

Mollusks, Worms, Arthropods, Echinoderms

chapter preview

sections

- 1 Mollusks
- 2 Segmented Worms
- 3 Arthropods
Lab Observing a Crayfish
- 4 Echinoderms
Lab What do worms eat?

 **Virtual Lab** How are mollusks, worms, arthropods, and echinoderms classified?

An Army of Ants!




These green weaver worker ants are working together to defend their nest. These ants, and more than a million other species, are members of the largest and most diverse group of animals, the arthropods. In this chapter, you will be studying these animals, as well as mollusks, worms, and echinoderms.

Science Journal Write three animals from each animal group that you will be studying: mollusks, worms, arthropods, and echinoderms.

Start-Up Activities



Mollusk Protection

If you've ever walked along a beach, especially after a storm, you've probably seen many seashells. They come in different colors, shapes, and sizes. If you look closely, you will see that some shells have many rings or bands. In the following lab, find out what the bands tell you about the shell and the organism that made it.   

1. Use a magnifying lens to examine a clam's shell.
2. Count the number of rings or bands on the shell. Count as number one the large, top point called the crown.
3. Compare the distances between the bands of the shell.
4. **Think Critically** Do other students' shells have the same number of bands? Are all of the bands on your shell the same width? What do you think the bands represent, and why are some wider than others? Record your answers in your Science Journal.

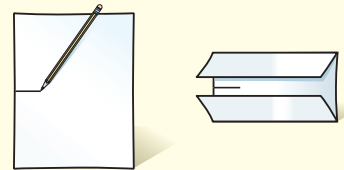


Preview this chapter's content and activities at bookc.msscience.com

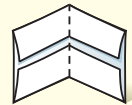
FOLDABLES™ Study Organizer

Invertebrates Make the following Foldable to help you organize the main characteristics of the four groups of complex invertebrates.

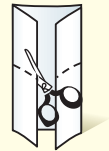
- STEP 1** **Draw** a mark at the midpoint of a sheet of paper along the side edge. Then **fold** the top and bottom edges in to touch the midpoint.



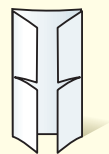
- STEP 2** **Fold** in half from side to side.



- STEP 3** **Turn** the paper vertically. **Open and cut** along the inside fold lines to form four tabs.



- STEP 4** **Label** the tabs *Mollusks*, *Worms*, *Arthropods*, and *Echinoderms*.



Classify As you read the chapter, list the characteristics of the four groups of invertebrates under the appropriate tab.

Mollusks

as you read

What You'll Learn

- **Identify** the characteristics of mollusks.
- **Describe** gastropods, bivalves, and cephalopods.
- **Explain** the environmental importance of mollusks.

Why It's Important

Mollusks are a food source for many animals. They also filter impurities from the water.

Review Vocabulary

visceral mass: contains the stomach and other organs

New Vocabulary

- mantle
- gill
- open circulatory system
- radula
- closed circulatory system

Characteristics of Mollusks

Mollusks (MAH lusks) are soft-bodied invertebrates with bilateral symmetry and usually one or two shells. Their organs are in a fluid-filled cavity. The word *mollusk* comes from the Latin word meaning “soft.” Most mollusks live in water, but some live on land. Snails, clams, and squid are examples of mollusks. More than 110,000 species of mollusks have been identified.

Body Plan All mollusks, like the one in **Figure 1**, have a thin layer of tissue called a mantle. The **mantle** covers the body organs, which are located in the visceral (VIH suh rul) mass. Between the soft body and the mantle is a space called the mantle cavity. It contains **gills**—the organs in which carbon dioxide from the mollusk is exchanged for oxygen in the water.

The mantle also secretes the shell or protects the body if the mollusk does not have a shell. The shell is made up of several layers. The inside layer is the smoothest. It is usually the thickest layer because it's added to throughout the life of the mollusk. The inside layer also protects the soft body.

