Chapter

10

Mollusks, Arthropods, and Echinoderms

The BIG Idea

Diversity of Life

Q What are the key characteristics of mollusks, arthropods, and echinoderms?

Georgia Performance Standards

S7L2 Students will describe the structure and function of cells, tissues, organs, and organ systems.

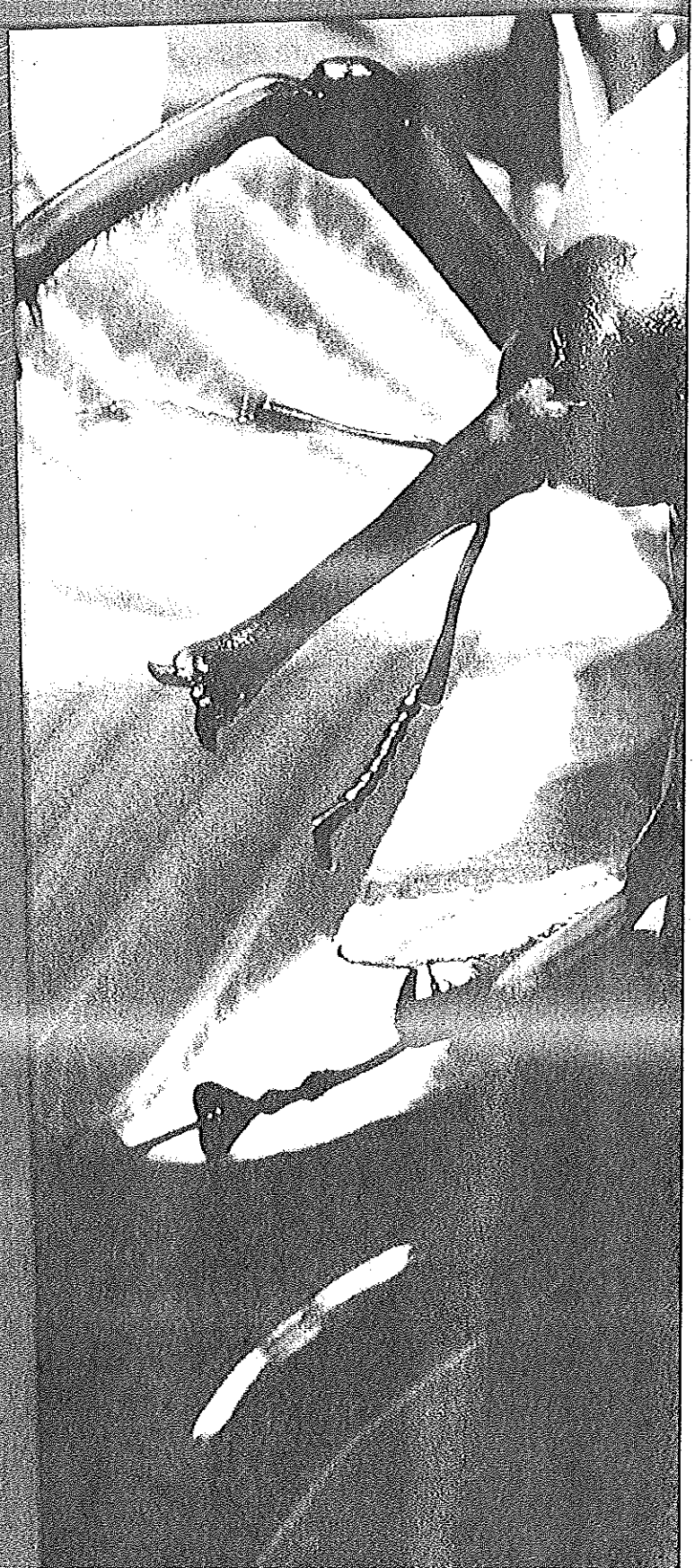
d. Explain that tissues, organs, and organ systems serve the needs cells have for oxygen, food, and waste removal.

S7L3 Students will recognize how biological traits are passed on to successive generations.

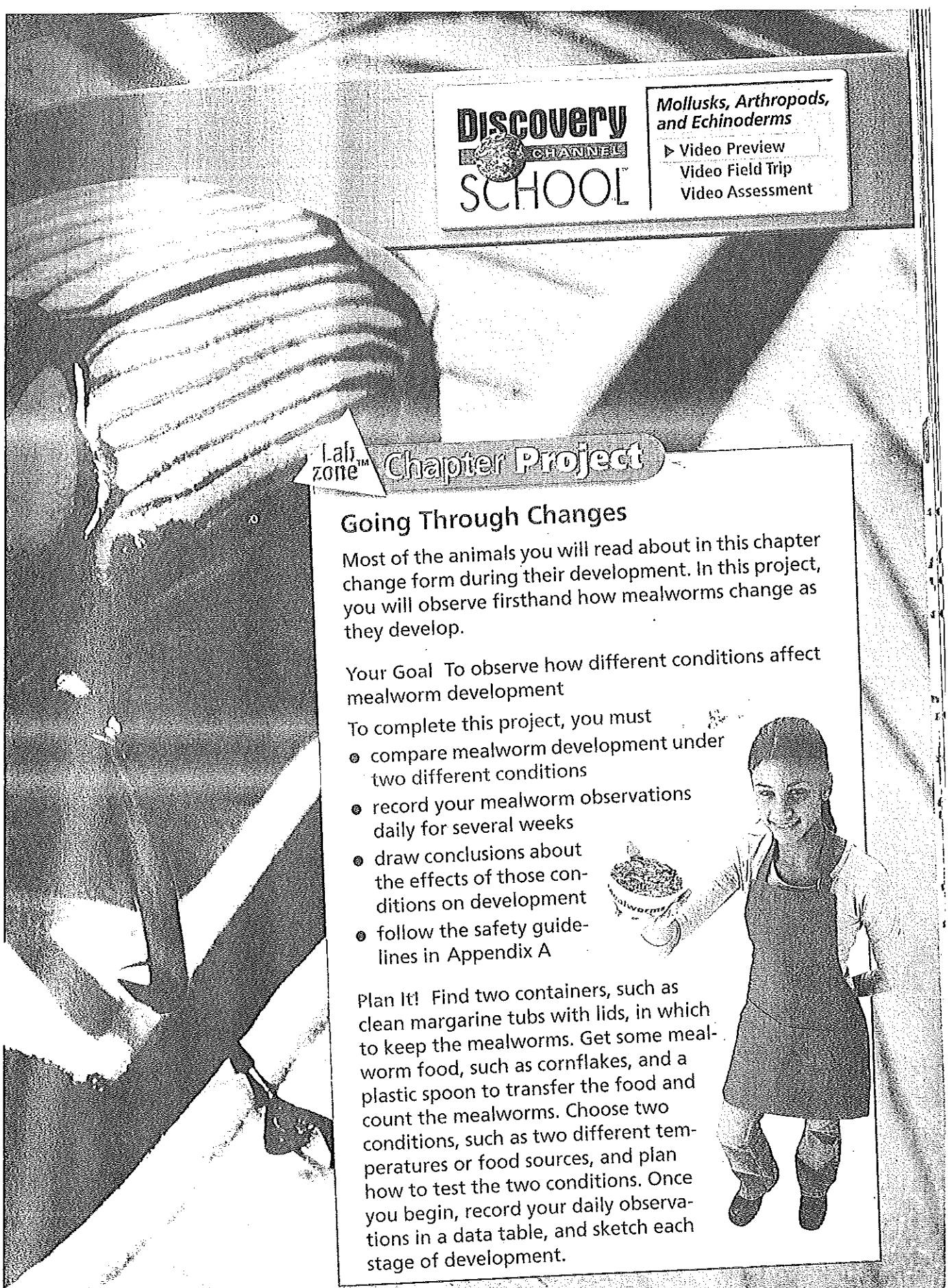
b. Compare and contrast that organisms reproduce asexually and sexually (bacteria, protists, fungi, plants & animals).

S7L4 Students will examine the dependence of organisms on one another and their environments.

a. Demonstrate in a food web that matter is transferred from one organism to another and can recycle between organisms and their environments.



This weevil from Southeast Asia uses its impressive front legs to court females. ▶



Discovery Channel School

Mollusks, Arthropods, and Echinoderms

- ▶ Video Preview
- Video Field Trip
- Video Assessment

Lab zone™ Chapter Project

Going Through Changes

Most of the animals you will read about in this chapter change form during their development. In this project, you will observe firsthand how mealworms change as they develop.

Your Goal To observe how different conditions affect mealworm development

To complete this project, you must

- compare mealworm development under two different conditions
- record your mealworm observations daily for several weeks
- draw conclusions about the effects of those conditions on development
- follow the safety guidelines in Appendix A

Plan It! Find two containers, such as clean margarine tubs with lids, in which to keep the mealworms. Get some mealworm food, such as cornflakes, and a plastic spoon to transfer the food and count the mealworms. Choose two conditions, such as two different temperatures or food sources, and plan how to test the two conditions. Once you begin, record your daily observations in a data table, and sketch each stage of development.

Section 1

Mollusks

Reading Preview

Key Concepts

- What are the main characteristics of mollusks?
- What are the major groups of mollusks and how do they differ?

Key Terms

- mollusk
- open circulatory system
- gill
- gastropod
- herbivore
- carnivore
- radula
- bivalve
- omnivore
- cephalopod

Target Reading Skill

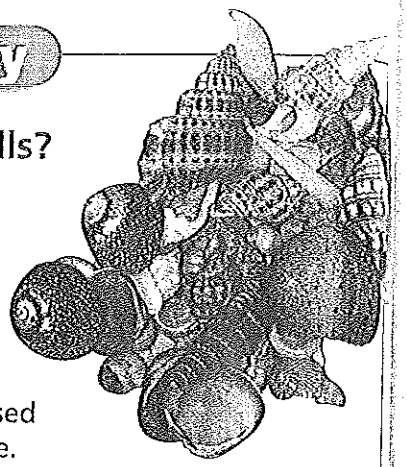
Comparing and Contrasting

When you compare and contrast things, you explain how they are alike and different. As you read, compare and contrast three groups of mollusks by completing a table like the one below.

Characteristics of Mollusks

Type of Mollusk	How They Obtain Food	How They Move
Gastropod		
Bivalve		
Cephalopod		

Lab zone Discover Activity



How Can You Classify Shells?

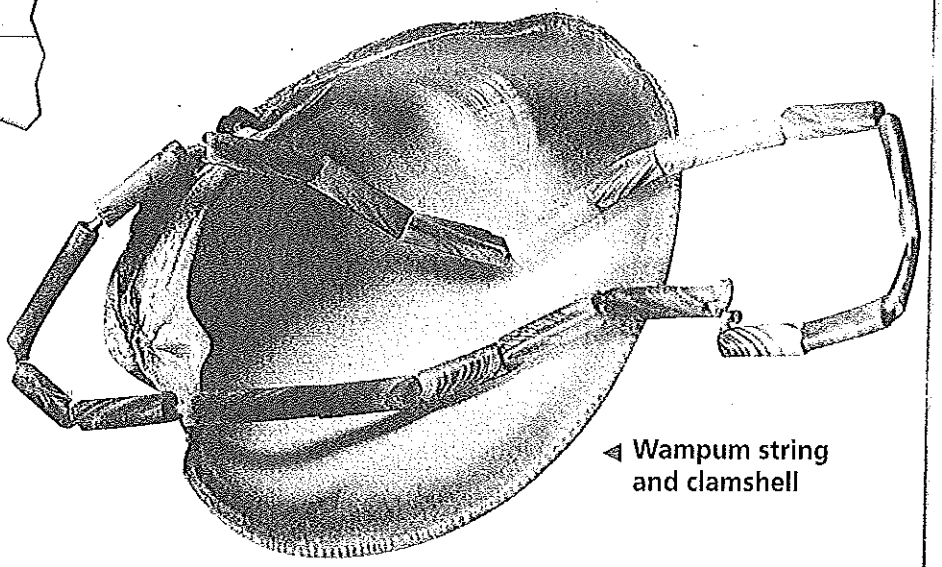
1. Your teacher will give you an assortment of shells.
2. Examine each shell carefully. Look at the shape and color of the shells and feel their inner and outer surfaces.
3. Classify the shells into groups based on the characteristics you observe.

Think It Over

Inferring How might it help an animal to have a shell? How might it be a disadvantage?

From the shells of clams, Native Americans in the Northeast once carved purple and white beads called wampum. They wove these beads into belts with complex designs that often had special, solemn significance. A wampum belt might record a group's history. When warring groups made peace, they exchanged weavings made of wampum. Iroquois women would honor a new chief with gifts of wampum strings.

The soft bodies inside the shells used to make wampum were a major source of food for Native Americans. Today, clams and similar animals, such as scallops and oysters, are still valuable sources of food for people in many parts of the world.



◀ Wampum string and clamshell

Characteristics of Mollusks

Clams, oysters, and scallops are all mollusks (phylum Mollusca). Snails and squids are mollusks, too. **Mollusks** are invertebrates with soft, unsegmented bodies that are often protected by a hard outer shell. **In addition to a soft body often covered by a shell, a mollusk has a thin layer of tissue called a mantle that covers its internal organs, and an organ called a foot.** In many mollusks, the mantle produces the hard shell. Depending on the type of mollusk, the foot has different functions—crawling, digging, or catching prey.

Body Structure Like segmented worms, mollusks have bilateral symmetry and a digestive system with two openings. However, unlike segmented worms, the body parts of mollusks are not usually repeated. Instead, the internal organs are located together in one area, as shown in Figure 1.

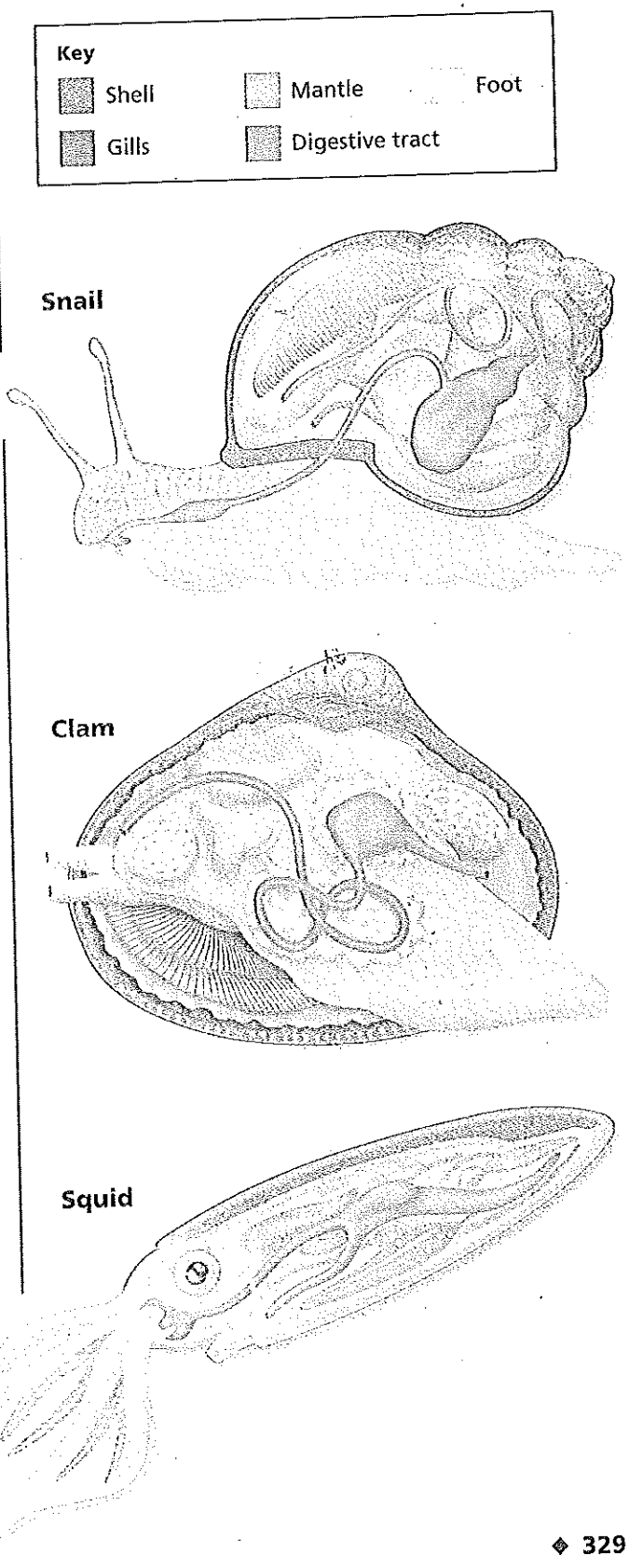
Circulatory System Most groups of mollusks have an **open circulatory system,** in which the blood is not always inside blood vessels. The heart pumps blood into a short vessel that opens into the body spaces containing the internal organs. The blood sloshes over the organs and returns eventually to the heart.

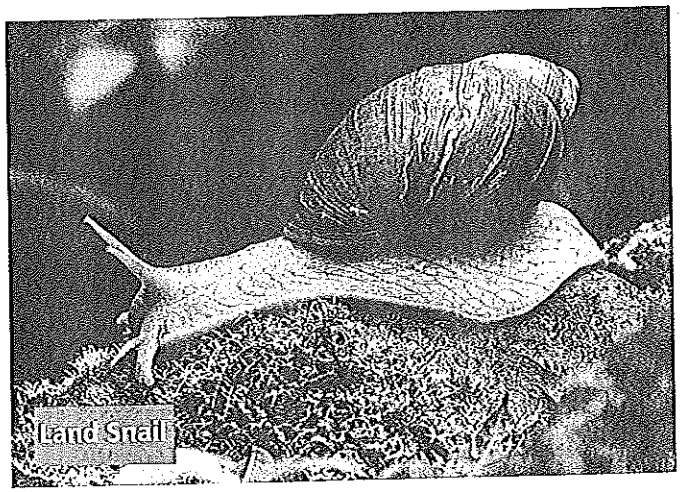
Obtaining Oxygen Most mollusks that live in water have **gills,** organs that remove oxygen from the water. The gills have tiny, hairlike structures called cilia and a rich supply of blood vessels. The cilia move back and forth, making water flow over the gills. The gills remove the oxygen from the water and the oxygen moves into the blood. At the same time, carbon dioxide, a waste gas, moves out of the blood and into the water.

