: Electric eels can deliver an electrical charge of 650 volts, which stuns or kills their prey. Some deep-sea fishes have their own bioluminescent lures to catch prey.
Longest-lived: Lake sturgeon, 80 years.
Numbers of species:
Class Agnatha—jawless fishes, 63 species
Class Chondrichthyes—cartilaginous fishes, 850 species
Class Osteichthyes—bony fishes, 18 000 species

Most fishes fertilize their eggs externally and leave their survival to chance. Female sea horses deposit their eggs directly into brood pouches found underneath the tails of the males. The eggs develop inside the brood pouch.

Bony Fishes

Most fish species belong to the bony fishes. All bony fishes have a bony skeleton, gills, paired fins, flattened bony scales, and a lateral line system. Bony fishes breathe by drawing water into their mouths, then passing it over gills where gas exchange occurs. They adjust their depth in the water by regulating the amount of gas that diffuses out of their blood into a swim bladder.

Amphibians

Amphibians are ectothermic vertebrates with three-chambered hearts, lungs, and thin, moist skin. Although they have lungs, most gas exchange in amphibians is carried out through the skin. As adults, amphibians live on land but rely on water for reproduction. Almost all amphibians go through metamorphosis, in which the young hatch into tadpoles, which gradually lose their tails and gills as they develop legs, lungs, and other adult structures.

Amphibian Classification

Amphibians are classified into three orders: Anura, the frogs and toads; Caudata, the salamanders and newts; and Apoda, the legless caecilians. Frogs and toads have vocal cords that can produce a wide range of sounds. Frogs have thin, smooth, moist skin and toads have thick, bumpy skin with poison glands. Salamanders have long, slender bodies with a neck and tail. Caecilians are amphibians with long, wormlike bodies and no legs.

Vital Statistics

Amphibians
Size ranges: Largest: Goliath frog, length, 30 cm; Chinese giant salamander, length, 1.8 m; Smallest frog: *Psyllophryne didactyla,* length, 9.8 mm.
Distribution: Tropical and temperate regions worldwide.
Numbers of species:
Class Amphibia
Order Anura—frogs and toads, 3700 species
Order Caudata—salamanders and newts, 400 species
Order Apoda—legless caecilians, 168 species

Vibrations from air or water are picked up by the frog's tympanic membrane and transmitted to the inner ear. The tympanic membrane is located behind and below the frog's eye.

Although salamanders resemble lizards, they have smooth, moist skin and lack claws on their toes, features used to classify salamanders as amphibians.

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Meeting Individual Needs, p. 912; Building a Model, p. 913; Activity, p. 915; Extension, p. 918

Visual-Spatial Visual Learning, pp. 917, 915; Display, p. 911, 912; Quick Demo, p. 912; Biology Journal, p. 915; Portfolio, p. 918

Interpersonal Tech Prep, p. 913; Project, p. 916

Linguistic Tech Prep, p. 914; Biology Journal, p. 918

Auditory-Musical Meeting Individual Needs, p. 914

Naturalist Field Trip, p. 911; Biology Journal, p. 916; Meeting Individual Needs, p. 917

Assessment Planner

Portfolio Assessment
Portfolio, TWE, p. 918
Performance Assessment
Assessment, TWE, pp. 917, 918
BioDigest Assessment, TWE, p. 918
Knowledge Assessment
BioDigest Assessment, SE, p. 919

2 Teach

Field Trip

Naturalist Arrange a class trip to a local zoological park, nature center, or other park or natural area where students will be able to see representatives of the classes of vertebrates discussed in this unit. Ask students to list as many vertebrates as they see, then divide the animals into classes. Ask them to identify the characteristics they used to classify the animals. L2

Display

Visual-Spatial Ask students to prepare a bulletin board display of bony fishes by cutting out pictures of bony fishes from nature magazines. Fishes should be identified and each fish should have one part labeled. Have students use the following labels: scales, lateral line, gills, swim bladder, and fins. L1 ELL

Visual Learning

Direct students' attention to the photos of the snake and the crocodile. Ask them to explain how the snake and the crocodile are alike and how they are different. *They are both ectotherms with skin that is dry, thick, and covered with scales. They both have lungs and lay eggs with leathery shells. The snake does not have legs, whereas the crocodile has four legs. The snake has a three-chambered heart and the crocodile has a four-chambered heart.*

Quick Demo

Visual-Spatial Show students a live snake, lizard, or turtle from the local environment or borrowed from a pet shop. Have students point out the reptile features of the animal.