The circulatory system of most mollusks is an open system. In an **open circulatory system**, the heart moves blood out into the open spaces around the body organs. The blood, which contains nutrients and oxygen, completely surrounds and nourishes the body organs.

Most mollusks have a well-developed head with a mouth and some sensory organs. Some mollusks, such as squid, have tentacles. On the underside of a mollusk is the muscular foot, which is used for movement.

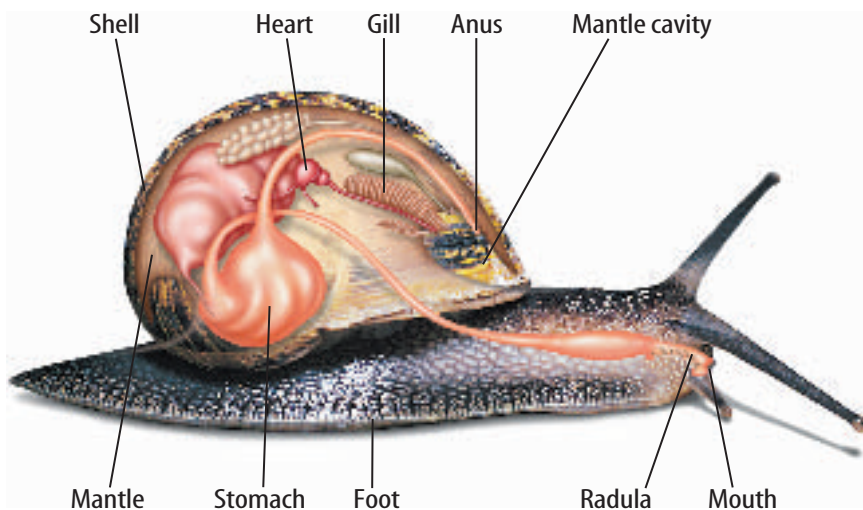


Figure 1 The general mollusk body plan is shown by this snail. Most mollusks have a head, foot, and visceral mass.



Conch



Garden slugs

Classification of Mollusks

The first thing scientists look at when they classify mollusks is whether or not the animal has a shell. Mollusks that have shells are then classified by the kind of shell and kind of foot that they have. The three most common groups of mollusks are gastropods, bivalves, and cephalopods.

Gastropods The largest group of mollusks, the gastropods, includes snails, conchs like the one in **Figure 2**, abalones, whelks, sea slugs, and garden slugs, also shown in **Figure 2**. Conchs are sometimes called univalves. Except for slugs, which have no shell, gastropods have a single shell. Many have a pair of tentacles with eyes at the tips. Gastropods use a **radula** (RA juh luh)—a tonguelike organ with rows of teeth—to obtain food. The radula works like a file to scrape and tear food materials. That's why snails are helpful to have in an aquarium—they scrape the algae off the walls and keep the tank clean.

 **Reading Check** *How do gastropods get food?*

Slugs and many snails are adapted to life on land. They move by rhythmic contractions of the muscular foot. Glands in the foot secrete a layer of mucus on which they slide. Slugs and snails are most active at night or on cloudy days when they can avoid the hot Sun. Slugs do not have shells but are protected by a layer of mucus instead, so they must live in moist places. Slugs and land snails damage plants as they eat leaves and stems.

Figure 2 Conchs, sometimes called marine snails, have a single shell covering their internal organs. Garden slugs are mollusks without a shell.

Identify the mollusk group that both conchs and garden slugs belong to.