Reading Checkpoint **Which organs of a mollusk obtain oxygen from water?**

FIGURE 1
Comparing Mollusks

Although they don't look much alike at first, a snail, a clam, and a squid have the same basic body structures.





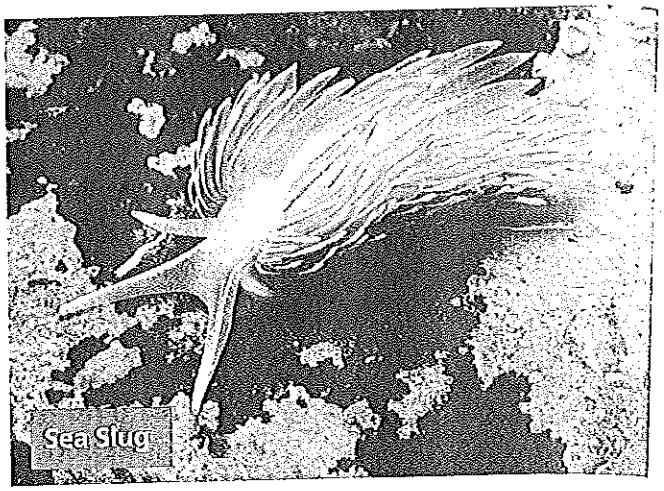


FIGURE 2
Gastropods
Although the land snail has a shell and the sea slug does not, both are gastropods.

Snails and Slugs

Biologists classify mollusks into groups based on their physical characteristics. These characteristics include the presence of a shell, the type of shell, the type of foot, and the type of nervous system. **The three major groups of mollusks are gastropods, bivalves, and cephalopods.**

The **gastropods** are the largest group of mollusks. They include snails and slugs, like the ones shown in Figure 2, and live nearly everywhere on Earth. They live in oceans, on rocky shores, in fresh water, and on land. **Gastropods have a single external shell or no shell at all.**

Obtaining Food Like all organisms, gastropods need food. Some gastropods are **herbivores,** animals that eat only plants. Some are scavengers that eat decaying material. Still others are **carnivores,** animals that eat only other animals.

But no matter what they eat, gastropods use an organ called a **radula** (RAJ oo luh), a flexible ribbon of tiny teeth, to obtain food. Herbivores use the radula like sandpaper to tear through plant tissues. Carnivores use their radulas in different ways. For example, a gastropod called an oyster drill uses its radula to bore a hole through an oyster's shell. Then it scrapes up the oyster's soft body tissues.

Movement A gastropod usually moves by creeping along on a broad foot. The foot may ooze a carpet of slippery mucus, which you may have seen if you've ever watched a snail move. The mucus makes it easier for the gastropod to move.

Reading Checkpoint **What is the function of a radula?**

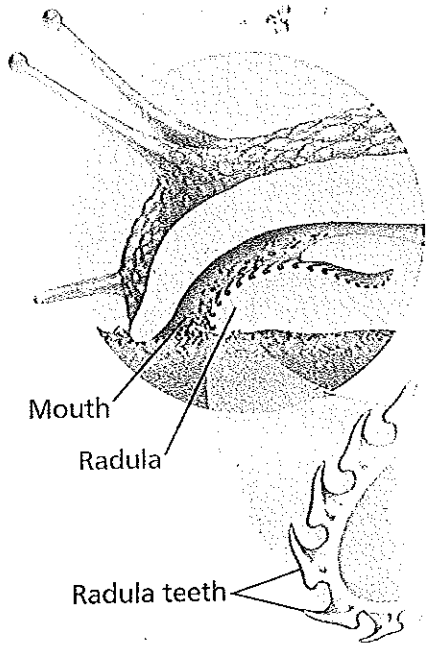


FIGURE 3
The Radula of a Snail
A snail has a food-gathering organ called a radula, which tears and scrapes up food.

Two-Shelled Mollusks

A second group of mollusks, **bivalves,** includes oysters, clams, scallops, and mussels. **Bivalves are mollusks that have two shells held together by hinges and strong muscles.** They are found in all kinds of watery environments.

Obtaining Food Like gastropods, bivalves need food. But unlike gastropods, bivalves do not have radulas. Instead, most are filter feeders that strain tiny organisms from water. Bivalves capture food as water flows over their gills. Food particles stick to mucus that covers the gills. The cilia on the gills then move the food particles into the bivalve's mouth. Most bivalves are omnivores, animals that eat both plants and animals.

Movement Like gastropods, bivalves don't move quickly. The larvae of most bivalves float or swim through the water. But the adults stay in one place or use their foot to move very slowly. For example, oysters and mussels attach themselves to rocks or other underwater surfaces. Clams, in contrast, move. Look at Figure 4 to see how a clam digs into mud.

Protection Sometimes an object such as a grain of sand gets stuck between a bivalve's mantle and shell. The object irritates the soft mantle. Just as you might put smooth tape around rough bicycle handlebars to protect your hands, the bivalve's mantle produces a smooth, pearly coat to cover the irritating object. Sometimes a pearl forms eventually around the object. Some oysters make beautiful pearls that are used in jewelry.

Lab zone Skills Activity

Classifying

While wading in a stream, you step on a small animal with a hard covering. As you examine the animal, you discover that it has a soft body inside its shell. It may be a mollusk. What characteristics would you look for to classify the animal into a group of mollusks?

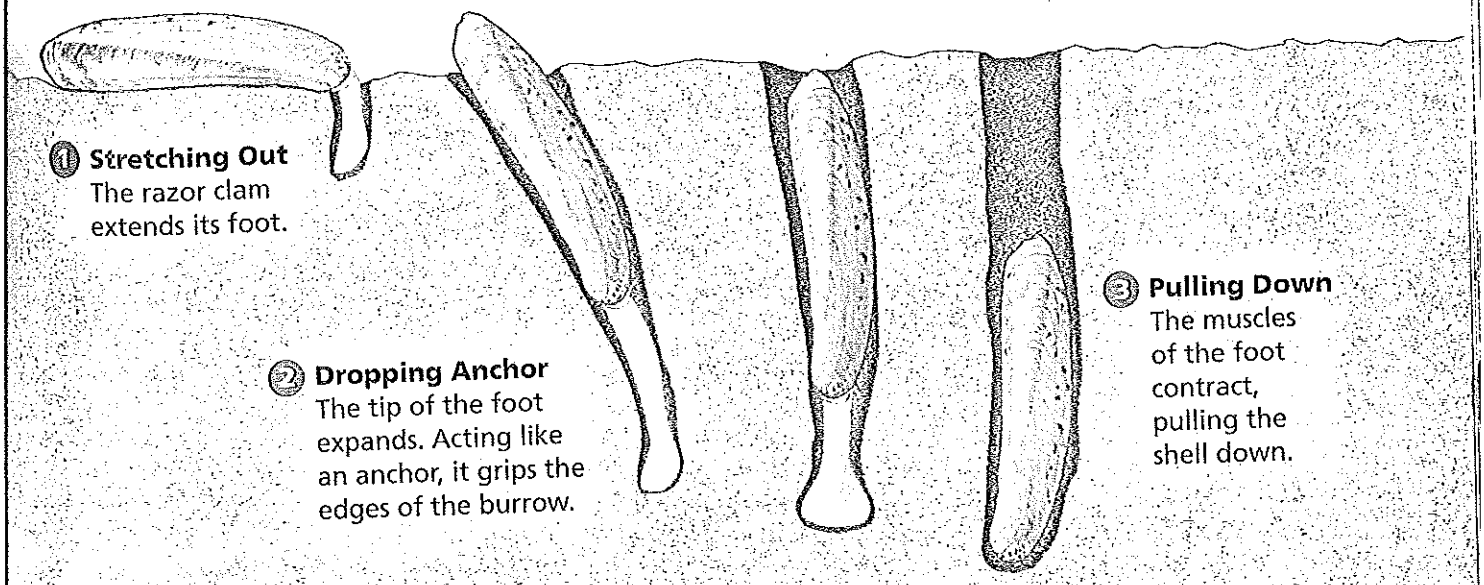


FIGURE 4
How a Clam Digs
A razor clam digs into the mud by changing the shape of its foot.
Predicting *How might the clam use its foot to move back up?*

Discovery Channel School

Mollusks, Arthropods, and Echinoderms

Video Preview
▷ Video Field Trip
Video Assessment

Octopuses and Their Relatives

Octopuses and squids are **cephalopods** (SEF uh luh pahdz). So are nautiluses and cuttlefishes. **A cephalopod is an ocean-dwelling mollusk whose foot is adapted to form tentacles around its mouth.** Unlike bivalves, not all cephalopods have shells. For example, nautiluses have an external shell, squids and cuttlefish have a small shell within the body, and octopuses have no shells. Cephalopods are the only mollusks with a closed circulatory system.

Obtaining Food Cephalopods are carnivores. A cephalopod captures prey using its muscular tentacles. Then it crushes the prey in a beak and scrapes and cuts the flesh with its radula.

A cephalopod's tentacles contain sensitive suckers, which you can see on the octopus in Figure 5. The suckers receive sensations of taste as well as touch. A cephalopod doesn't have to touch something to taste it because the suckers respond to chemicals in the water. For example, when an octopus feels beneath a rock, its tentacles may find a crab by taste before touching it.

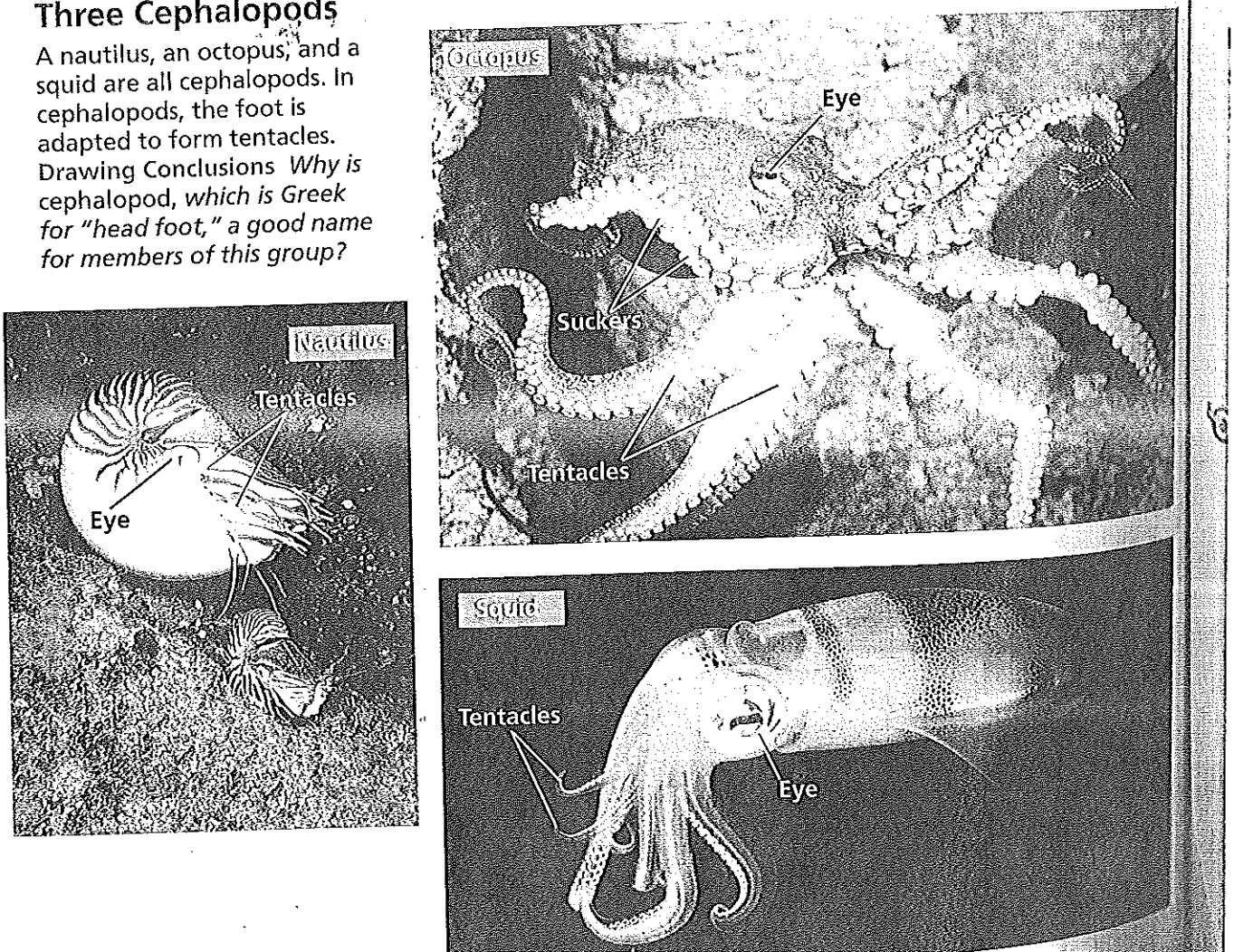


FIGURE 5
Three Cephalopods
A nautilus, an octopus, and a squid are all cephalopods. In cephalopods, the foot is adapted to form tentacles.
Drawing Conclusions *Why is* cephalopod, *which is Greek for "head foot," a good name for members of this group?*

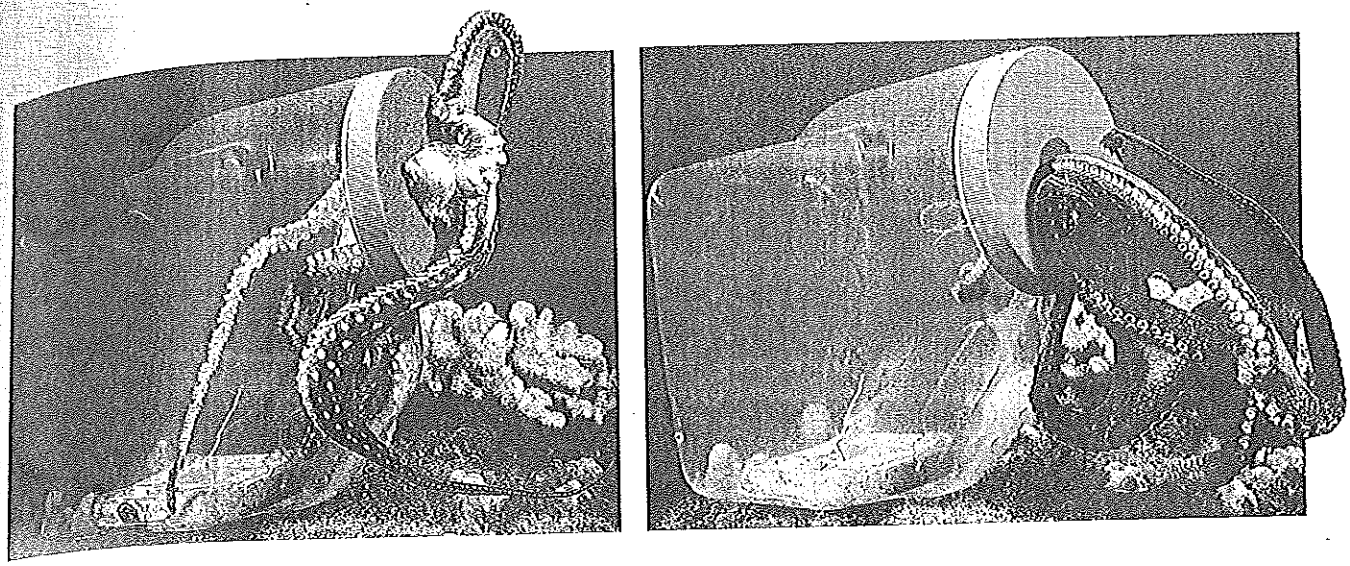


FIGURE 6
An Escaping Octopus
This octopus has figured out how to escape from a jar through a tiny hole in the lid.

Nervous System Cephalopods have large eyes and excellent vision. They also have the most complex nervous system of any invertebrate. Cephalopods have large brains and can remember things they have learned. For example, in captivity, octopuses can learn when to expect deliveries of food. Some even figure out how to escape from their tanks.

Movement Cephalopods swim by jet propulsion. They squeeze a current of water out of the mantle cavity and through a tube. Then, like rockets, they shoot off in the opposite direction. By turning the tube around, they can reverse direction.

Reading Checkpoint **What does the foot of a cephalopod look like?**

Section 1 Assessment

Target Reading Skill Comparing and Contrasting Use the information in your table about mollusks to help you answer Question 2 below.

Reviewing Key Concepts

1. a. Listing List the characteristics of a mollusk.
   b. Explaining How is a mollusk's mantle related to its shell?
   c. Predicting What would happen to a mollusk if the cilia on its gills did not work? Explain.
2. a. Identifying What are three groups of mollusks?
   b. Classifying What are the characteristics of the three groups of mollusks?
   c. Comparing and Contrasting How are the foot structures of a snail, a clam, and an octopus similar? How are they different?

Lab zone **At-Home Activity**

Edible Mollusks Visit a local supermarket with a family member and identify any mollusks that are being sold as food. Be sure to look in places other than the fish counter, such as the canned-foods section. Discuss the parts of the mollusks that are used for food and the parts that are not edible.

Section 2

Arthropods

Reading Preview

Key Concepts

- What are the four major groups of arthropods and what are their characteristics?
- How do crustaceans, arachnids, and centipedes and millpedes differ?

Key Terms

- arthropod
- exoskeleton
- molting
- antenna
- crustacean
- metamorphosis
- arachnid
- abdomen

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what* or a *how* question for each heading. As you read, write the answers to your questions.

Characteristics of Arthropods

Question	Answer
What is an arthropod?	

Lab zone Discover Activity

Will It Bend and Move?

1. Have a partner roll a piece of cardboard around your arm to form a tube that covers your elbow. Your partner should put three pieces of tape around the tube to hold it closed—one at each end and one in the middle.
2. With the tube in place, try to write your name on a piece of paper. Then try to scratch your head.
3. Keep the tube on your arm for 10 minutes. Observe how the tube affects your ability to do things.

Think It Over

Inferring Insects and many other animals have rigid skeletons on the outside of their bodies. Why do their skeletons need joints?

At dusk near the edge of a meadow, a grasshopper leaps through the grass. Nearby, a hungry spider waits in its web. The grasshopper leaps into the web. It's caught! As the grasshopper struggles to free itself, the spider rushes toward it. Quickly, the spider wraps the grasshopper in silk. The grasshopper cannot escape. Soon it will become a tasty meal for the spider.