Display

Visual-Spatial Have students prepare a bulletin board display of local reptiles. Have them do research to determine if there are any local endangered reptiles. L1

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *The Five Kingdoms*
Disc 3
BioQuest: *Biodiversity Park*
Disc 3, 4

Reptiles

Reptiles are ectotherms with dry, scaly skin and clawed toes. They include snakes, lizards, turtles, crocodiles, and alligators. With the exception of snakes, all reptiles have four legs that are positioned somewhat underneath their bodies. Most reptiles have a three-chambered heart, but crocodilians have a four-chambered heart in which oxygenated blood is kept entirely separate from blood without oxygen. The scaly skin of reptiles reduces the loss of body moisture on land, but scales also prevent the skin from absorbing or releasing gases to the air. Reptiles are entirely dependent upon lungs for this essential gas exchange.

Constrictors, such as this emerald tree boa, hold prey with their mouths, then wrap coils around the prey's body. The snake tightens its coils, preventing inhalation, and the prey suffocates.

All crocodilians have nostrils and eyes that extend above the rest of their faces. This enables the animal to breathe and see while most of its body is under water.

FOCUS ON ADAPTATIONS

The Amniotic Egg

Nile crocodile hatchling

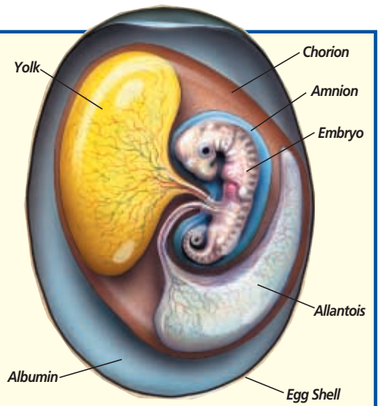
Reptiles were the first group of vertebrates to live entirely on land. They evolved a thick, scaly skin that prevented water loss from body tissues. They evolved strong skeletons, with limbs positioned somewhat underneath their bodies. These limbs enabled them to move quickly on land, avoiding or seeking the sun as their body temperatures demanded. But perhaps their most important adaptation to life on land was the development of the amniotic egg.

Protecting the Embryo

An amniotic egg encloses the embryo in amniotic fluid; provides the yolk, a source of food for the embryo; and surrounds both embryo and food with membranes and a tough, leathery shell. These structures in the egg help prevent dehydration and injury to the embryo as it develops on land. Most reptiles lay their eggs in protected places beneath sand, soil, gravel, or bark.

Membranes Inside the Egg

Membranes found inside the amniotic egg include the amnion, the chorion, and the allantois. The amnion is a membrane filled with fluid that surrounds the developing embryo. The embryo's nitrogenous wastes are excreted into a membranous sac called the allantois. The chorion surrounds the yolk, allantois, amnion, and embryo. With this egg, reptiles do not need water for reproduction. The evolution of the amniotic egg completed the move of tetrapods from water to land.



Marine turtles, such as this olive ridley, come ashore only to lay eggs in nests they dig on sandy beaches. Once the eggs are laid and covered with sand, mother turtles head back to sea.

The shell of a turtle is unique among vertebrates. Consisting of bony plates covered with horny shields, the turtle's shell provides protection from most predators, but it also prevents turtles from making rapid movements.

Internal Fertilization

All reptiles have internal fertilization and lay eggs. The development of the amniotic egg enabled reptiles to move away from a dependence upon water for reproduction. The amniotic egg provides nourishment to the embryo and protects it from drying out as it develops.

VITAL STATISTICS

Reptiles
Size ranges: Largest: Anaconda snake, length, 9 m; Leatherback turtle, weight, 680 kg; smallest: Thread snake, length, 1.3 cm.
Distribution: Temperate and tropical forests, deserts, and grasslands, and freshwater, saltwater, and estuarine habitats worldwide.
Reptile that causes most human death: King cobra, 7500 deaths per year.
Numbers of species:
Class Reptilia
- Order Squamata—snakes and lizards, 6800 species
- Order Chelonia—turtles, 250 species
- Order Crocodilia—crocodiles and alligators, 25 species
- Order Rhynchocephalia—tuataras, 1 species

MEETING INDIVIDUAL NEEDS

English Language Learners/ Visually Impaired

Kinesthetic Give each group of students several scientifically accurate reptile models that are available in toy stores. As they handle the models, ask them to make a list of the reptilian features of each model. L1 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Amphibians*
Disc 4
Video: *Sea Turtle*
Disc 4

PROJECT

Reptile Misconceptions

Ask students to research and report on misconceptions about reptiles such as: that snakes sting with their tongues and you can tell the age of a rattlesnake by counting its rattles.