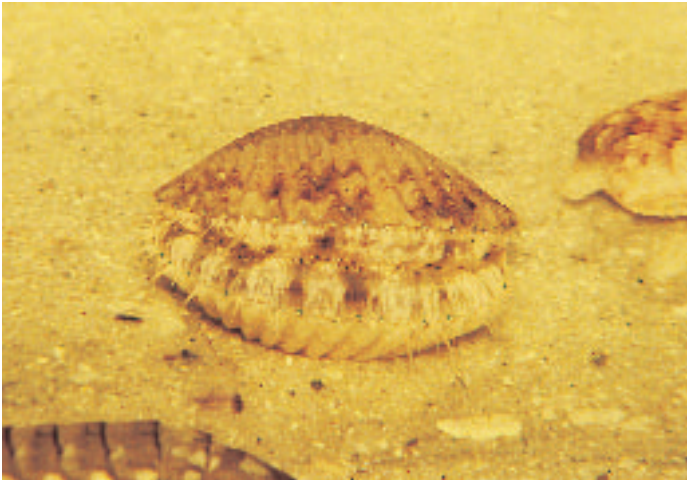


Figure 3 Scallops force water between their valves to move away from sea stars and other predators. They can move up to 1 m with each muscular contraction.

Bivalves Mollusks that have a hinged, two-part shell joined by strong muscles are called bivalves. Clams, oysters, and scallops are bivalve mollusks and are a familiar source of seafood. These animals pull their shells closed by contracting powerful muscles near the hinge. To open their shells, they relax these muscles.

Bivalves are well adapted for living in water. For protection, clams burrow deep into the sand by contracting and relaxing their muscular foot. Mussels and oysters attach themselves with a strong thread or

cement to a solid surface. This keeps waves and currents from washing them away. Scallops, shown in **Figure 3**, escape predators by rapidly opening and closing their shells. As water is forced out, the scallop moves rapidly in the opposite direction.

Cephalopods The most specialized and complex mollusks are the cephalopods (SE fuh luh pawdz). Squid, octopuses, cuttlefish, and chambered nautilus belong to this group. The word *cephalopod* means “head-footed” and describes the body structure of these invertebrates. Cephalopods, like the cuttlefish in **Figure 4**, have a large, well-developed head. Their foot is divided into many tentacles with strong suction cups or hooks for capturing prey. All cephalopods are predators. They feed on fish, crustaceans, worms, and other mollusks.

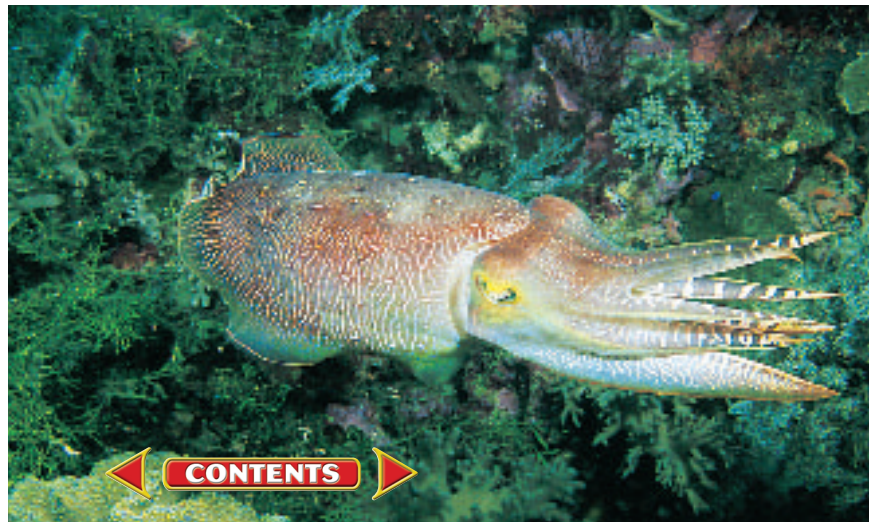
Squid and octopuses have a well-developed nervous system and large eyes similar to human eyes. Unlike other mollusks, cephalopods have closed circulatory systems. In a **closed circulatory system**, blood containing food and oxygen moves through the body in a series of closed vessels, just as your blood moves through your blood vessels.

 **Reading Check**

What makes a cephalopod different from other mollusks?