The spider and grasshopper are both **arthropods,** or members of the arthropod phylum (phylum Arthropoda). Animals such as crabs, lobsters, centipedes, and scorpions are also arthropods.

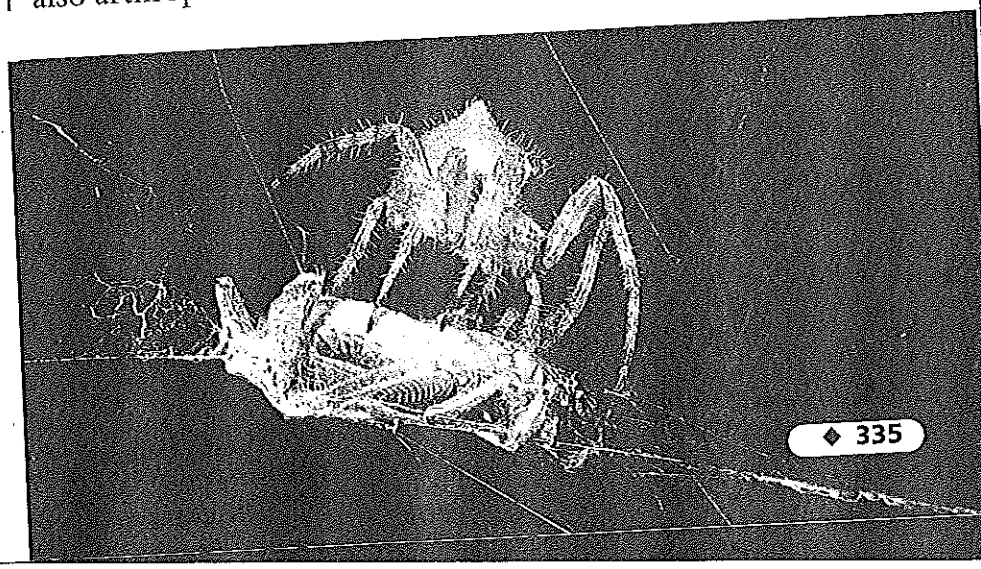


FIGURE 7
A Spider at Work
This spider wraps its prey, a grasshopper, in silk. Both animals are arthropods.

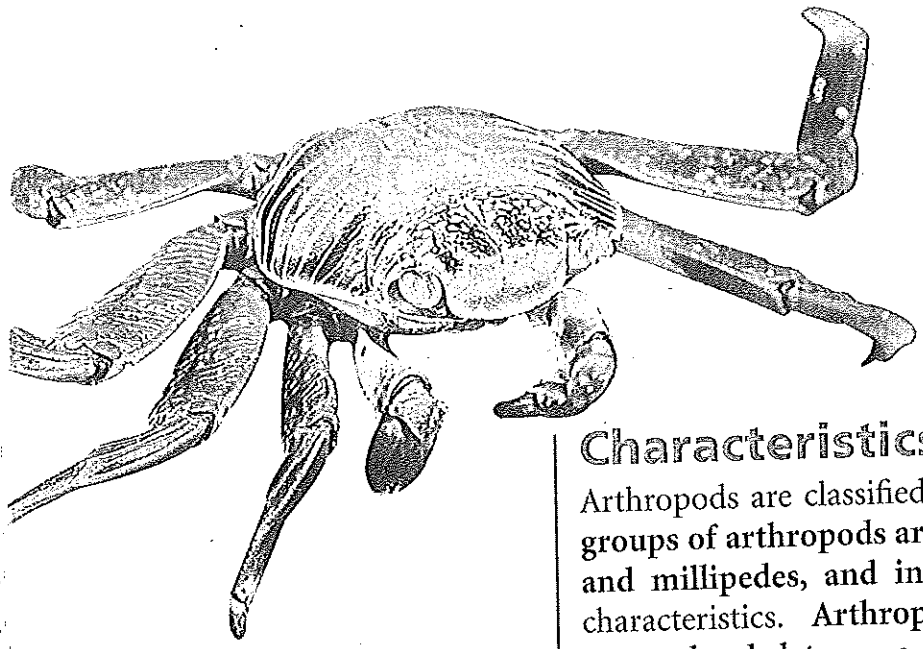


FIGURE 8
Arthropod Characteristics
This Sally lightfoot crab shows the tough exoskeleton, the segmented body, and the jointed appendages that are characteristic of arthropods.

Characteristics of Arthropods

Arthropods are classified into four major groups. **The major groups of arthropods are crustaceans, arachnids, centipedes and millipedes, and insects.** All arthropods share certain characteristics. **Arthropods are invertebrates that have an external skeleton, a segmented body, and jointed attachments called appendages.** Wings, mouthparts, and legs are all appendages. Jointed appendages are such a distinctive characteristic that arthropods are named for it. *Arthros* means "joint" in Greek, and *podos* means "foot" or "leg."

Arthropods share some characteristics with many other animals, too. They have bilateral symmetry, an open circulatory system, and a digestive system with two openings. In addition, most arthropods reproduce sexually.

Outer Skeleton If you were an arthropod, you would have a waterproof covering. This waxy covering is called an **exoskeleton,** or outer skeleton. It protects the animal and helps prevent evaporation of water. Water animals are surrounded by water, but land animals need a way to keep from drying out. Arthropods may have been the first animals to live on land. Their exoskeletons probably enabled them to do this because they keep the arthropods from drying out.

As an arthropod grows larger, its exoskeleton cannot expand. The growing arthropod is trapped within its exoskeleton, like a knight in armor that is too small. Arthropods solve this problem by occasionally shedding their exoskeletons and growing new ones that are larger. The process of shedding an outgrown exoskeleton is called **molting.** After an arthropod has molted, its new skeleton is soft for a time. During that time, the arthropod has less protection from danger than it does after its new skeleton has hardened.

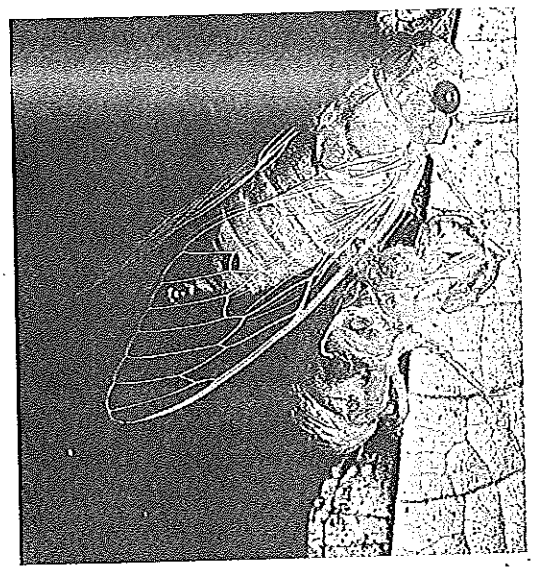


FIGURE 9
A Molting Cicada
This cicada has just molted. You can see its old exoskeleton hanging on the leaf just below it.
Applying Concepts *Why must arthropods molt?*

Comparisons of the Largest Arthropod Groups

Characteristic	Crustaceans	Arachnids	Centipedes and Millipedes	Insects
Number of body sections	2 or 3	2	2	3
Pairs of legs	5 or more	4	Many	3
Pairs of antennae	2	None	1	1

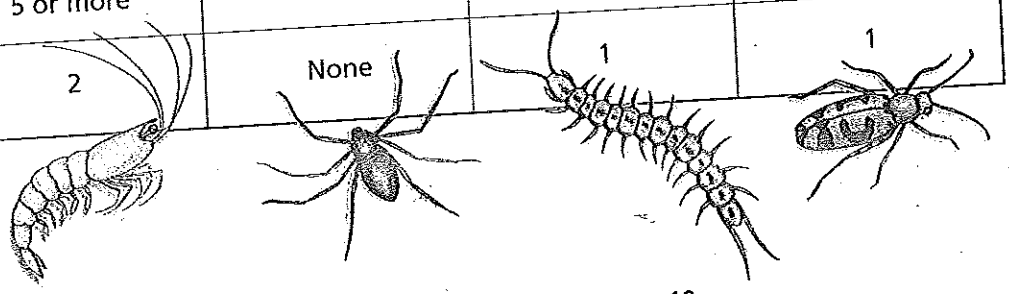


FIGURE 10
Members of the largest arthropod groups differ in several characteristics. Interpreting Tables *Which group of arthropods has no antennae?*

Segmented Body The bodies of arthropods are segmented. A segmented body plan is easiest to see in centipedes and millipedes, which have bodies made up of many identical-looking segments. In fact, their bodies look something like the bodies of earthworms. You can also see segments on the tails of shrimp and lobsters. In some groups of arthropods, several body segments become joined into distinct sections. An arthropod may have up to three sections—a head, a midsection, and a hind section.

Jointed Appendages Just as your fingers are appendages attached to your palms, many arthropods have jointed appendages attached to their bodies. The joints in the appendages give the animal flexibility and enable it to move. If you did the Discover activity, you saw how important joints are for allowing movement. Arthropod appendages tend to be highly specialized tools used for moving, obtaining food, reproducing, and sensing the environment. For example, arthropods use legs to walk and wings to fly. In addition, most arthropods have appendages called antennae (singular *antenna*). An **antenna** is an appendage attached to the head that contains sense organs.

Diversity Scientists have identified more species of arthropods—over one million—than all other species of animals combined! There are probably many others that have not yet been discovered. Look at Figure 10 to compare some characteristics of the four major groups of arthropods.

Go Online
NSTA SCILINKS
For: Links on arthropods
Visit: www.SciLinks.org
Web Code: scn-0222

Reading Checkpoint **What does an antenna do?**

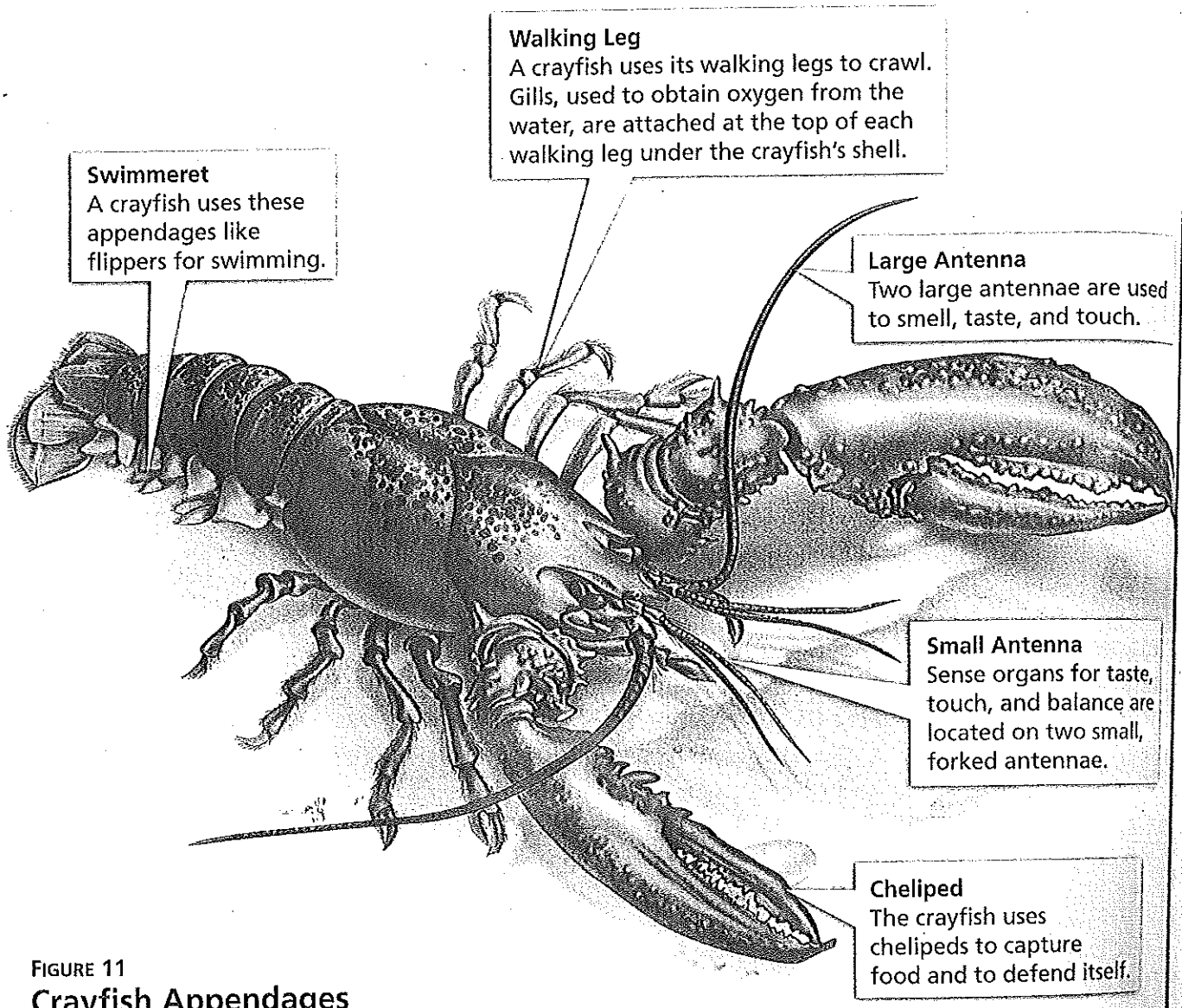


FIGURE 11
Crayfish Appendages
A crayfish's appendages are as varied as the tools on a Swiss army knife. The appendages are adapted for different functions.
Interpreting Diagrams *What functions do the chelipeds serve?*

Crustaceans

If you've ever eaten shrimp cocktail or crab cakes, you've dined on crustaceans (krus TAY shunz). Crayfish and lobsters are other familiar crustaceans. Crustaceans thrive in freshwater lakes and rivers, and even in puddles that last a long time. You can find them in the deepest parts of oceans and along coastlines. A few, like the pill bug, live in damp places on land.

Body Structure Crustaceans share certain characteristics. **A crustacean is an arthropod that has two or three body sections, five or more pairs of legs, and two pairs of antennae.** Each crustacean body segment has a pair of legs or another type of appendage attached to it. The various types of appendages function differently, as you can see in Figure 11.

The appendages attached to the head of a crayfish include two pairs of antennae that are used for smelling, tasting, touching, and keeping balance. The crayfish uses most of its leg appendages for walking. However, it uses its first pair of legs, called chelipeds, for obtaining food and defending itself.

Obtaining Oxygen and Food Because crustaceans live in watery environments, most have gills to obtain oxygen. The gills are located beneath the shell of a crustacean. Water containing oxygen reaches the gills as a crustacean moves along in its environment.

Crustaceans obtain food in many ways. Some are scavengers that eat dead plants and animals. Others are predators, eating animals they have killed. The pistol shrimp is a predator with an appendage that moves with such force that it stuns its prey. Krill, which are shrimplike crustaceans that live in cold ocean waters, are herbivores that eat plantlike microorganisms. In turn, krill are eaten by predators such as fishes, penguins, seals, and even great blue whales, the world's largest animals.

Life Cycle Most crustaceans, such as crabs, barnacles, and shrimp, begin their lives as microscopic, swimming larvae. The bodies of these larvae do not resemble those of adults. Crustacean larvae develop into adults by **metamorphosis** (met uh MAWR fuh sis), a process in which an animal's body undergoes dramatic changes in form during its life cycle.

Reading Checkpoint **What organs does a crustacean use to obtain oxygen?**

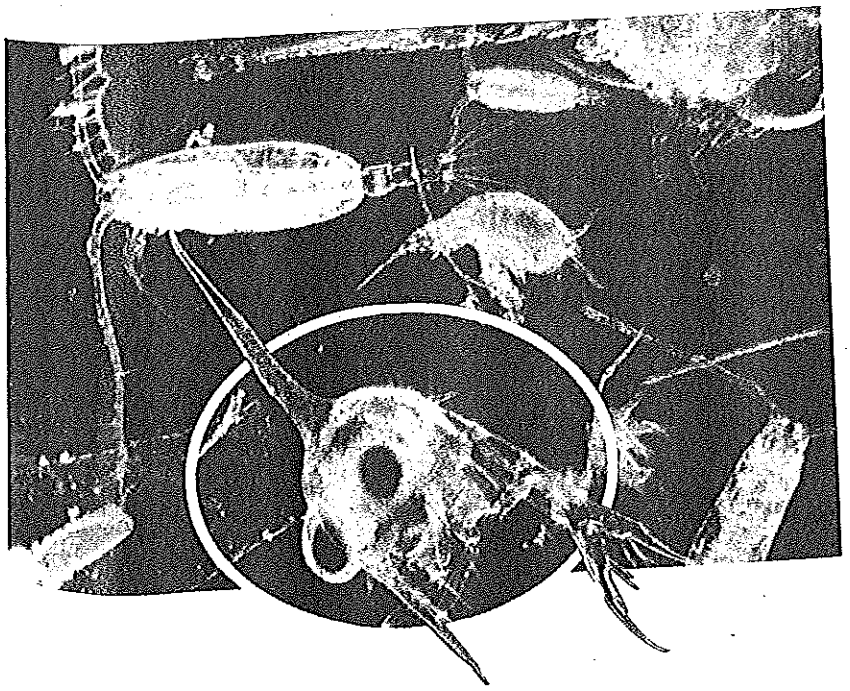
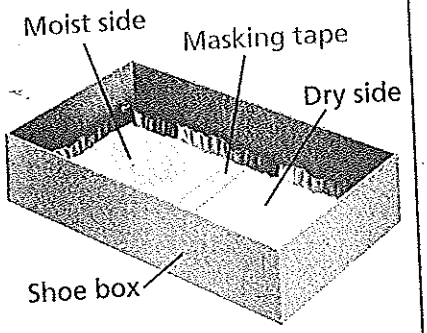


FIGURE 12
Crab Larva
This larva of a crab floats in the ocean with other microscopic animals.

Lab zone **Try This Activity**

Pill Bugs—Wet or Dry?

1. Line a box with aluminum foil. Tape down two paper towels side by side in the box. Tape a strip of masking tape between the two towels. Moisten one of the paper towels. Keep the other towel dry.



2. Put ten pill bugs on the masking tape. Then put a lid on the box.
3. After 5 minutes, lift the lid and count the pill bugs on the dry towel, the moist towel, and the masking tape. Record your results in a data table.
4. Repeat Steps 2 and 3 two more times. Then average the results of the three trials. Wash your hands after handling the pill bugs.