Building a Model

Kinesthetic Ask students in groups to make a model of an amniotic egg using the following materials: a small lump of clay, two small zipper-type plastic bags, two pill vials or plastic film containers, and a larger lunch-size paper bag.

Do not tell them how to make their model, but give hints if they have trouble. Ask each group to explain their model. A model might be constructed as follows. The lump of clay represents the embryo. The pill vials stick into the lump of clay, one representing the yolk, and the other the allantois. The clay with attached vials can be placed into one plastic bag that represents the amnion. The amniotic sac and its contents can be placed inside the other plastic bag, which represents the chorion. The chorion and its contents can be placed inside the paper bag, which is folded closed to represent the shell. L1 ELL

COOP LEARN

TECHPREP

First Aid for Snake Bite

Interpersonal Have a group of students investigate and demonstrate first aid for snake bites to the class. L2 ELL

TECHPREP

Endangered State Birds

Linguistic Have students do research to find out which endangered birds live in your state. Have them prepare a videotaped public service announcement about the birds' status with information about what can be done to enhance their chances of survival. L3 COOP LEARN

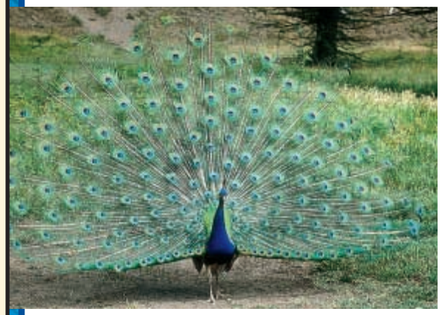
GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Bird Adaptations*
Disc 4

BIODIGEST

Birds

Birds are the only class of animals with feathers. Feathers, which are lightweight, modified scales, help insulate birds and enable them to fly. Birds have forelimbs that are modified into wings. Like reptiles, birds have scales on their feet and clawed toes; unlike reptiles, they are endotherms, animals that maintain a constant body temperature. Endotherms must eat frequently to provide the energy needed for producing body heat.



Feathers keep birds warm and streamline them for flight. Feather colors are often important in courtship or camouflage. The peacock attracts the peahen with its display of tail feathers.

Penguins are flightless birds with wings and feet modified for swimming and a body surrounded by a thick layer of insulating fat. This young emperor penguin may reach a height of 1 m and weigh nearly 34 kg.

Bird Flight

Birds have thin, hollow bones with cross braces that provide support for strong flight muscles while reducing their body weight. Birds also have a four-chambered heart and a unique respiratory system in which oxygen is available during both inhalation and exhalation.

Nest Builders

Like reptiles, birds lay amniotic eggs. Unlike reptiles, birds incubate their eggs in nests, keeping eggs warm until the young birds hatch.

VITAL STATISTICS

Birds
Size ranges: Largest: Ostrich, height, 2.4 m, mass, 156 kg; smallest: Bee hummingbird, length, 57 mm, mass, 1.5 g.
Distribution: Worldwide in all habitats.
Widest wingspan: Wandering albatross, 3.7 m.
Fastest flyer: White-throated spinetail swift, 171 kph.
Largest egg: Ostrich, length, 13.5 cm, mass, 1.5 kg.
Longest yearly migration: Arctic tern, 40 000 km.
Numbers of species:
Class Aves—8600 species in 27 present-day orders
- Order Passeriformes—perching song birds, 5400 species
- Order Ciconiiformes—herons, bitterns, ibises, 127 species
- Order Anseriformes—swans, ducks, geese, 161 species
- Order Falconiformes—eagles, hawks, falcons, 298 species

The cedar waxwing is found in open woodlands, orchards, and backyards across the United States. They spend most of the year in flocks, descending upon orchards and eating until the fruit is gone.

The largest bird's nest is built by the bald eagle. Every year, eagles add another layer of sticks to the nest until some nests are 2 m across and 2 tons in mass.