Figure 4 Most cephalopods, like this cuttlefish, have an internal shell.

Infer why an internal shell would be a helpful adaptation.



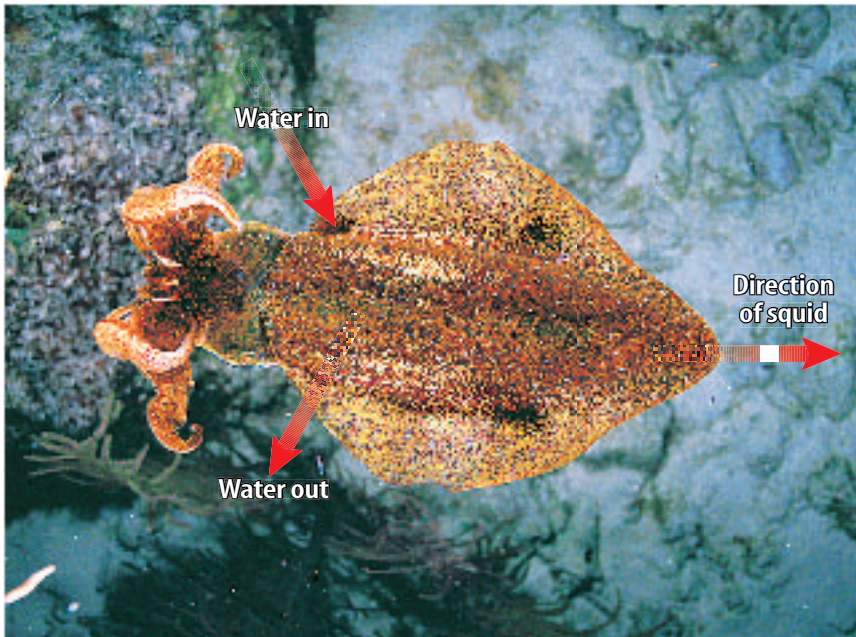


Figure 5 Squid and other cephalopods use jet propulsion to move quickly away from predators.



Cephalopod Propulsion

All cephalopods live in oceans and are adapted for swimming. Squid and other cephalopods have a water-filled cavity between an outer muscular covering and its internal organs. When the cephalopod tightens its muscular covering, water is forced out through an opening near the head, as shown in **Figure 5**. The jet of water propels the cephalopod backwards, and it moves away quickly. According to Newton's third law of motion, when one object exerts a force on a second object, the second object exerts a force on the first that is equal and opposite in direction. The movement of cephalopods is an example of this law. Muscles exert force on water under the mantle. Water being forced out exerts a force that results in movement backwards.

A squid can propel itself at speeds of more than 6 m/s using this jet propulsion and can briefly outdistance all but whales, dolphins, and the fastest fish. A squid even can jump out of the water and reach heights of almost 5 m above the ocean's surface. It then can travel through the air as far as 15 m. However, squid can maintain their top speed for just a few pulses. Octopuses also can swim by jet propulsion, but they usually use their tentacles to creep more slowly over the ocean floor.

Origin of Mollusks Some species of mollusks, such as the chambered nautilus, have changed little from their ancestors. Mollusk fossils date back more than 500 million years. Many species of mollusks became extinct about 65 million years ago. Today's mollusks are descendants of ancient mollusks.



Mollusk Extinction By about 65 million years ago, many mollusks had become extinct. What were the major physical events of the time that could have contributed to changing the environment? Write your answers in your Science Journal.



Figure 6 A pearl starts as an irritant—a grain of sand or a parasite—to an oyster. The oyster coats the irritant with a material that forms smooth, hard layers. It can take years for a pearl to form. Culturing pearls is a commercial industry in some countries.