Interpreting Data Do pill bugs prefer a moist or a dry environment?

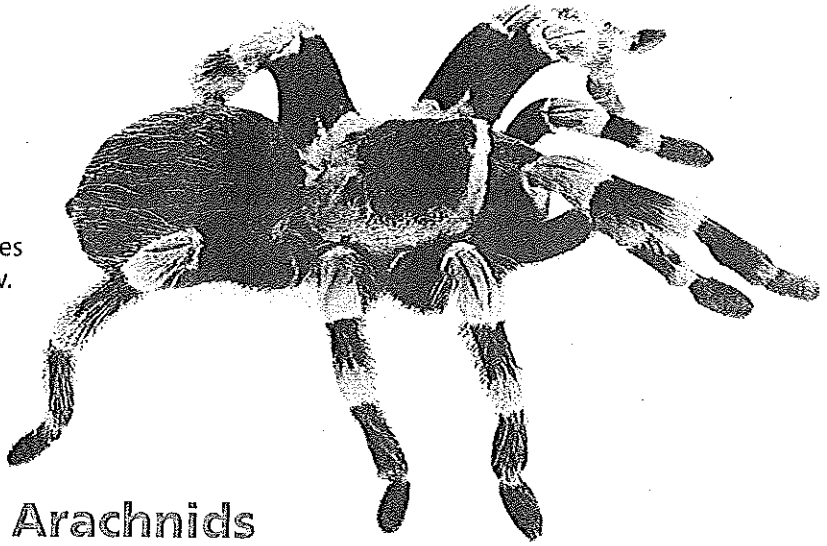


FIGURE 13
Red Knee Tarantula
This red knee tarantula lives in an underground burrow. The spider uses fangs to inject venom into its prey.

Arachnids

Spiders, mites, ticks, and scorpions are the **arachnids** (uh RAK nidz) that people most often meet. **Arachnids are arthropods with two body sections, four pairs of legs, and no antennae.** Their first body section is a combined head and midsection. The hind section, called the **abdomen,** is the other section. The abdomen contains the reproductive organs and part of the digestive system.

Spiders Spiders are probably the most familiar, most feared, and most fascinating kind of arachnid. All spiders are predators, and most of them eat insects. Some, such as tarantulas and wolf spiders, run down their prey. Others, such as golden garden spiders, spin sticky webs to trap their prey.

Spiders have hollow fangs through which they inject venom into their prey. Spider venom turns the tissues of the prey into mush. Later the spider uses its fangs like drinking straws, and sucks in the food. In spite of what some people might think, spiders rarely bite people. When spiders do bite, their bites are often painful but not life-threatening. However, the bite of a brown recluse or a black widow may require hospital care.

FIGURE 14
Dust Mite
This microscopic dust mite feeds on dead skin and hair shed by humans. Classifying *Would you describe the mite as a carnivore, scavenger, or filter feeder? Why?*

Mites If chiggers have ever given you an itchy rash, you've had an unpleasant encounter with tiny arachnids called mites. Chiggers and many other mites are parasites. Ear mites, for example, give dogs and cats itchy ears. Mites are everywhere. Even the cleanest houses have microscopic dust mites. If you are allergic to dust, you may actually be allergic to the exoskeletons of dust mites. In addition to living in dry areas, mites also live in fresh water and in the ocean.

Reading Checkpoint **What kind of arachnid is a chigger?**

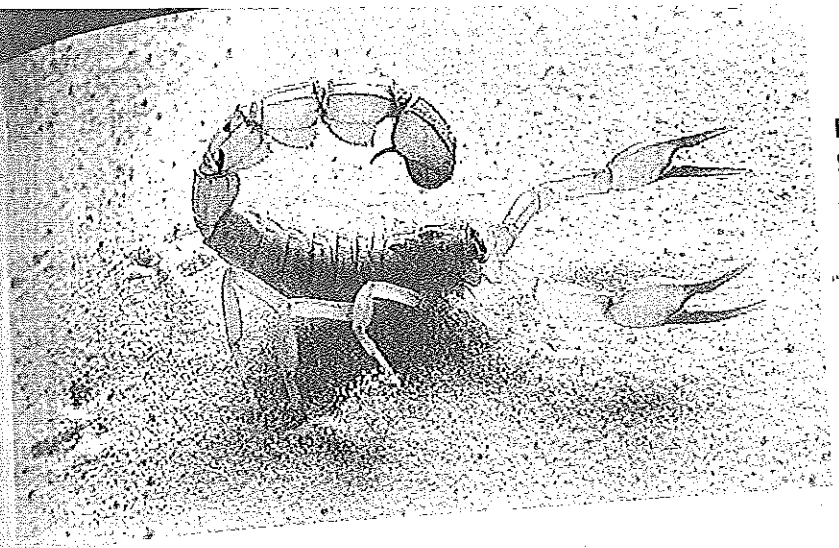
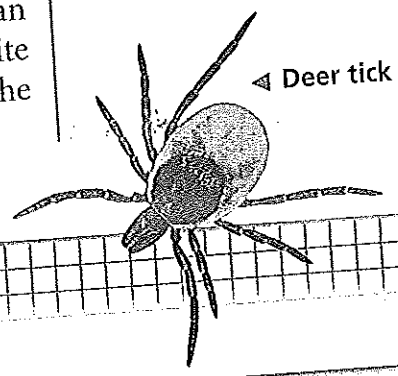


FIGURE 15
Scorpion
A scorpion is a carnivore that injects venom from a stinger at the end of its abdomen.

Scorpions Scorpions live mainly in hot climates, and are usually active at night. During the day, scorpions hide in cool places—under rocks and logs, or in holes in the ground, for example. At the end of its abdomen, a scorpion has a spinelike stinger. The scorpion uses the stinger to inject venom into its prey, which is usually a spider or an insect.

Ticks Ticks are parasites that live on the outside of a host animal's body. Nearly every kind of land animal has a species of tick that sucks its blood. Some ticks that attack humans can carry diseases. Lyme disease, for example, is spread by the bite of an infected deer tick. You can see an enlarged deer tick to the right. In reality, a deer tick is just a few millimeters long.



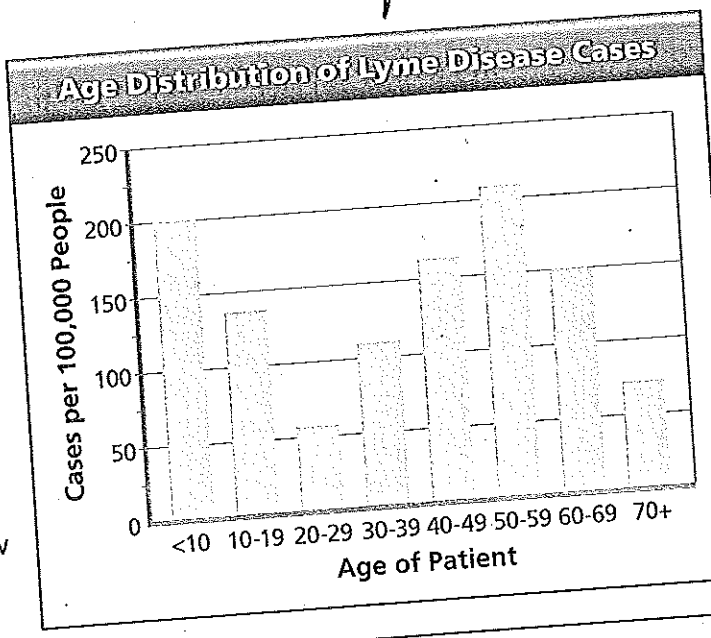
◀ Deer tick

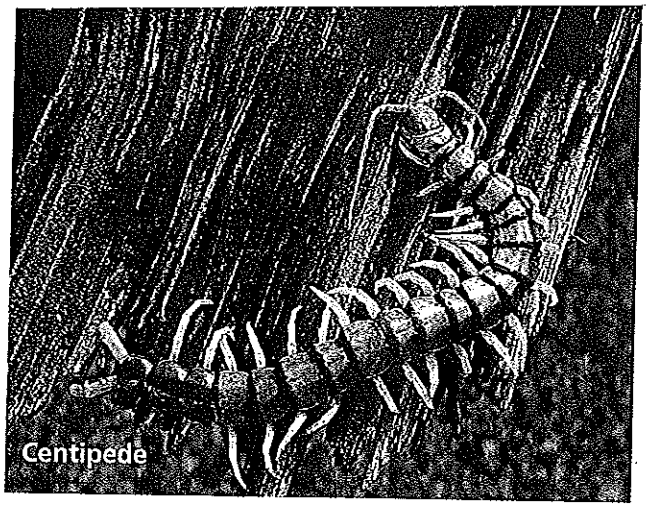
Math Analyzing Data

Lyme Disease Cases

The graph shows the numbers of cases of Lyme disease by age group reported by Connecticut during one year. Use the graph to answer the questions.

1. Reading Graphs What variable is plotted on the *y*-axis? What does the first bar tell you?
2. Interpreting Data Which age group is least at risk for Lyme disease? Explain.
3. Interpreting Data Which two age groups are most at risk?
4. Calculating Suppose a particular school in Connecticut has 1,000 students ranging in age from 10 to 19. About how many of these students would you expect to get Lyme disease per year?





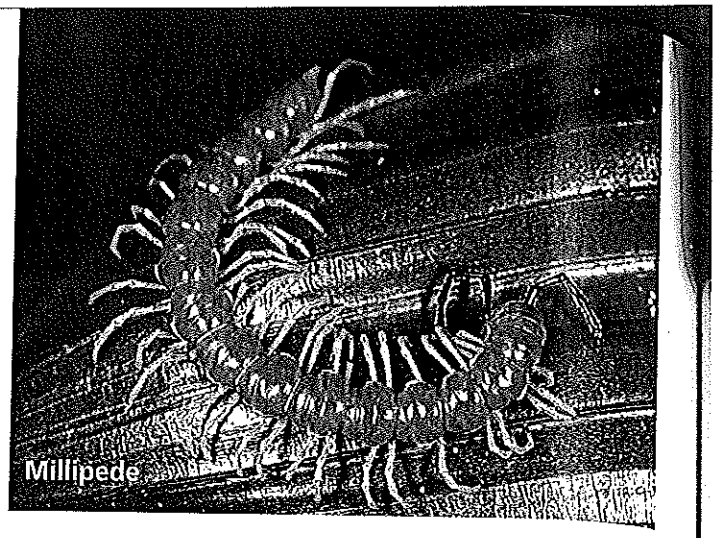


FIGURE 16
Centipede and Millipede
Both centipedes and millipedes have many pairs of legs.
Interpreting Photographs *How many pairs of legs does each segment of the centipede have?*

Centipedes and Millipedes

Centipedes and millipedes are arthropods with two body sections and many pairs of legs. The two body sections are a head with one pair of antennae, and a long abdomen with many segments. Centipedes have one pair of legs attached to each segment. Some centipedes have more than 100 segments. In fact, the word *centipede* means "hundred feet." Centipedes are swift predators that inject venom into their prey.

Millipedes, which may have more than 80 segments, have two pairs of legs on each segment—more legs than any other arthropod. Though *millipede* means "thousand feet," they don't have quite that many legs. Most millipedes are scavengers that graze on partly decayed leaves. When they are disturbed, millipedes can curl up into a ball, protected by their tough exoskeleton. Some will also squirt an awful-smelling liquid at a potential predator.

Section 2 Assessment

Vocabulary Skill **Prefixes** Explain the meaning of the key term *exoskeleton*. Include the meaning of the prefix *exo-* in your explanation.

Reviewing Key Concepts

1. a. **Naming** What are the major groups of arthropods?
   b. **Summarizing** How are all arthropods alike?
   c. **Applying Concepts** Some restaurants serve soft-shelled crab. What do you think happened to the crab just before it was caught?
2. a. **Identifying** What are the characteristics of a crustacean?
   b. **Reviewing** Describe the body structure of an arachnid.
   c. **Comparing and Contrasting** How are centipedes and millipedes alike? How are they different?

Writing in Science

Observation Write about an arthropod that you have observed. Describe details about its physical appearance, its movements, and any other behaviors that you observed.

Section 3

Insects

Reading Preview

Key Concepts

- What are the main characteristics of insects?
- What is one way insects are adapted to obtain particular types of food?
- What are two types of metamorphosis that insects undergo?

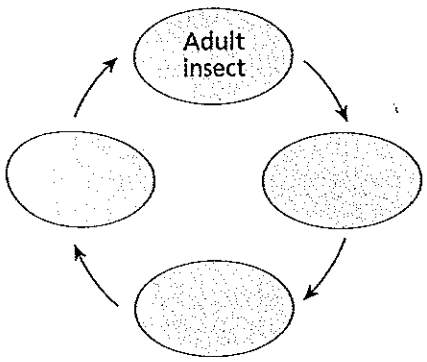
Key Terms

- insect
- thorax
- complete metamorphosis
- pupa
- gradual metamorphosis
- nymph

Target Reading Skill

Sequencing A sequence is the order in which a series of events or steps in a process occurs. As you read, make a cycle diagram that shows the steps in the complete metamorphosis of an insect. Write each step in a separate circle.

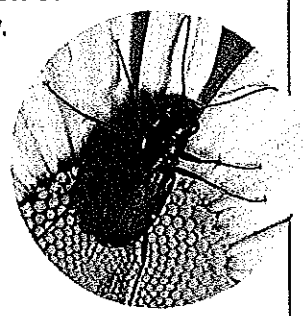
Complete Metamorphosis



Lab zone Discover Activity

What Characteristics Do Insects Share?

1. Your teacher will give you a collection of insects. Observe the insects carefully.
2. Note the physical characteristics of each insect's body covering. Count the number of body sections.
3. Count the number of legs, wings, and antennae on each insect. Then return the insects to your teacher and wash your hands.

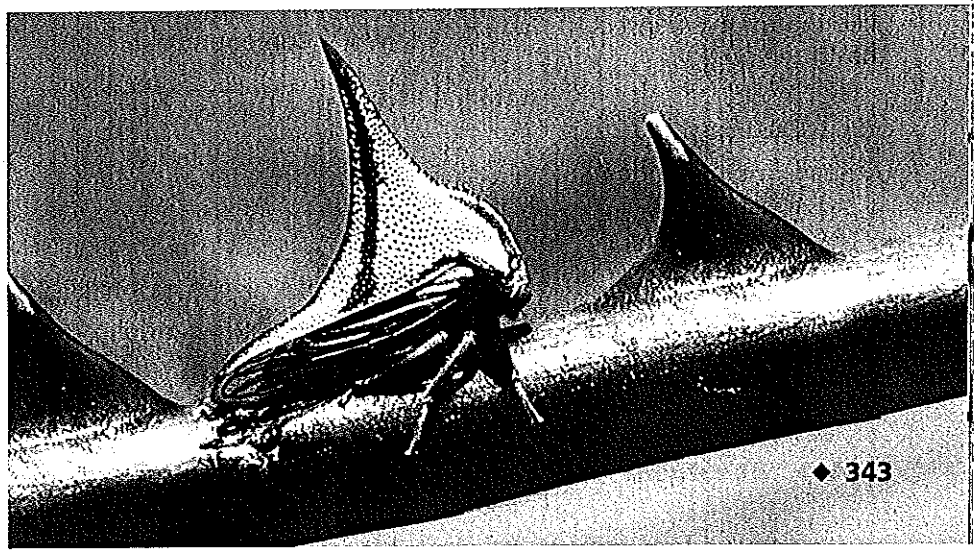


Think It Over

Inferring Compare the legs and the wings of two different species of insect. How is each insect adapted to move?

What do you do if you want to avoid being noticed? You keep perfectly quiet and you don't do anything that will attract attention. You might even wear clothes that help you to blend into the environment—a tactic called camouflage. The thorn insect is a master of camouflage. Not only does it look like a thorn, but it acts like one, too, staying quite still unless a predator like a bird comes too close. Then it springs away to safety.

Other kinds of insects have different camouflage tactics. For example, some caterpillars look like bird droppings, and others look and act like twigs. Plant hoppers may gather in clusters that look like yellow blossoms. And many kinds of moths resemble dead leaves.



Thorn insect ▶

Lab zone Skills Activity

Graphing

Use the data to make a circle graph that shows the percentage of total insect species in each group. (See the Skills Handbook.)

Insect Groups

Group	Number of Species
Ants, bees, and wasps	115,000
Beetles and weevils	350,000
Butterflies and moths	178,000
Flies and mosquitoes	110,000
Other insect groups	147,000

Body Structure

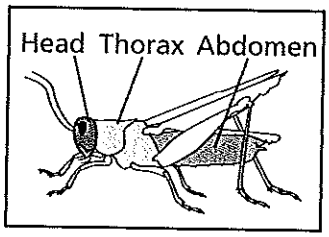
Moths are **insects,** as are caterpillers, plant hoppers, dragonflies, cockroaches, and bees. You can identify insects, like other arthropods, by counting their body sections and legs. **Insects are arthropods with three body sections, six legs, one pair of antennae, and usually one or two pairs of wings.** The three body sections are the head, thorax, and abdomen, as you can see in Figure 17.

Head Most of an insect's sense organs, such as the eyes and antennae, are located on the head. Insects usually have two large compound eyes. These eyes contain many lenses, which are structures that focus light to form images. Compound eyes are especially keen at seeing movement. Most insects also have small simple eyes that can distinguish between light and darkness.

Thorax An insect's midsection, or **thorax,** is the section to which wings and legs are attached. Most species of insects can fly once they are adults. Insects are the only invertebrates that can fly. By flying, insects can travel long distances to find mates, food, and new places to live. Being able to fly also enables insects to escape from many predators.

Abdomen Inside the abdomen are many of the insect's internal organs. Small holes on the outside of the abdomen lead to a system of tubes inside the insect. These tubes allow air, which contains oxygen, to enter the body. The oxygen in the air travels directly to the insect's cells.