FOCUS ON ADAPTATIONS

Bird Flight

Peregrine falcon

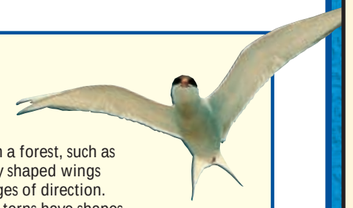
What selection pressure may have resulted in bird flight? Maybe an early bird's need to escape from a predator caused it to run so fast its feet left the ground. Whatever caused birds to evolve an ability to fly, there must first have been adaptations that made flight possible. What are some of these adaptations? A bird's body is lighter in weight than any other animals' of the same size because it has hollow bones and air sacs throughout its body. It also has a beak instead of a heavy jaw with teeth, and its legs are made mostly of skin, bone, and tendons.

Efficient Respiration

Birds receive oxygenated air when they breathe in as well as when they breathe out. Air sacs enable birds to get more oxygen because 75 percent of the air inhaled by a bird passes directly into posterior air sacs rather than into its lungs. When a bird exhales, oxygenated air in the sacs passes into its lungs, then into anterior air sacs and out through the trachea. This one-way flow of air provides the large amounts of oxygen that birds need to power flight muscles.

Wings Adapted for Flight

Flight is also supported by feathers that streamline a bird's body and shape the wings. Wing shape and size determine the type of flight a bird is capable of. Birds that fly through the branches of trees in a forest, such as finches, have elliptically shaped wings adapted to quick changes of direction. Wings of swallows and terns have shapes that sweep back and taper to a slender tip, promoting high speed in open areas. The broad wings of hawks, eagles, and owls provide strong lift and slow speeds. These birds are predators that carry prey while in flight.



Arctic tern

MEETING INDIVIDUAL NEEDS

Visually Impaired

Auditory-Musical Play a recording of various types of bird songs and calls. Ask students to distinguish among distress calls, calls made to the young, courtship songs, and territorial calls. L2 ELL

BIOLOGY JOURNAL

Observing Feathers

Visual-Spatial Provide students with contour and down feathers and a magnifying glass. Feathers may be purchased from craft shops. Ask students to examine both feathers with a magnifying glass and draw diagrams of them in their journals. Ask them to hypothesize how the function of each feather differs. *Down feathers keep birds warm by trapping warm air near their bodies. Contour feathers are used for flight.* L1 ELL

BIODIGEST

Visual Learning

Visual-Spatial Show students slides or pictures of birds in flight and ask them to hypothesize about what types of flight each bird could undertake: quick movements, high speeds, or soaring. *Elliptical wings are adapted to quick movements. Wings that sweep back and taper to a slender tip promote high speed. Soaring birds have broad wings.* L1

Activity

Kinesthetic Have students determine what kinds of birds live on school grounds. Look up specifications for houses for these birds and build bird houses to place on school grounds. L1

Concept Development

In one year, 45 bears were killed on the roads of Florida. Accidents between large mammals and vehicles are common. Ask students to find out which large mammals are killed each year in their state. Ask them to find out what measures are being, or could be, taken to prevent these accidents.

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage
The Keepers of Eden
Preserves of Endangered Species: San Diego and Kenya
(Ch. 8), 8 min. 30 sec.

BioDigest

Mammals

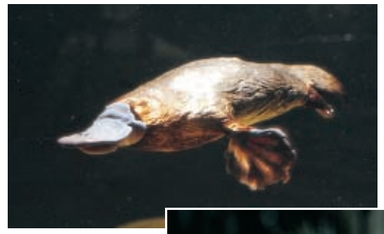
Mammals are endotherms. Mammals are named for their mammary glands, which produce milk to feed their young. Most mammals have hair that helps insulate their bodies and sweat glands that help keep them cool. Mammals need a high level of energy for maintaining body temperature and high speeds of locomotion. An efficient four-chambered heart and the muscular diaphragm beneath the lungs help to deliver the necessary oxygen for these activities.

Mammal Diversity

All mammals have internal fertilization, and the young begin development inside the mother's uterus. But from that point, developmental patterns in mammals diverge. Mammals are classified into three groups. Monotremes are mammals that lay eggs. Marsupials are mammals in which the young complete a second stage of development after birth in a pouch made of skin and hair on the outside of the mother's body. Placental mammals carry their young inside the uterus until development is nearly complete.

Female mammals, such as this moose, feed their young milk secreted from mammary glands. Often, the young are cared for until they become adults.

Most mammals are placental mammals. They have extraordinary ranges in sizes and body structures. Many hoofed mammals, such as this deer, have an adaptation known as cud chewing that enables them to break down the cellulose of plants to make nutrients available to the animal.