Value of Mollusks

Mollusks have many uses. They are food for fish, sea stars, birds, and humans. Many people make their living raising or collecting mollusks to sell for food. Other invertebrates, such as hermit crabs, use empty mollusk shells as shelter. Many mollusk shells are used for jewelry and decoration. Pearls are produced by several species of mollusks, but most are made by mollusks called pearl oysters, shown in **Figure 6**. Mollusk shells also provide information about the conditions in an ecosystem, including the source and distribution of water pollutants. The internal shell of a cuttlefish

is the cuttlebone, which is used in birdcages to provide birds with calcium. Squid and octopuses are able to learn tasks, so scientists are studying their nervous systems to understand how learning takes place and how memory works.

Even though mollusks are beneficial in many ways, they also can cause problems for humans. Land slugs and snails damage plants. Certain species of snails are hosts of parasites that infect humans. Shipworms, a type of bivalve, make holes in submerged wood of docks and boats, causing millions of dollars in damage each year. Because clams, oysters, and other mollusks are filter feeders, bacteria, viruses, and toxic protists from the water can become trapped in the animals. Eating these infected mollusks can result in sickness or even death.

section 1 review

Summary

Mollusks

- The body plans of mollusks include a mantle, visceral mass, head, and foot.

Classification of Mollusks

- Gastropods typically have one shell, a foot, and eat using a radula.
- Bivalves have a hinged two-part shell, a muscular foot, and eat by filtering their food from the water.
- Cephalopods have a head, a foot which has been modified into tentacles, and a well-developed nervous system.

Value of Mollusks

- Mollusks are food for many animals, have commercial uses, and are used for research.

Self Check

1. **Explain** how a squid and other cephalopods can move so rapidly.
2. **Identify** some positive and negative ways that mollusks affect humans.
3. **Think Critically** Why is it unlikely that you would find garden slugs or land snails in a desert?

Applying Skills

4. **Interpret Scientific Illustrations** Observe the images of gastropods and bivalves in this section, and infer how bivalves are not adapted to life on land, but gastropods are.
5. **Use a Computer** Make a data table that compares and contrasts the following for gastropods, bivalves, and cephalopods: *methods for obtaining food, movement, circulation, and habitat.*

Segmented Worms

Segmented Worm Characteristics

The worms you see crawling across sidewalks after a rain and those used for fishing are called annelids (A nuh ludz). The word *annelid* means “little rings” and describes the bodies of these worms. They have tube-shaped bodies that are divided into many segments.

Have you ever watched a robin try to pull an earthworm out of the ground or tried it yourself? Why don't they slip out of the soil easily? On the outside of each body segment are bristlelike structures called **setae** (SEE tee). Segmented worms use their setae to hold on to the soil and to move. Segmented worms also have bilateral symmetry, a body cavity that holds the organs, and two body openings—a mouth and an anus. Annelids can be found in freshwater, salt water, and moist soil. Earthworms, like the one in **Figure 7**, marine worms, and leeches are examples of annelids.

 **Reading Check** *What is the function of setae?*

Earthworm Body Systems

The most well-known annelids are earthworms. They have a definite anterior, or front end, and a posterior, or back end. Earthworms have more than 100 body segments. The segments can be seen on the outside and the inside of the body cavity. Each body segment, except for the first and last segments, has four pairs of setae. Earthworms move by using their setae and two sets of muscles in the body wall. One set of muscles runs the length of the body, and the other set circles the body. When an earthworm contracts its long muscles, it causes some of the segments to bunch up and the setae to stick out. This anchors the worm to the soil. When the circular muscles contract, the setae are pulled in and the worm can move forward.

Figure 7 One species of earthworm that lives in Australia can grow to be 3.3 m long.



as you read

What You'll Learn

- **Identify** the characteristics of segmented worms.
- **Describe** the structures of an earthworm and how it takes in and digests food.
- **Explain** the importance of segmented worms.

Why It's Important

Earthworms condition and aerate the soil, which helps increase crop yields.