Reading Checkpoint **What are the three sections of an insect's body?**



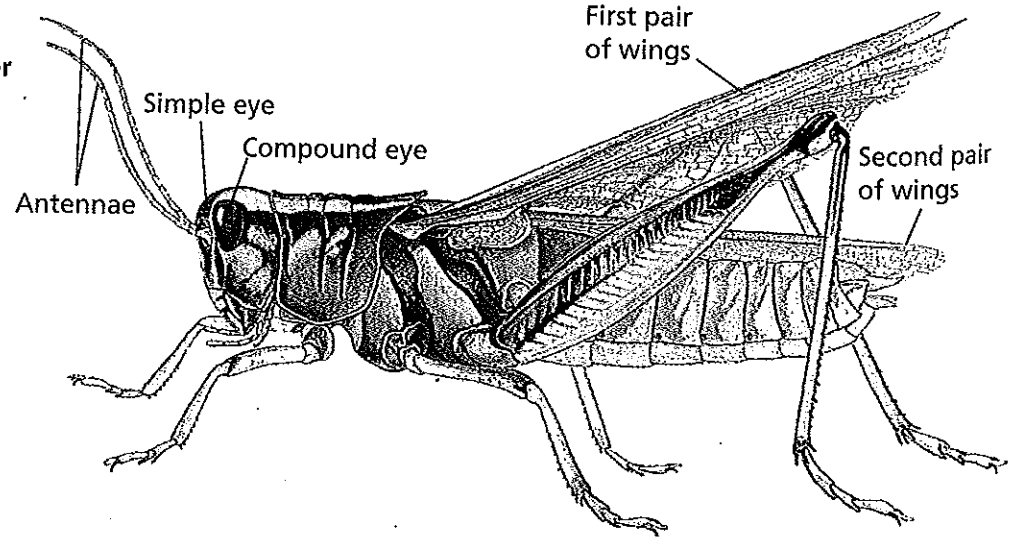


FIGURE 17
Structure of a Grasshopper
A grasshopper's body, like that of every insect, has three sections.

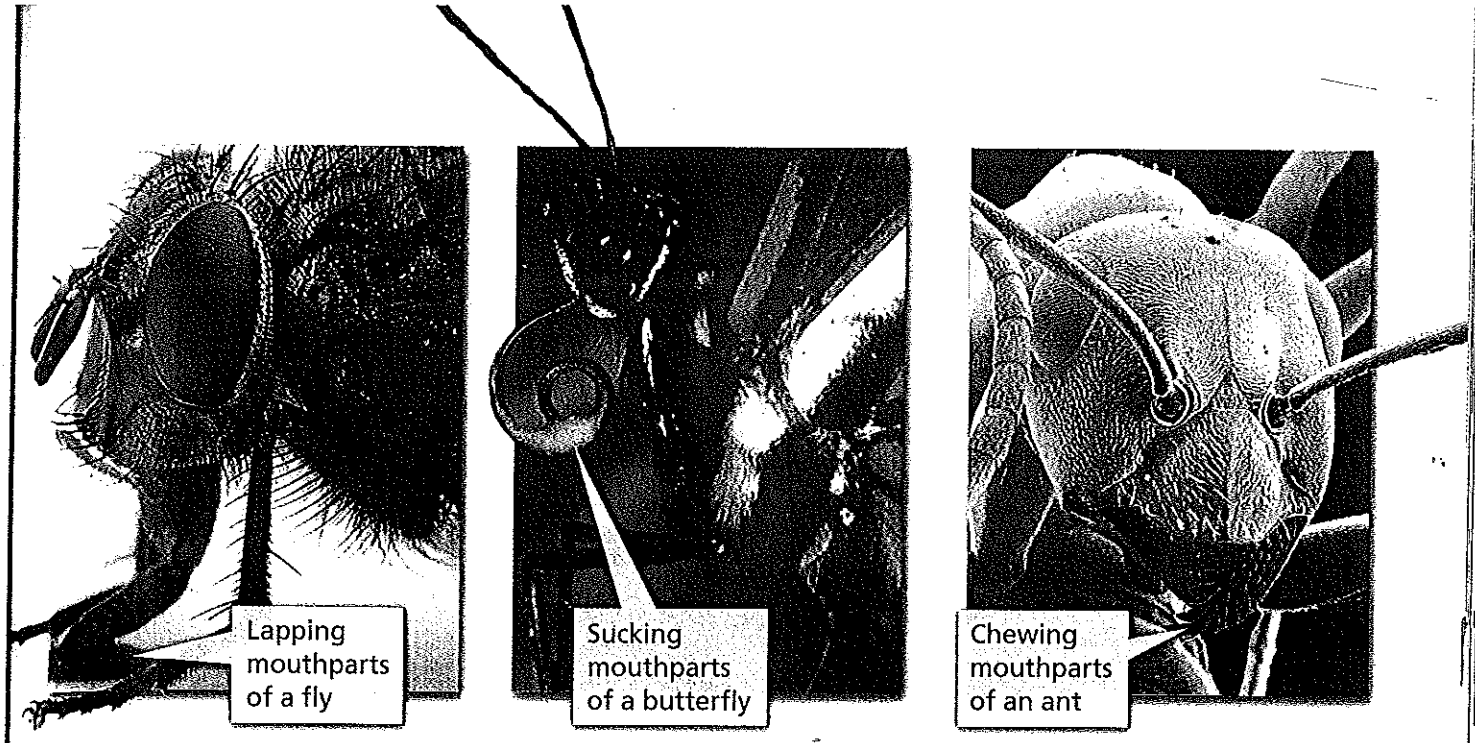


FIGURE 18
Diversity of Mouthparts
The mouthparts of this fly, butterfly, and wood ant are very different in their structure.
Inferring *Could a butterfly eat an ant's food? Explain.*

Obtaining Food

The rule seems to be this: If it is living, or if it once was living, some kind of insect will eat it. You probably know that many insects eat parts of plants, such as leaves or nectar. But insects also eat products that are made from plants, such as paper. If you open a very old book, watch for book lice. These tiny insects live in old books, chewing crooked tunnels through the pages.

Insects may feed on animals, too. Some, like fleas and mosquitoes, feed on the blood of living animals. Others, like dung beetles, feed on animal droppings. Still others, like burying beetles, feed on the decaying bodies of dead animals.

An insect's mouthparts are adapted for a highly specific way of getting food. You can see some of these adaptations in Figure 18. Some flies have a sponge-like mouthpart that they use to lap up decaying flesh. A butterfly's mouthparts are shaped like a coiled tube, which can be uncoiled and used like a drinking straw to suck up nectar from flowers. Most ants have sharp-edged mouthparts that can cut through seeds, wood, and other foods.

Reading Checkpoint **How does a butterfly obtain food?**

Life Cycle

Insects begin life as tiny, hard-shelled, fertilized eggs. After they hatch, insects begin a process of metamorphosis that eventually produces an adult insect. **Each insect species undergoes either complete metamorphosis or gradual metamorphosis.**

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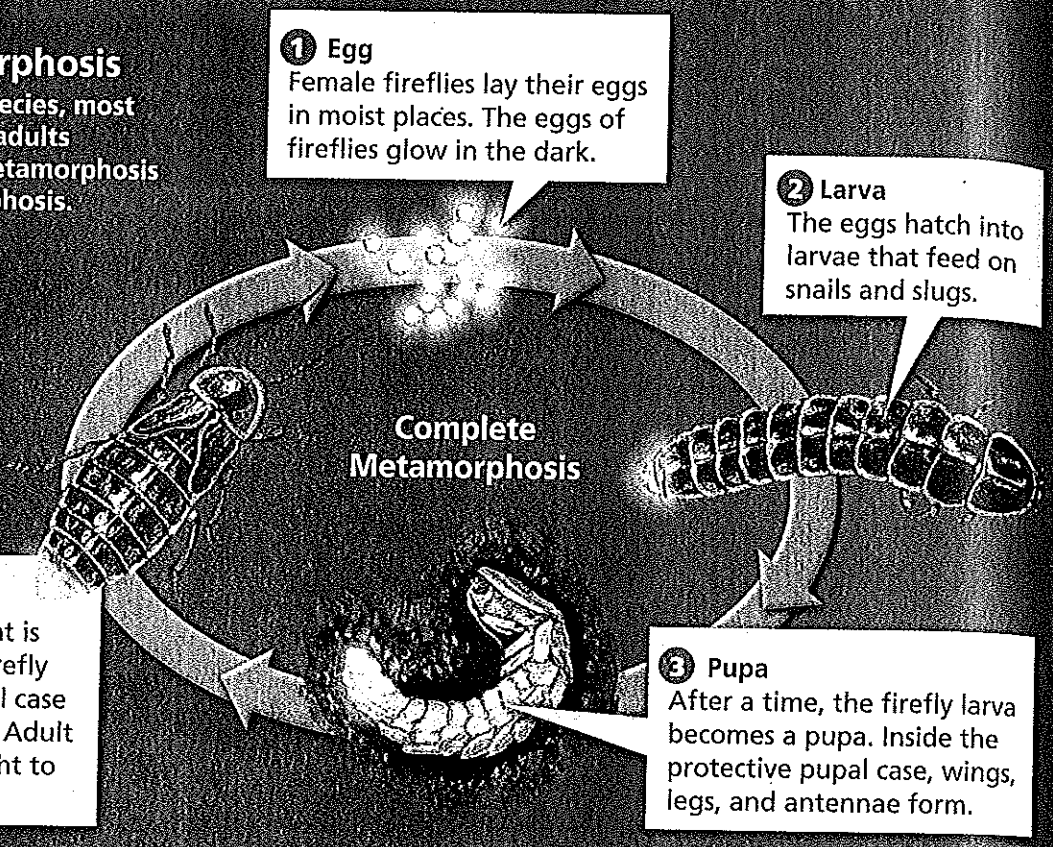
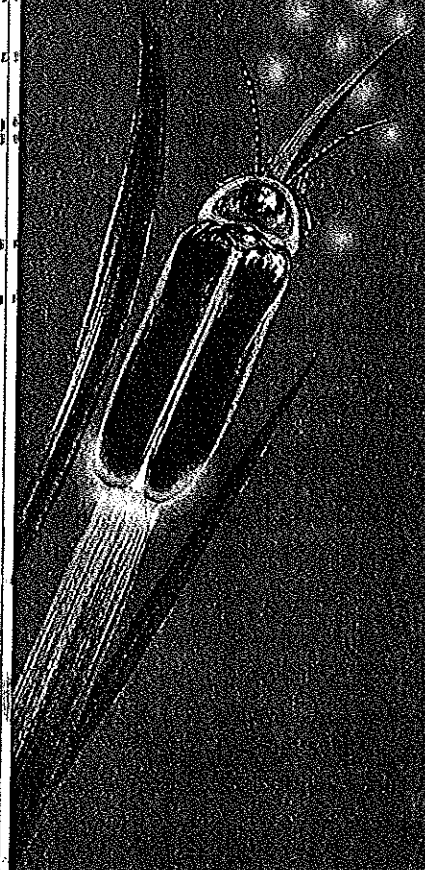
FIGURE 19

Insect Metamorphosis

Depending on the species, most insects develop into adults through complete metamorphosis or gradual metamorphosis.



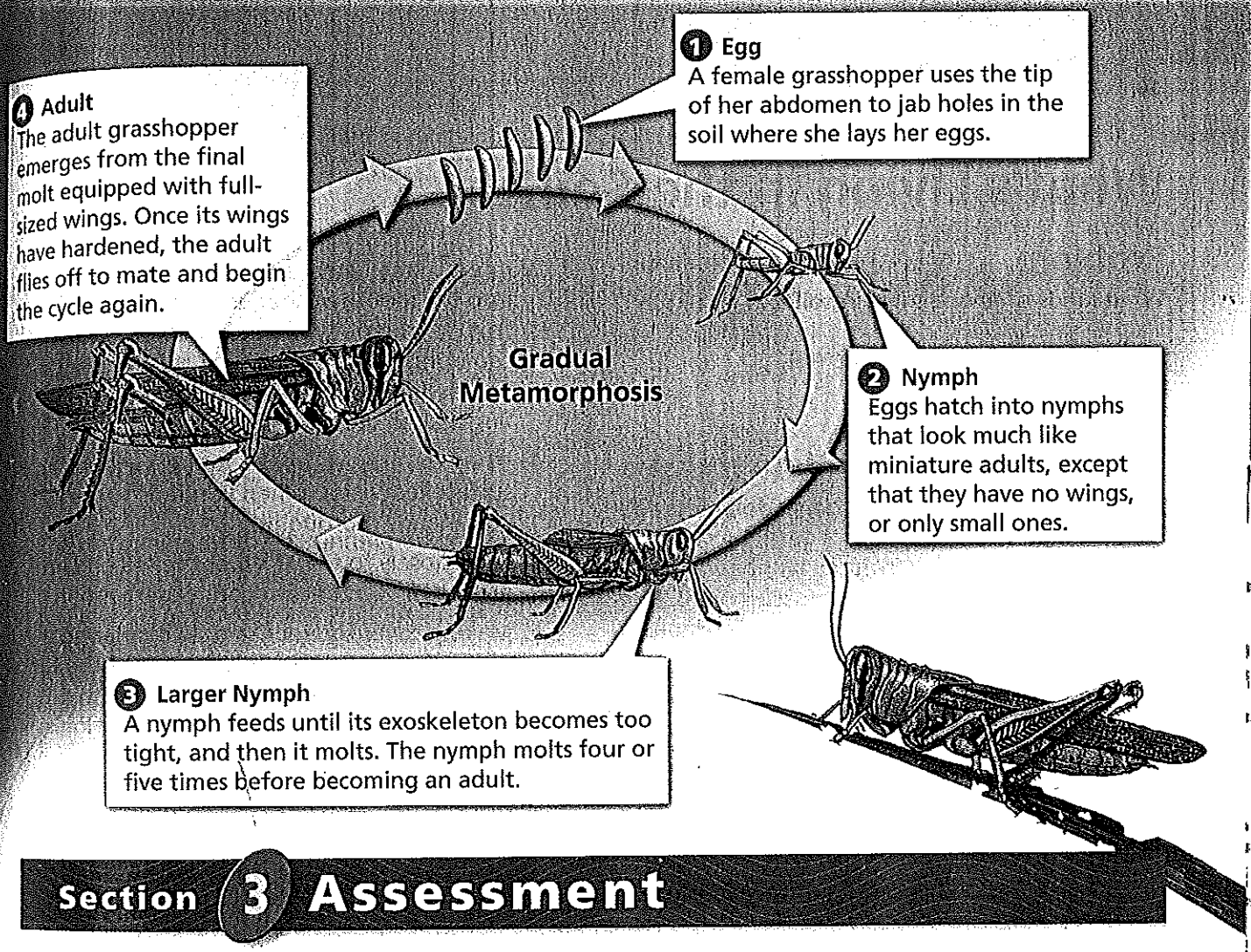


Complete Metamorphosis In Figure 19 you can see that an insect with **complete metamorphosis** has four different stages: egg, larva, pupa, and adult. Eggs hatch into larvae. The larvae, such as the caterpillars of butterflies and the grubs of beetles, usually look something like worms. Larvae are specialized for eating and growing. After a time, a larva enters the next stage of the process and becomes a **pupa** (PYOO puh). As a pupa, the insect is enclosed in a protective covering.

Although the pupa does not eat and moves very little, it is not resting. Major changes in body structure are taking place in this stage, as the pupa becomes an adult insect. Beetles, butterflies, flies, and ants all undergo complete metamorphosis.

Gradual Metamorphosis In contrast, the second type of metamorphosis, called **gradual metamorphosis**, has no distinct larval stage. An egg hatches into a stage called a **nymph** (nimf), which usually looks like the adult insect without wings. A nymph may molt several times before becoming an adult. Grasshoppers, termites, cockroaches, and dragonflies go through gradual metamorphosis.

Reading Checkpoint **What is gradual metamorphosis?**



Section 3 Assessment

Target Reading Skill **Sequencing** Refer to your cycle diagram about complete metamorphosis as you answer Question 3.

Reviewing Key Concepts

1. a. **Identifying** What characteristics do insects share?
   b. **Interpreting Diagrams** Look at Figure 17. To which body section are a grasshopper's wings attached?
   c. **Making Generalizations** Suppose the adaptation of wings was suddenly lost in all insects. Predict what would happen to the number and diversity of insects.
2. a. **Naming** Name a type of insect that has chewing mouthparts.
   b. **Reviewing** What are three ways that the mouthparts of insects are adapted for obtaining food?
3. a. **Listing** List the stages of gradual metamorphosis and the stages of complete metamorphosis.
   b. **Interpreting Diagrams** Look at Figure 19. How are complete metamorphosis and gradual metamorphosis different?
   c. **Applying Concepts** Why is a nymph more likely than a larva to eat the same food as its parents?

Lab zone At-Home Activity

Bug Hunt Walk with a family member in your backyard or neighborhood. Search the undersides of leaves, under woodchips or rocks, and other likely places for insects. Show your family member what distinguishes an insect from other kinds of arthropods.

Section 4

Integrating Environmental Science

Insect Ecology

Reading Preview

Key Concepts

- Why are insects important in food chains?
- What are two other ways insects interact with their environments?
- What are some ways used to control insect pests?

Key Terms

- food chain
- ecology
- producer
- consumer
- decomposer
- pollinator
- pesticide
- biological control

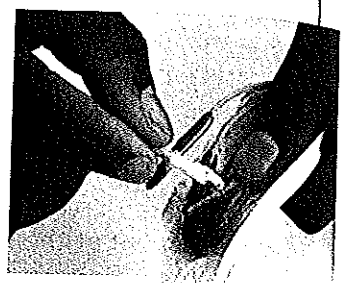
Target Reading Skill

Building Vocabulary Using a word in a sentence helps you think about how best to explain the word. After you read the section, reread the paragraphs that contain definitions of key terms. Use all the information you have learned to write a meaningful sentence using the key term.

Lab zone **Discover Activity**

What Materials Carry Pollen Best?

1. Use an eraser to transfer some pollen between two flowers your teacher gives you.
2. Next, use a cotton swab to do the same. Did the eraser or cotton swab transfer pollen better?



Think It Over

Inferring How might its ability to transfer pollen between flowers affect an insect's role in the environment?

In a meadow, a caterpillar munches the leaves of a plant. Later that day, a bird eats the caterpillar. Years later, after the bird has died, a beetle eats the dead bird. The plant, caterpillar, bird, and beetle are all part of one food chain. A **food chain** is a series of events in which one organism eats another and obtains energy. The study of food chains and other ways that organisms interact with their environment is called **ecology.**

Insects and the Food Chain

A food chain starts with a **producer**—an organism that makes its own food. Most producers, such as grass and other plants, use energy from sunlight to make their food. In a food chain, producers are food for consumers. A **consumer** is an organism that obtains energy by eating other organisms. Some consumers, like caterpillars, eat producers, and some eat other consumers. Decomposers, such as carrion beetles, also play a role in food chains. A **decomposer** breaks down the wastes and dead bodies of other organisms. In a food chain insects may play the roles of consumer and decomposer. In addition, some insects are prey for other consumers.