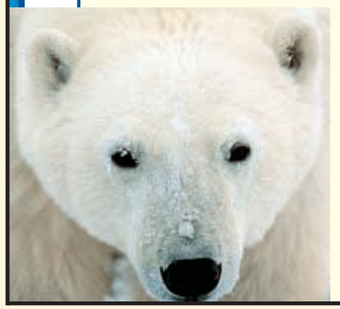
The duck-billed platypus is a monotreme with webbed front feet adapted for swimming, and sharp claws for digging and burrowing into the soil.

This young wallaby is a marsupial that is old enough to survive outside its mother's pouch, but it still seeks protection there when danger threatens.

Hibernating bat

Focus on Adaptations

Endothermy



Polar bear

Both birds and mammals are endotherms. Endotherms have internal processes that maintain a constant body temperature. Just as a thermostat controls the temperature of your home, internal processes cool endotherms if they are too warm, and warm them if they are too cool, thus maintaining homeostasis.

A variety of adaptations enables mammals to maintain body temperature. Hair helps many mammals conserve heat. The thick coat of a polar bear is an adaptation to living in a cold climate. Small ears and an accumulation of body fat under the skin also help prevent heat loss. Small ears have less surface area than large ears from which body heat can escape.

Hibernation Many rodents hibernate during periods of extreme cold. During hibernation, the body temperature lowers. For example, when the surrounding temperature drops to about 0°C, a ground squirrel's temperature drops to 2°C, and it goes into hibernation, which conserves the animal's energy.

Estivation In hot desert environments, where water is limited, some small rodents survive without drinking. They obtain enough water from the foods they eat. Other desert mammals, such as the fennec fox, have large ears that aid in heat loss. During periods of intense heat, some desert mammals go into a state of reduced metabolism called estivation. As a result, the animal's body temperature is lowered and energy is conserved.

Fennec fox

Project

Campaign to Save Mammals

Interpersonal Ask students to develop a campaign to save a local mammal from extinction. They should prepare a list of recommendations, publicity in the form of commercials, bumper stickers, and a poster and suggest an original idea to raise money to create a sanctuary. L2 COOP LEARN

Biology Journal

Mammal Range Maps

Naturalist Give students a blank map of the United States and field guides. Ask them to make a list of local mammals. Have them look up each mammal on their list in field guides and indicate the range of each animal on their maps. They should also make a color-coded key for their maps. L2 ELL

Meeting Individual Needs

Gifted

Naturalist Ask students to develop a wildlife-management plan for a particular mammal in your area. They should develop and carry out a census. Then, based on the census, they should develop a management plan that will protect and maintain appropriate habitat for 25 years. L3

BioDigest

Assessment

Performance Have students sketch, on a sheet of butcher paper, a scale map of the school grounds or a spot near the school. Have them indicate how the area could be made more suitable for local wildlife. Have students work in groups to add features to their maps that would make the area more attractive to wildlife. Books about wildlife habitat restoration are available in libraries. L2 ELL COOP LEARN

Visual Learning

Show students slides of local mammals and ask them to point out how they are adapted to their habitats. *Make sure they point out features that help them move, feed, and give them protection from predators and environmental elements.*

3 Assess

Check for Understanding

Show students a variety of mammal skulls or transparencies of mammal skulls you have made from field guides to mammals. Direct their attention to how teeth reflect what the animal eats. Ask them to make comparisons of teeth in carnivores and herbivores. *Carnivores have sharp, pointed canines that enable them to tear apart prey. Herbivores have premolars and molars adapted to grinding the plant materials they eat.*

Reteach

Show students slides or photos of the three groups of mammals and ask them to identify them by their features.

Extension

Kinesthetic Mammals must use their teeth exclusively to eat as most mammals do not have hands or opposable thumbs to assist. Ask students to shell a peanut with their fingers taped together so that only the top joint of the thumb can move. Ask them why diversified teeth are important to mammals. L1 ELL

Assessment

Performance Ask students to design an experiment that would test the suitability of fat as insulation. Lard or cooking fat can be used in their experiments. L2

4 Close

Audiovisual

Rent a feature film in which a wild mammal or mammals play an important role. Ask students to identify important features of the mammals in the film.

BioDigest

Mammal Teeth

Mammals can be classified by the number and type of teeth. All mammals have diversified teeth used for different purposes. Incisors are used to cut food. Canines—long, pointed teeth—are used to stab or hold food. Molars and premolars have flat surfaces with ridges and are used to grind and chew food.

The chisel-like incisors of beavers and other rodents never stop growing.