Insects as Consumers of Plants The roles of insects in a food chain are shown in Figure 20. **Insects play key roles in food chains because of the many different ways that they obtain food and then become food for other animals.**

Many insects are consumers of plants. Perhaps you have tried growing tomato plants and seen how fat green caterpillars ate up the leaves. In fact, insects eat about 20 percent of the crops grown for humans. Insects eat most species of wild plants, too. Some insects eat the leaves of plants, while others eat the sap, bark, roots, and other parts of plants.

Insects as Prey Insects play another role in food chains—they are prey for many animals. That is, other consumers eat insects. Many fishes and birds eat insects to survive. For example, the main source of food for trout and bass is insects. Indeed, that's why people use lures called "flies" to catch fishes like these. The lures look like the mayflies and stoneflies these fishes normally eat. Some species of birds feed their young, called chicks, only insects. And the chicks are big eaters! A single swallow chick, for example, may consume about 200,000 insects before it leaves the nest.

Math Skills

Percentage

A percentage is a ratio that compares a number to 100. If 25 percent of 900,000 insect species eat other insects, how many insect-eating species are there? Set up a proportion and solve it.

$$\frac{\text{Insect-eating species}}{\text{900,000 insect species}} = \frac{25\%}{100\%}$$

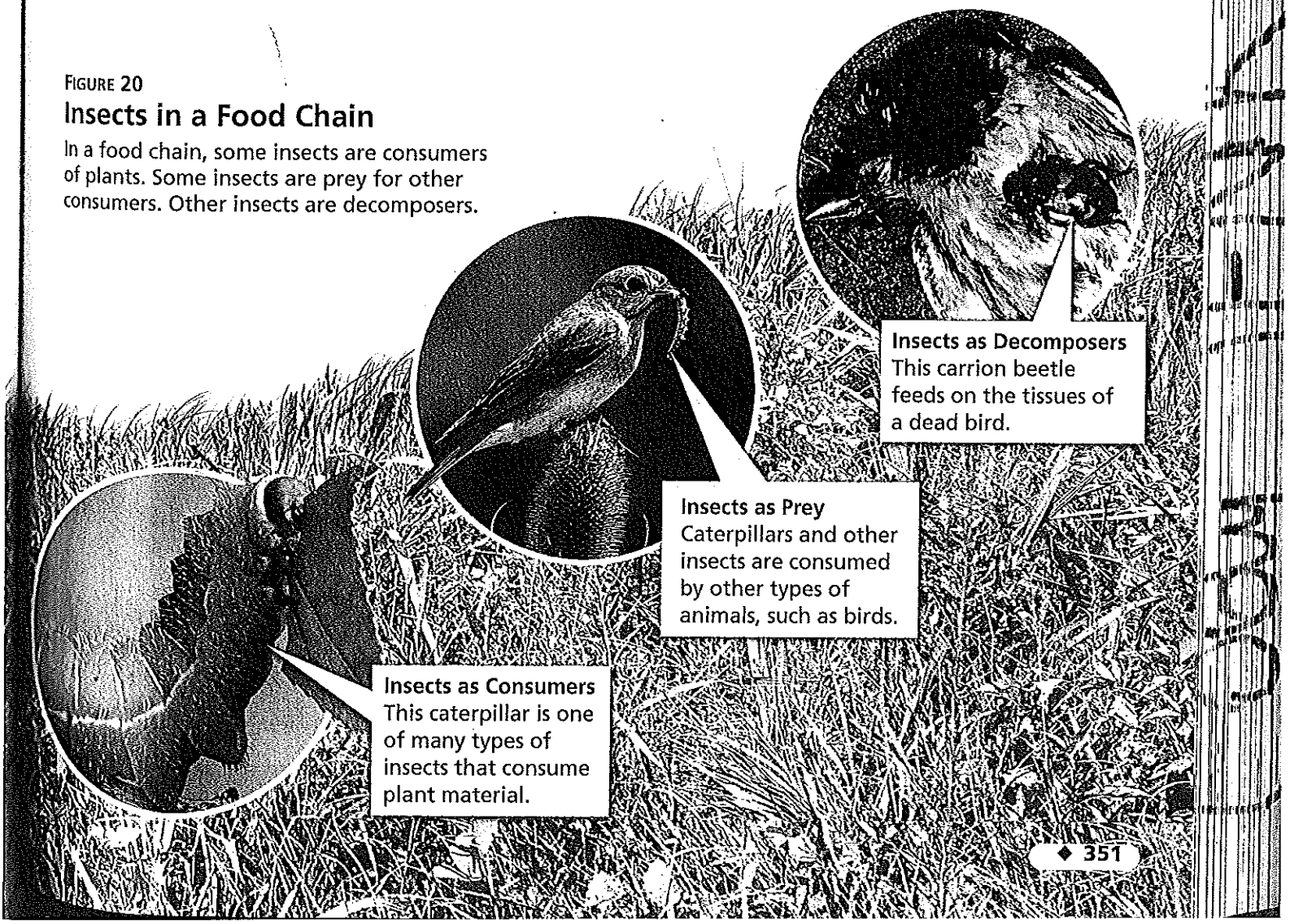
$$\text{Insect-eating species} = 225{,}000$$

Practice Problem A swallow chick eats 200,000 insects. If 12 percent of the insects are beetles, how many beetles does it eat?

FIGURE 20

Insects in a Food Chain

In a food chain, some insects are consumers of plants. Some insects are prey for other consumers. Other insects are decomposers.



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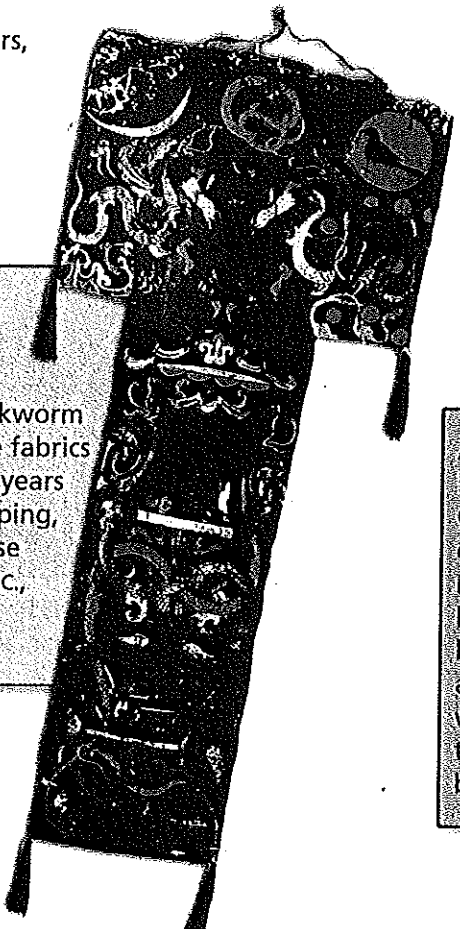
Insects as Decomposers In a food chain some insects play the role of decomposers by breaking down the wastes and bodies of dead organisms. For example, in some tropical food chains, termites may break down up to one third of the dead wood, leaves, and grass produced there every year. In other food chains, flies and dung beetles break down animal droppings, called manure. By doing this, the buildup of manure from large animals is prevented.

The substances that insect decomposers break down enrich the soil. In addition, insect decomposers may burrow and nest in the ground. By doing so, these insects expose soil to oxygen from the air and mix up the nutrients in the soil.

• Tech & Design in History •

Products From Insects

Over the last few thousand years, insects have supplied humans with some important products.



100 B.C.
Silk Draping
Humans first spun silk from silkworm cocoons into fine fabrics more than 4,000 years ago. This silk draping, found in a Chinese tomb from 100 B.C., depicts scenes of the netherworld.

A.D. 1200
Medieval Bee Hives
Collecting honey to eat and wax for candles and other products became much easier when humans began keeping bees. At first, humans made hives from mud or clay. In the middle ages, bees were kept in inverted woven baskets, called skeps, like those shown above. Today, honeybees are kept in wooden boxes.

100 B.C. | A.D. 1000 | 1250

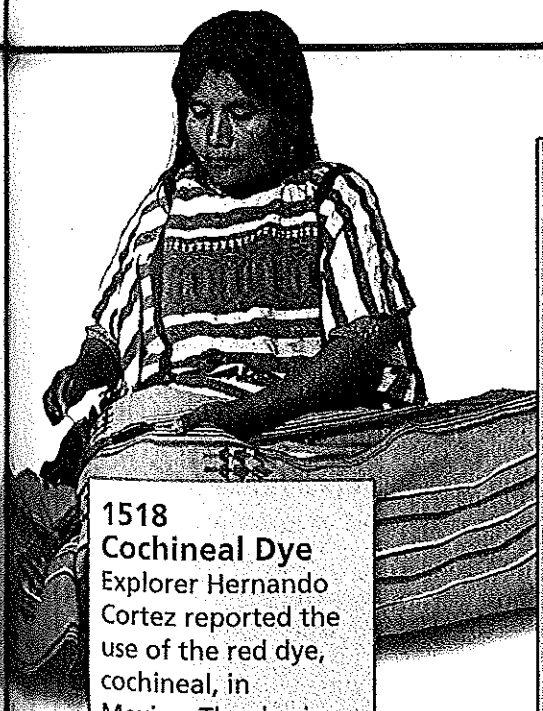
Insects as Food for Humans Did you know that insects were an important source of nutrition for prehistoric humans? Even today, insects are collected and eaten by people in many parts of the world. In some Mexican villages, dried grasshoppers are ground up and mixed with flour to make tortillas. In other parts of the world, the larvae of certain species of beetles are roasted over an open fire. Ants, crickets, and cicadas are just a few of the other types of insects eaten by humans.

Maybe you are thinking, "Yuck! I'd never eat an insect." Even if you'd never allow an insect on your dinner plate, you are likely to have used the products of insects in other aspects of your daily life. You can see some of the major uses of insect products through history in the timeline below.

Reading Checkpoint **What is an animal that breaks down wastes and dead organisms called?**

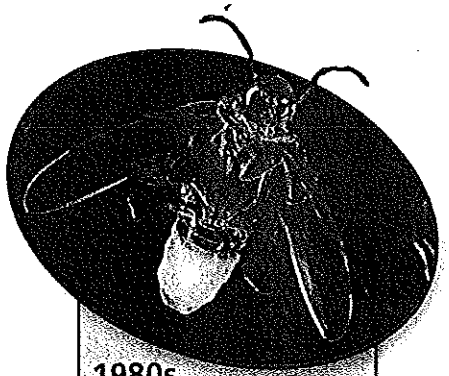
Writing in Science

Research and Write
Research one of the products described in the timeline below. Then write an advertisement for the product. Include information about the species of insect used to develop the product, and details about how the product is made.



1518
Cochineal Dye
Explorer Hernando Cortez reported the use of the red dye, cochineal, in Mexico. The dye is extracted from a tiny cactus-eating insect called the cochineal scale. Today, humans use the dye to color some textiles, foods, and cosmetics.

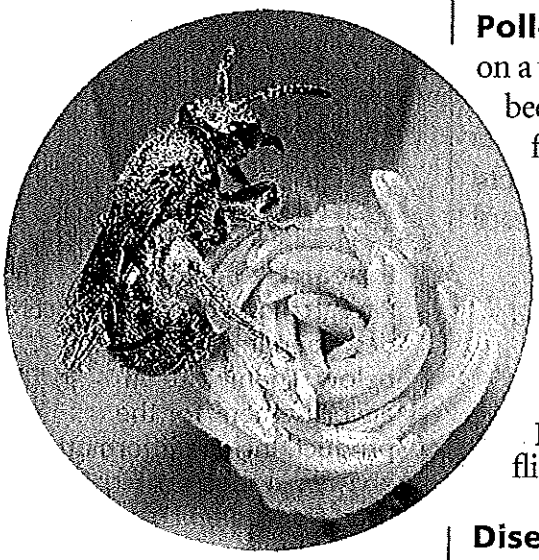
1920s
Shellac Records
Humans make shellac from a waxy substance secreted by the lac scale insect. Shellac has been used to seal furniture, polish floors, and coat records. Shellac was especially important to the record industry in the 1920s and 1930s (until synthetic vinyl came along in the 1940s).



1980s
Firefly Light
Since the 1980s, scientists have used the light-producing chemicals from fireflies in many applications, including the study of genes and diseases.

1500 — 1750 — 2000

FIGURE 21
A Bee as a Pollinator
This bee is getting dusted with yellow pollen as it drinks nectar from the flower. Observing *On which of the bee's structures can you observe pollen grains?*



Other Interactions

Besides eating and being eaten, insects interact in other ways with the living things in their environments. **Two ways insects interact with other living things are by moving pollen among plants and by spreading disease-causing organisms.**

Pollen Carriers Have you ever seen a bee crawling into a flower on a warm summer day? Have you wondered what it is doing? The bee is helping itself to the plant's nectar and pollen, which are food for bees. But plants also need to share their pollen with other plants. Pollen contains cells that become sperm cells, allowing plants to reproduce. When the bee crawls into a flower to obtain its food, it gets dusted with pollen, as shown in Figure 21. Then, as the bee enters the next flower, some of the pollen on its body is left in the second flower. An animal that carries pollen among plants is called a **pollinator.** Bees are pollinators, and so are many beetles and flies. Without pollinators, some plants cannot reproduce.

Disease Carriers Not all interactions between insects and other living things have happy endings. While some insects transfer pollen, others spread diseases to both plants and animals, including humans. Insects that spread diseases include some mosquitoes and fleas. These insects often have sucking mouthparts that pierce the skin of their prey, providing an opening for the disease-causing organisms to enter. Diseases that are carried by insects include malaria, which is spread by mosquitoes. Malaria causes high fevers and can be treated with medicines today.

Reading Checkpoint **What is a pollinator?**

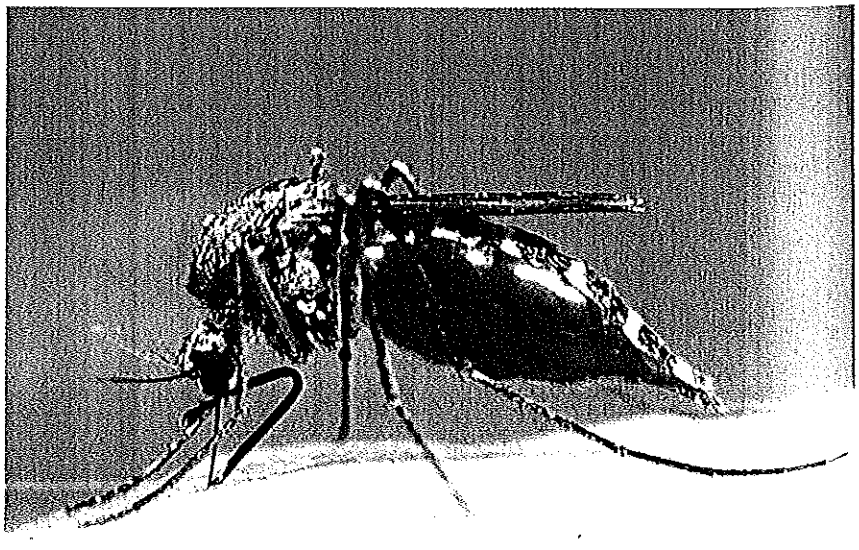


FIGURE 22
Disease-Causing Mosquito
A mosquito like the one shown here can spread disease-causing organisms such as malaria among humans.

Controlling Pests

Some insects are harmful, even though they don't spread diseases. Harmful insects are called pests. **To try to control pests, people use chemicals, traps, and living things, including other insects.** Chemicals that kill pests are called **pesticides.** However, pesticides also kill pollinators, such as bees, and can harm other animals.

What are the alternatives to pesticides? Biologists are using their knowledge of insect ecology to develop new pest controls. One such control is a trap that attracts mosquitoes in a way similar to how humans attract mosquitoes. Another control is to surround crops with wild plants that are bad-tasting or even poisonous to the harmful insect.

People may prefer to use biological controls. A **biological control** is a natural predator or disease released into an area to fight a harmful insect. For example, ladybugs, which eat other insects, have been introduced to some areas where crops grow to control aphids. Aphids are tiny insects that damage plants by sucking plant sap.

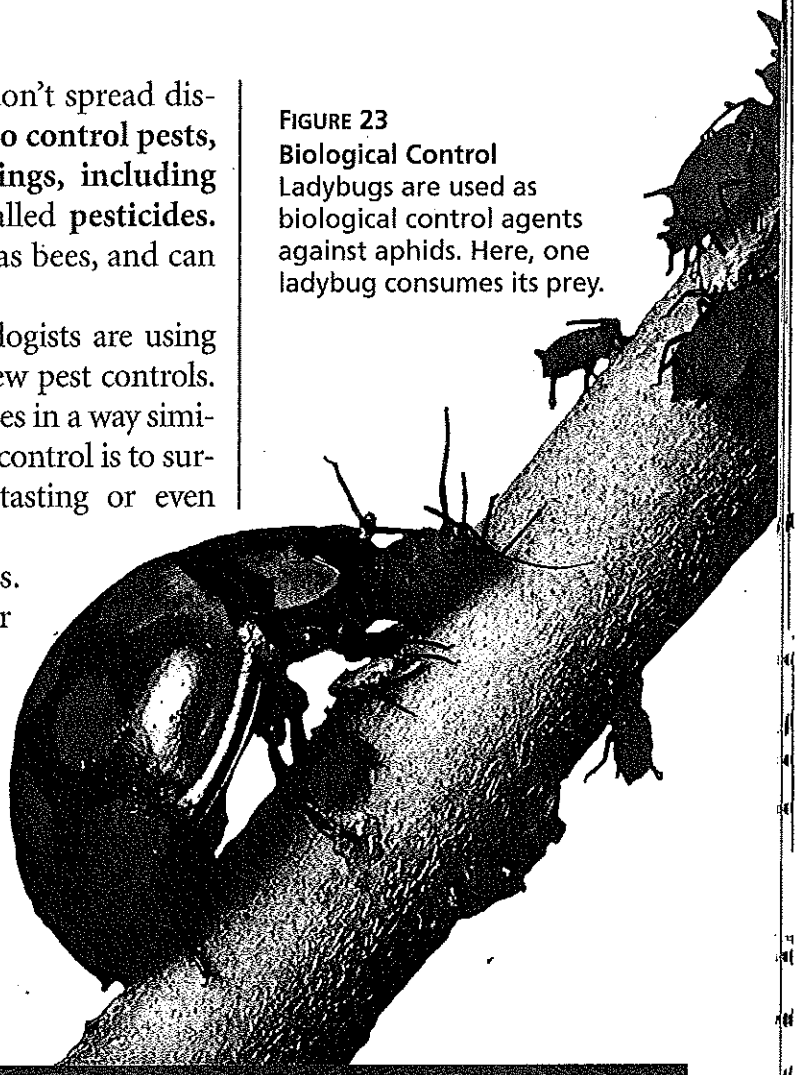


FIGURE 23
Biological Control
Ladybugs are used as biological control agents against aphids. Here, one ladybug consumes its prey.

Reading Checkpoint **What is a chemical intended to kill pest insects called?**

Section 4 Assessment

Target Reading Skill Building Vocabulary
Use your sentences to help answer the questions.

Reviewing Key Concepts

1. a. Defining What is a food chain?
   b. Interpreting Photographs What three roles do insects play in the food chain shown in Figure 20?
2. a. Reviewing Besides their role in food chains, what are two other ways insects interact with their environment?
   b. Summarizing What effect do pollinators have on their environment?
   c. Predicting What would a world without pollinators be like?
3. a. Reviewing How can insect pests be controlled?
   b. Comparing and Contrasting How are the effects of using biological controls similar to the effects of using pesticides? How are they different?
   c. Applying Concepts Some insect species are harmful only in areas of the world where they do not normally live but have been accidentally released. Why might this be?

Math Practice

4. Percentage Suppose 33 percent of the 50 tons of wood produced in one year by a forest is consumed by termites and other insects. How many tons do the insects eat?

Battling Pest Insects

It's hard to believe that insects can cause much harm. But some species, such as the cotton boll weevil, can devastate crops. Boll weevils eat cotton bolls, the part of the plant that produces cotton fibers. Other insects, such as some mosquitoes, spread diseases. To control insect pests, people often use pesticides—chemicals or substances that kill insects or alter their life processes.

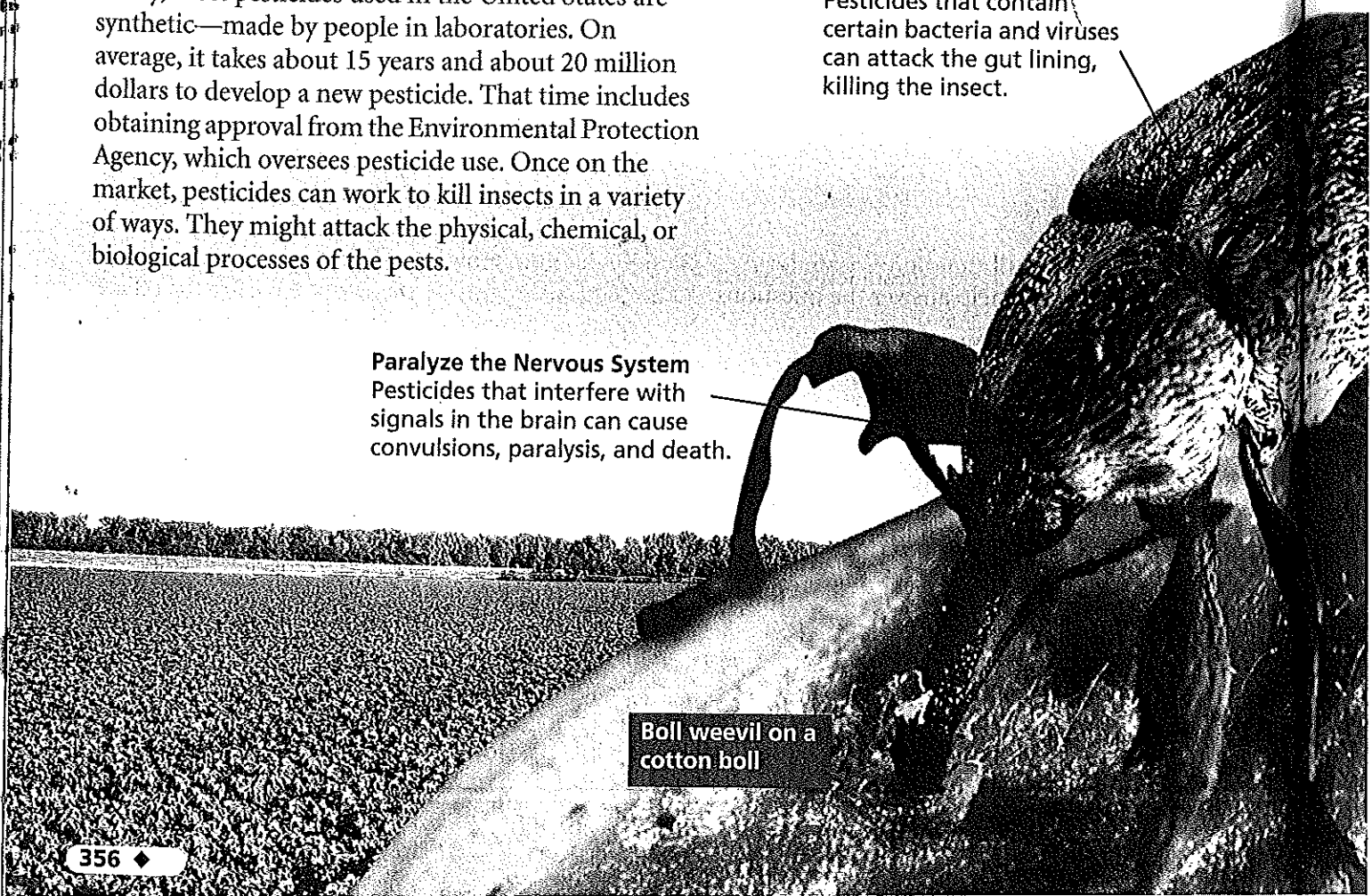
What Are Pesticides?

Since ancient times, people have used substances such as sulfur to kill pests. In the 1900s, people began developing new chemicals to battle harmful insects. Today, most pesticides used in the United States are synthetic—made by people in laboratories. On average, it takes about 15 years and about 20 million dollars to develop a new pesticide. That time includes obtaining approval from the Environmental Protection Agency, which oversees pesticide use. Once on the market, pesticides can work to kill insects in a variety of ways. They might attack the physical, chemical, or biological processes of the pests.

How Pesticides Work
Pesticides kill insects in a variety of ways. People may select one or more pesticides to attack a particular pest.

Attack the Gut
Pesticides that contain certain bacteria and viruses can attack the gut lining, killing the insect.

Paralyze the Nervous System
Pesticides that interfere with signals in the brain can cause convulsions, paralysis, and death.



Boll weevil on a cotton boll

Problems With Pesticides

Using pesticides has increased food production worldwide. However, the technology of pesticides has drawbacks. Pesticides that kill harmful insects can also kill helpful insects, such as bees. In large doses, these chemicals are also toxic to humans and pets. Even low levels of chemicals can build up and affect animals in the food chain. Rain can carry pesticides into rivers and lakes and pollute water supplies. The best pesticides target only pests and do not stay in the environment for a long time.

Applying the Pesticide
One way to apply pesticides is by using an airplane to spray crops.

Destroy the Exoskeleton
Pesticides can cause the exoskeleton to become so thin that the insect dies while molting. Pesticides can also absorb the waxy coating, leading to water loss and death.

Disrupt the Life Cycle
Certain pesticides prevent larvae from maturing into adults.

Interfere With Reproduction
Pesticides that are oils can smother and kill insect eggs. Other pesticides sterilize adult insects.

Weigh the Impact

1. Identify the Need
Why do people use pesticides?

2. Research
Using the Internet, research different insects affecting major crops in your state. Choose one pest insect. Find out the methods used in controlling it. Are there alternatives to pesticides?

3. Write
Write a proposal to your governor for insect control in your state. Use your research and notes to explain how your method works.

Go Online
PHSchool.com

For: More on pesticides
Visit: PHSchool.com
Web Code: ceh-2020

Section 5

Echinoderms

Reading Preview

Key Concepts

- What are the main characteristics of echinoderms?
- What are the major groups of echinoderms?

Key Terms

- echinoderm
- endoskeleton
- water vascular system
- tube feet

Target Reading Skill

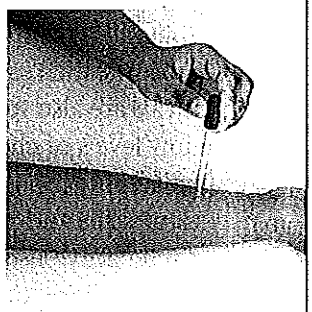
Previewing Visuals When you preview, you look ahead at the material to be read. Preview Figure 24. Then write two questions that you have about the diagram in a graphic organizer like the one below. As you read, answer your questions.

Water Vascular System

Q. What are tube feet?
A.
Q.

Lab zone Discover Activity

How Do Sea Stars Hold On?



1. Use a plastic dropper and water to model how a sea star moves and clings to surfaces. Fill the dropper with water, and then squeeze out most of the water.
2. Squeeze the last drop of water onto the inside of your arm. Then, while squeezing the bulb, touch the tip of the dropper into the water drop. With the dropper tip against your skin, release the bulb.
3. Hold the dropper by the tube and lift it slowly, paying attention to what happens to your skin.

Think It Over

Predicting Besides moving and clinging to surfaces, what might sea stars use their suction structures for?

While exploring a rocky beach one day, you see what looks like a dill pickle at the bottom of a tide pool. You think it might be a plant or a rock covered with green slime. But as you look more closely, the pickle begins to crawl very slowly. This amazing creature is a sea cucumber, a relative of sea stars.

Characteristics of Echinoderms

Sea cucumbers, sea stars, sea urchins, and sand dollars are all **echinoderms** (ee KY noh durmz), members of the phylum Echinodermata. **Echinoderms are invertebrates with an internal skeleton and a system of fluid-filled tubes called a water vascular system.** All echinoderms live in salt water.

Body Structure The skin of most echinoderms is stretched over an internal skeleton, or **endoskeleton,** made of hardened plates. These plates give the animal a bumpy texture. Adult echinoderms have a unique kind of radial symmetry in which the body parts, usually in multiples of five, are arranged like spokes on a wheel.

Movement The internal system of fluid-filled tubes in echinoderms is called the **water vascular system.** You can see a sea star's water vascular system in Figure 24. Portions of the tubes in this system can contract, or squeeze together, forcing water into structures called **tube feet.** This process is something like how you move water around in a water balloon by squeezing different parts of the balloon.

The tube feet stick out from the echinoderm's sides or underside. The ends of tube feet are sticky. When filled with water, they act like small, sticky suction cups. The stickiness and suction enable the tube feet to grip the surface beneath the echinoderm. Most echinoderms use their tube feet to move along slowly and to capture food.

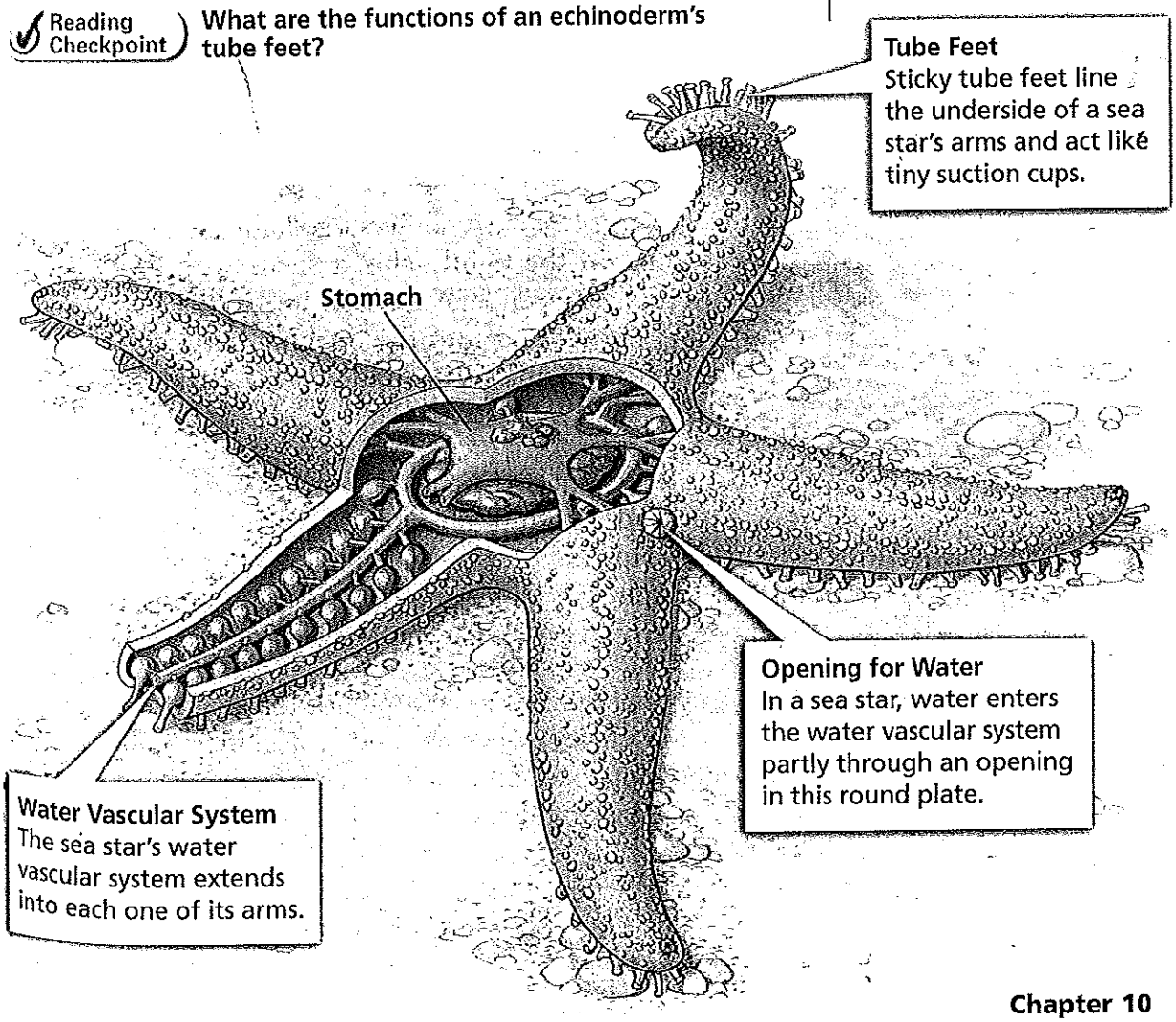
Reproduction and Life Cycle Almost all echinoderms are either male or female. Eggs are usually fertilized in the water, after a female releases her eggs and a male releases his sperm. The fertilized eggs develop into tiny, swimming larvae that look very different from the adults. The larvae eventually undergo metamorphosis and become adult echinoderms.

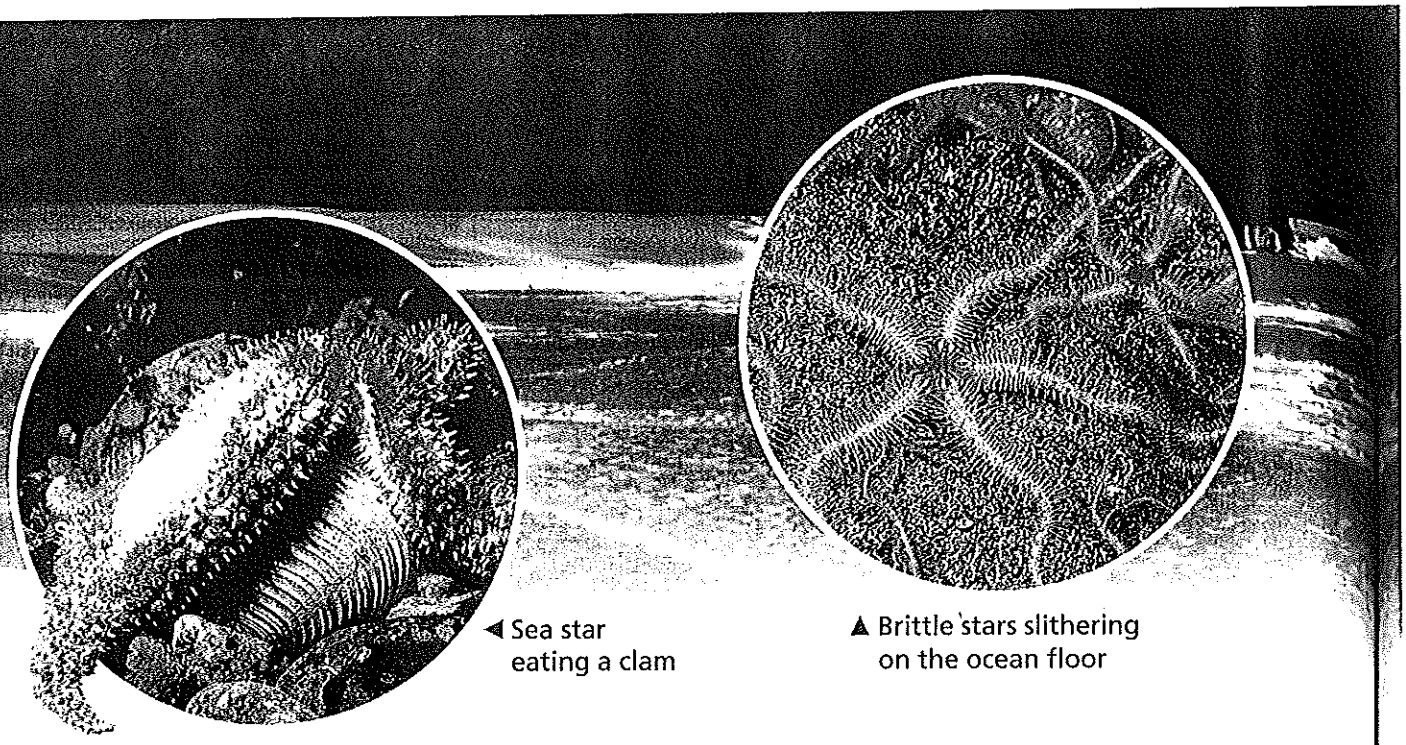
Reading Checkpoint What are the functions of an echinoderm's tube feet?