Carnivores, such as this coyote, have canine teeth that stab and pierce food.

Grazing animals, such as this horse, rely on incisors to cut grasses and molars to grind and crush their food. You can see that horses, like many other herbivores, lack canine teeth.

Vital Statistics

Mammals

Size ranges: Largest: Blue whale, length, 30 m, mass, 190 metric tons; smallest: Etruscan shrew, length, 6 cm, mass, 1.5 g.
Distribution: Worldwide in all habitats.
Fastest: Cheetah, 110 kph.
Longest-lived: Asiatic elephant, 80 years; humans, up to 120 years.
Numbers of species:
Class Mammalia
- Order Monotremata—egg-laying mammals, 3 species
- Order Marsupialia—pouched mammals, 260 species
- Orders of Placental Mammals—4418 species

Portfolio

Photo Essay

Visual-Spatial Ask a group of students to go to a nearby zoo and take photographs of the animals. Have them present a photo essay to the class. Ask them to discuss whether each animal is endangered or threatened and any programs undertaken for these animals. L2 ELL P COOP LEARN

Biology Journal

Create a Pet

Linguistic Ask students to use their creativity and knowledge of vertebrates to create their ideal vertebrate pet. They should write a description and draw a diagram of this pet in their journals. Have them label their diagrams with all the features unique to the vertebrate group to which their pet belongs. L2 ELL

BioDigest

BioDigest Assessment

Understanding Main Ideas

1. Which of the following animals are ectotherms?
   a. fishes, amphibians, reptiles, and birds
   b. birds and mammals
   c. fishes, amphibians, and reptiles
   d. fishes, amphibians, reptiles, birds, and mammals
2. Which of the following fishes have jaws?
   a. lampreys, sharks, and bony fishes
   b. lampreys only
   c. sharks, skates, and rays only
   d. cartilaginous and bony fishes only
3. Which of the following animals have eggs without shells?
   a. lizards, snakes, and turtles
   b. lizards, frogs, and toads
   c. frogs, toads, and salamanders
   d. frogs, snakes, and alligators
4. Which amphibian has thick, bumpy skin with poison glands?
   a. frogs **c.** lizards
   b. toads **d.** salamanders
5. The first animals to lay amniotic eggs were _____.
   a. fishes **c.** reptiles
   b. amphibians **d.** birds
6. Which reptile has a four-chambered heart?
   a. duck-billed platypus
   b. lizard
   c. snake
   d. alligator
7. The air sacs of birds enable them to _____.
   a. eat more food
   b. receive more oxygen
   c. hide from predators
   d. build large nests
8. Both birds and reptiles lay shelled, amniotic eggs; however, only birds sit on their eggs to _____ them, keeping them warm until they hatch.
   a. guard **c.** protect
   b. incubate **d.** nurse
9. Because the hearts of all mammals have four chambers, more _____ is delivered to their cells.
   a. energy **c.** heat
   b. oxygen **d.** sweat
10. Mammals are classified into subclasses based on their method of _____.
    a. locomotion **c.** breathing
    b. feeding **d.** reproduction

Thinking Critically

1. Why are endothermic animals able to live in areas of extreme temperatures such as the Arctic and the tropics? Explain.
2. Explain how the development of the amniotic egg was important for the transition of animals from life in the water to life on land.
3. How are reptiles and amphibians alike? How are they different?
4. If you found a mammal skull with chisel-like incisors, what type of feeding habits might this animal have?
5. Describe three structures of fishes not found in mollusks.

Three-toed sloth

Resource Manager

Reinforcement and Study Guide, pp. 149-150 L2
Content Mastery, pp. 165-168 L1

BioDigest

BioDigest Assessment

Understanding Main Ideas

1. c
2. d
3. c
4. b
5. c
6. d
7. b
8. b
9. b
10. d

Thinking Critically

1. When an animal can control its body temperature, it is able to live in habitats with temperature extremes without upsetting homeostasis of the body.
2. A food source, protective membranes and fluids, and a tough outer shell on the egg help prevent injury and dehydration of the embryo as it develops on land.
3. They are both ectotherms. All amphibians have a three-chambered heart, as do reptiles, with the exception of crocodilians. Reptiles have claws on their toes, whereas amphibians do not. Reptiles have thick, dry skin covered with scales, whereas amphibians have smooth, moist skin.
4. It might be an animal that gnaws on woody branches and bark.
5. Fishes have internal skeletons, fins, and lateral line systems.