Go Online
active art

For: Water Vascular System activity
Visit: PHSchool.com
Web Code: cep-2025

FIGURE 24
A Water Vascular System
Echinoderms, such as this sea star, have a water vascular system that helps them move and catch food.
Interpreting Diagrams *Where does water enter the water vascular system?*





◀ Sea star eating a clam

▲ Brittle stars slithering on the ocean floor

FIGURE 25

Diversity of Echinoderms

Echinoderms are diverse in their appearance, but all have radial symmetry and are found in the ocean. Interpreting Photographs *Why is echinoderm, which means "spiny skinned," a good name for this group?*

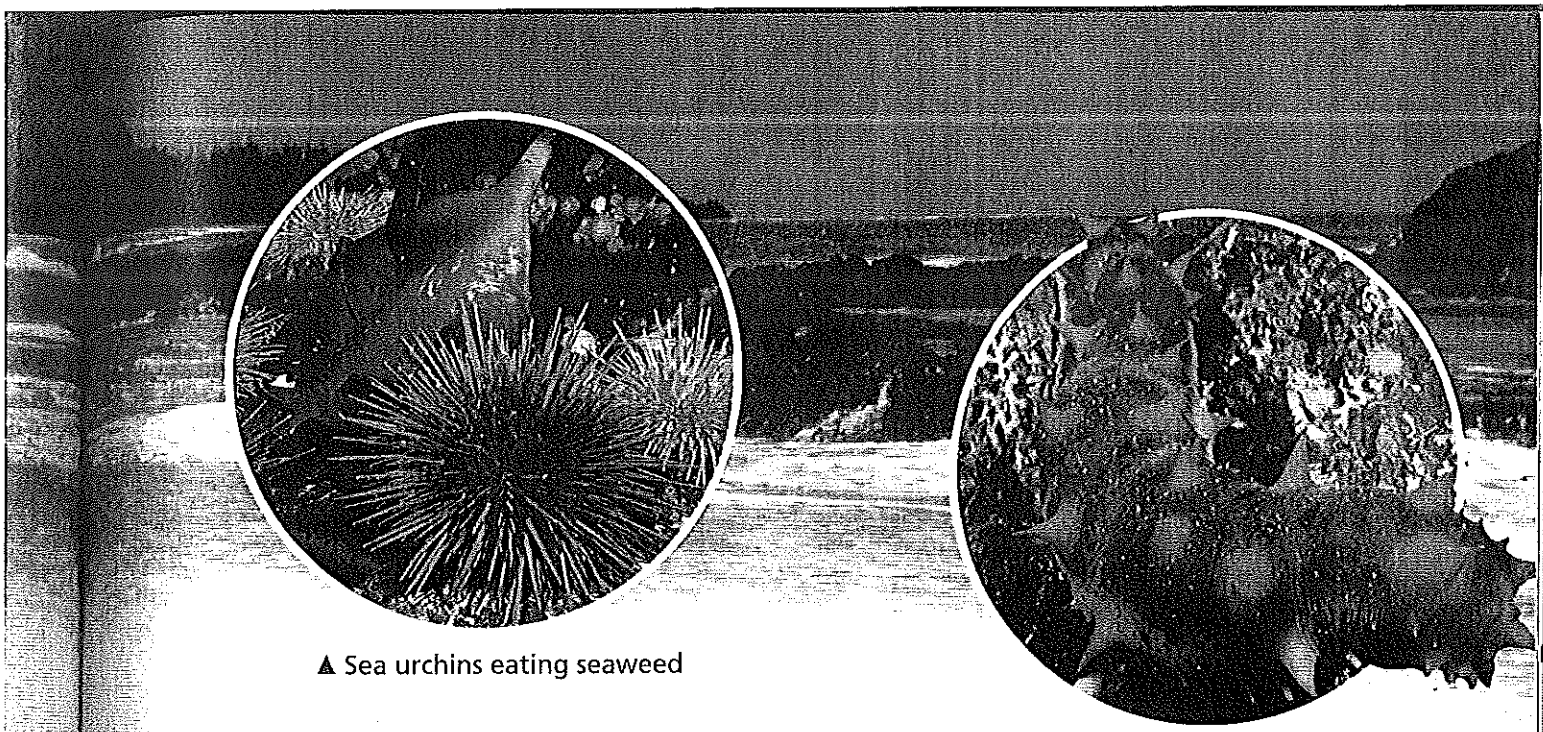
Diversity of Echinoderms

There are four major groups of echinoderms: sea stars, brittle stars, sea urchins, and sea cucumbers. The members of these groups share many characteristics, but look quite different. They also have different ways of feeding and moving.

Sea Stars Sea stars are predators that eat mollusks, crabs, and even other echinoderms. Sea stars use their tube feet to move across the ocean bottom. They also use their tube feet to capture prey. A sea star will grasp a clam with all five arms. Then it pulls on the tightly closed shells with its tube feet. When the shells open, the sea star forces its stomach out through its mouth and into the opening between the clam's shells. Digestive chemicals break down the clam's tissues, and the sea star sucks in the partially digested body of its prey.

Brittle Stars Unlike a sea star's arms, a brittle star's arms are long and slender, with flexible joints. The tube feet, which have no suction cups, are used for catching food but not for moving. Instead, brittle stars slither along the ocean bottom by waving their long arms in a snakelike motion against the ocean floor.

Sea Urchins Unlike sea stars and brittle stars, sea urchins have no arms. Moveable spines cover and protect their bodies, so they look something like a pincushion. These spines cover a central shell that is made of plates joined together. To move, sea urchins use bands of tube feet that extend out between the spines. They scrape and cut their food, such as seaweed, with five teethlike structures that they project from their mouths.



▲ Sea urchins eating seaweed

▲ Sea cucumber crawling on the ocean floor

Sea Cucumbers As you might expect from their name, sea cucumbers look a little bit like the cucumbers you eat. These animals can be red, brown, blue, or green. Underneath their leather-like skin, their bodies are soft, flexible, and muscular. Sea cucumbers have rows of tube feet on their underside, enabling them to crawl slowly along the ocean floor where they live. At one end of a sea cucumber is a mouth surrounded by tentacles. The sea cucumber, which is a filter feeder, can lengthen its tentacles to sweep food toward its mouth.

Reading Checkpoint **How does a sea cucumber move?**

Section 5 Assessment

Vocabulary Skill **Prefixes** Use the meanings of the prefixes *exo-* and *endo-* to contrast the meanings of *exoskeleton* and *endoskeleton.*

Reviewing Key Concepts

1. a. Reviewing What characteristics do echinoderms have?
   b. Summarizing How does an echinoderm use its tube feet to grip a surface?
   c. Inferring Why is movement using tube feet slow?
2. a. Identifying Identify the four major groups of echinoderms.
   b. Comparing and Contrasting Compare and contrast how sea stars and sea urchins feed.
   c. Predicting Would a sea star be able to eat clams without using its tube feet? Explain.

Writing in Science

Comparison Paragraph In a paragraph, compare and contrast how sea stars, brittle stars, and sea urchins move.

Chapter 10 Study Guide

The BIG Idea

Diversity of life Each group of invertebrates has distinctive characteristics, such as a mantle, exoskeleton, or water vascular system.

1 Mollusks

Key Concepts

- In addition to a soft body often covered by a shell, a mollusk has a thin layer of tissue called a mantle that covers its internal organs, and an organ called a foot.
- The three major groups of mollusks are gastropods, bivalves, and cephalopods.
- Gastropods are mollusks that have a single external shell or no shell at all.
- Bivalves are mollusks that have two shells held together by hinges and strong muscles.
- A cephalopod is an ocean-dwelling mollusk whose foot is adapted to form tentacles around its mouth.

Key Terms

• mollusk • open circulatory system • gill
• gastropod • herbivore • carnivore • radula
• bivalve • omnivore • cephalopod

2 Arthropods

Key Concepts

- The major groups of arthropods are crustaceans, arachnids, centipedes and millipedes, and insects.
- Arthropods are invertebrates that have an external skeleton, a segmented body, and jointed attachments called appendages.
- A crustacean is an arthropod that has two or three body sections, five or more pairs of legs, and two pairs of antennae.
- Arachnids are arthropods with two body sections, four pairs of legs, and no antennae.
- Centipedes and millipedes are arthropods with two body sections and many pairs of legs.

Key Terms

• arthropod • exoskeleton • molting
• antenna • crustacean • metamorphosis
• arachnid • abdomen

3 Insects

Key Concepts

- Insects are arthropods with three body sections, six legs, one pair of antennae, and usually one or two pairs of wings.
- An insect's mouthparts are adapted for a highly specific way of getting food.
- Each insect species undergoes either complete metamorphosis or gradual metamorphosis.

Key Terms

• insect • thorax • complete metamorphosis
• pupa • gradual metamorphosis • nymph

4 Insect Ecology

Key Concepts

- Insects play key roles in food chains because of the many different ways that they obtain food and then become food for other animals.
- Two ways insects interact with other living things are by moving pollen among plants and by spreading disease-causing organisms.
- To try to control pests, people use chemicals, traps, and living things, including other insects.

Key Terms

• food chain • ecology • producer
• consumer • decomposer • pollinator
• pesticide • biological control

5 Echinoderms

Key Concepts

- Echinoderms are invertebrates with an internal skeleton and a system of fluid-filled tubes called a water vascular system.
- There are four major groups of echinoderms: sea stars, brittle stars, sea urchins, and sea cucumbers.

Key Terms

• echinoderm • endoskeleton
• water vascular system • tube feet

Review and Assessment

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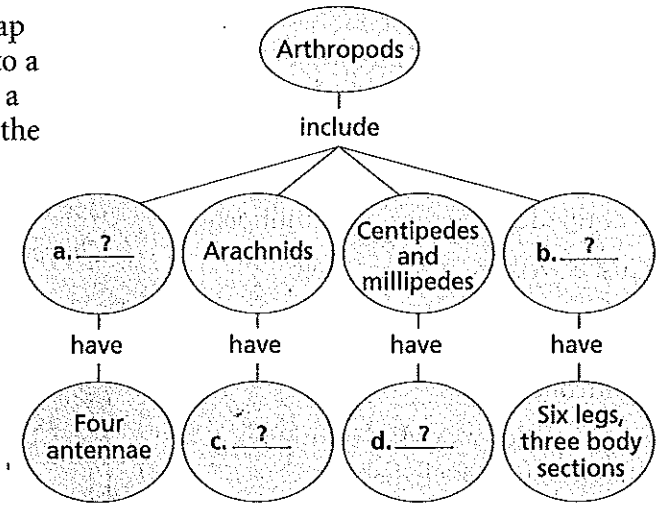
Organizing Information

Concept Mapping Copy the concept map about the classification of arthropods onto a sheet of paper. Then complete it and add a title. (For more on Concept Mapping, see the Skills Handbook.)



Reviewing Key Terms

Choose the letter of the best answer.

1. An animal that eats other animals is a(n)
   a. carnivore. b. omnivore.
   c. filter feeder. d. herbivore.

2. Mollusks with two shells are known as
   a. cephalopods. b. gastropods.
   c. bivalves. d. sea stars.

3. An arthropod's antennae are located on its
   a. head. b. thorax.
   c. abdomen. d. mantle.

4. To obtain oxygen from their environments, mollusks and crustaceans use which organ?
   a. radula b. lungs
   c. gills d. legs

5. The shedding of an outgrown exoskeleton is called
   a. complete metamorphosis.
   b. incomplete metamorphosis.
   c. molting.
   d. reproduction.

6. At which stage of development would an insect be enclosed in a cocoon?
   a. egg b. larva
   c. pupa d. adult

7. One example of a biological control is
   a. catching pest insects in traps.
   b. making and selling honey by raising bees in hives.
   c. killing pest insects with pesticides.
   d. introducing a pest insect's natural predator.

8. An echinoderm has
   a. a radula.
   b. tube feet.
   c. antennae.
   d. an exoskeleton.

Writing in Science

News Report As a television reporter, you are covering a story about a giant squid that has washed up on the local beach. Write a short news story describing the discovery. Be sure to describe how scientists classified the animal as a squid.

Discovery Channel School

Mollusks, Arthropods, and Echinoderms
Video Preview
Video Field Trip
▶ Video Assessment

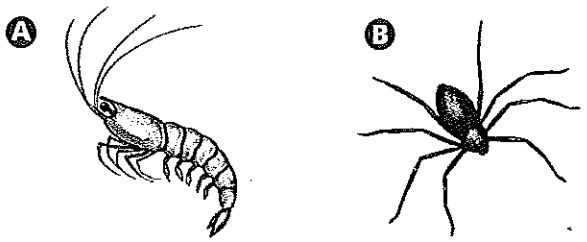
Review and Assessment

Checking Concepts

9. Explain how a snail uses its radula.
10. How is a cephalopod's nervous system different from that of other mollusks?
11. Describe four things that a crayfish can do with its appendages.
12. How are centipedes different from millipedes?
13. How are insects different from other arthropods?
14. Identify two reasons why insects sometimes must be controlled.
15. How is an echinoderm's radial symmetry different from that of a jellyfish?

Thinking Critically

16. **Comparing and Contrasting** Compare and contrast bivalves and cephalopods.
17. **Classifying** Which phylum does each of the animals below belong to? Explain your answer.



18. **Applying Concepts** Explain why the development of a lion, which grows larger as it changes from a tiny cub to a 90 kg adult, is not metamorphosis.
19. **Drawing Conclusions** A rancher imports dung beetles from Africa to help control manure build-up from cattle. Later, he observes that the pastures are producing more grass for the cattle to eat. What conclusion could the rancher draw about the dung beetles?
20. **Making Judgments** Do you think pesticides should be used to kill insect pests? Explain.
21. **Comparing and Contrasting** How is a spider's method of obtaining food similar to that of a sea star? How is it different?

Math Practice

22. **Percentage** Of approximately 150,000 species of mollusks, 27 percent are gastropods. About how many species of gastropods are there?

Applying Skills

Use the data table to answer Questions 23–25.
The following data appeared in a book on insects.

Flight Characteristics

Type of Insect	Wing Beats (per second)	Flight Speed (kilometers per hour)
Hummingbird moth	85	17.8
Bumblebee	250	10.3
Housefly	190	7.1

23. **Graphing** Use the data to make two bar graphs: one showing the three insect wing-beat rates and another showing the flight speeds.
24. **Interpreting Data** Which of the three insects has the highest wing-beat rate? Which insect flies the fastest?
25. **Drawing Conclusions** Based on the data, is there a relationship between the rate at which an insect beats its wings and the speed at which it flies? Explain. What factors besides wing-beat rate might affect flight speed?

Lab zone Chapter Project

Performance Assessment Prepare a display to show how you set up your experiment and what your results were. Construct and display graphs to show the data you collected. Include pictures of the mealworms in each stage of development. Write your conclusion of how the experimental conditions affected the growth and development of the mealworms. Also suggest some possible explanations for your results.

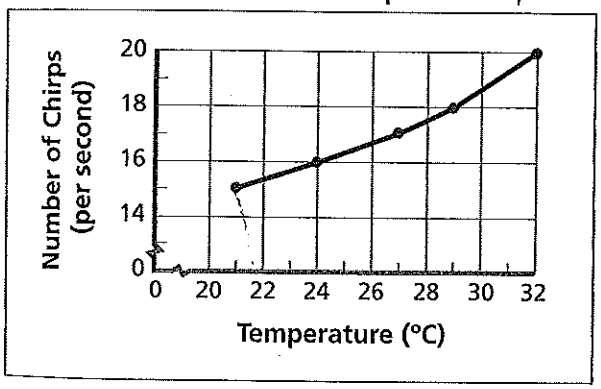
GA Preparing for the CRCT

Test-Taking Tip

Interpreting Graphs

Before you answer a question about a line graph, read all of its labels. The labels on the axes tell you what variables are being compared. On the graph below, the variables are temperature and the number of cricket chirps (sounds).

Relationship of Temperature and Cricket Chirps



Sample Question

How is the number of cricket chirps related to temperature?

A The number of chirps increases as the temperature decreases.
B The number of chirps stays the same as the temperature increases.
C The number of chirps increases as the temperature increases.
D The graph does not show a relationship.

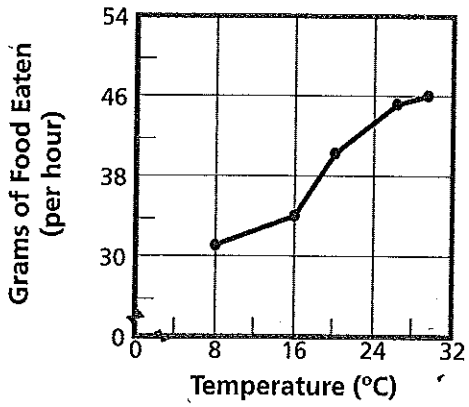
Answer

The correct answer is **C**. The plotted line reveals that as the temperature increases, the number of chirps also increases. Therefore, **A**, **B**, and **D** can not be correct.

Choose the letter of the best answer.

1. An animal that has a soft, unsegmented body surrounded by a hard outer shell is most likely
   A an earthworm.
   B a cnidarian.
   C a mollusk.
   D an arthropod. **S7L2.d**

2. Which animal feature most likely evolved as an adaptation to provide direct protection from a predator's attack?
   A a snail's radula
   B a sea urchin's spines
   C a crayfish's antennae
   D an insect's thorax **S7L2.d**



3. Examine the information in the graph above. Which is the best title for the graph?
   A Effect of Caterpillar Feeding Rate on Temperature
   B Caterpillar Behavior and Temperature
   C Respiration Rate and Temperature
   D Relationship of Temperature and Caterpillar Feeding Rate **S7CS3.d**

4. What is the most reasonable prediction for what the feeding rate would be at 32°C?
   A 60 g/hr
   B 46 g/hr
   C 40 g/hr
   D 0 g/hr **S7CS3.d**

Constructed Response

5. In a certain small country, mosquitoes are very common. The mosquitoes spread a disease that is deadly to humans. The government decides to spray the entire country with a pesticide that will kill all mosquitoes and other flying insects as well. How is this action likely to affect the food chain? **S7L4.a**