Review Vocabulary

aerate: to supply with air

New Vocabulary

- setae
- crop
- gizzard



Figure 8 Earthworm castings—also called vermicompost—are used as an organic fertilizer in gardens.

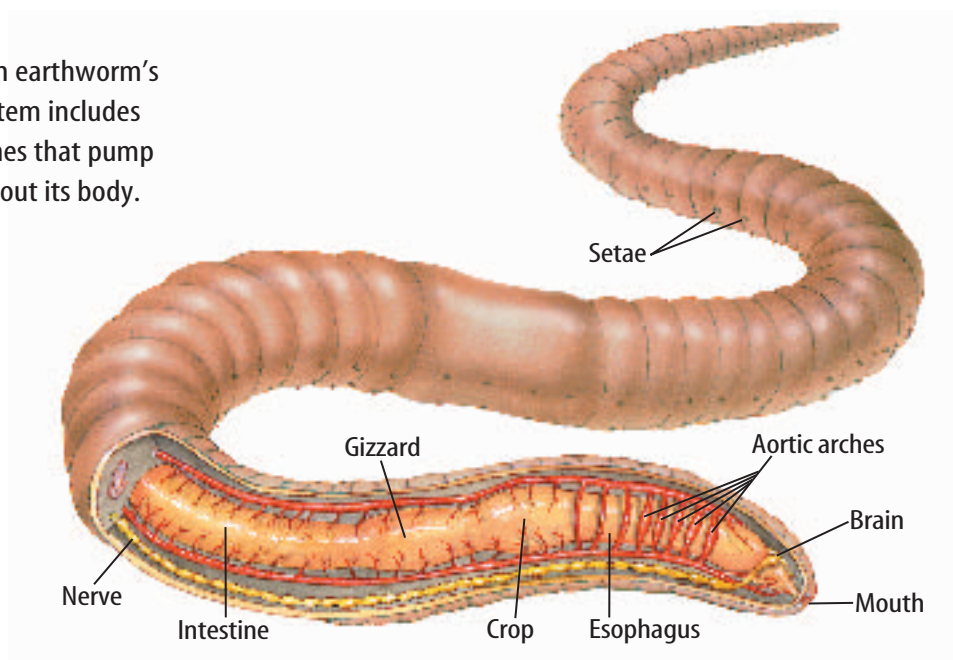
Infer why earthworms are healthy to have in a garden or compost pile.

Digestion and Excretion As an earthworm burrows through the soil, it takes soil into its mouth. Earthworms get energy from the bits of leaves and other organic matter found in the soil. The soil ingested by an earthworm moves to the **crop**, which is a sac used for storage. Behind the crop is a muscular structure called the **gizzard**, which grinds the soil and the bits of organic matter. This ground material passes to the intestine, where the organic matter is broken down and the nutrients are absorbed by the blood. Wastes leave the worm through the anus. When earthworms take in soil, they provide spaces for air and water to flow through it and mix the soil. Their wastes pile up at the openings to their burrows. These piles are called castings. Castings, like those in **Figure 8**, help fertilize the soil.

Circulation and Respiration Earthworms have a closed circulatory system, as shown in **Figure 9**. Two blood vessels along the top of the body and one along the bottom of the body meet in the front end of the earthworm. There, they connect to heartlike structures called aortic arches, which pump blood through the body. Smaller vessels go into each body segment.

Earthworms don't have gills or lungs. Oxygen and carbon dioxide are exchanged through their skin, which is covered with a thin film of watery mucus. It's important never to touch earthworms with dry hands or remove their thin mucous layer, because they could suffocate. But as you can tell after a rainstorm, earthworms don't survive in puddles of water either.

Figure 9 An earthworm's circulatory system includes five aortic arches that pump blood throughout its body.



Nerve Response and Reproduction Earthworms have a small brain in their front segment. Nerves in each segment join to form a main nerve cord that connects to the brain. Earthworms respond to light, temperature, and moisture.

Earthworms are hermaphrodites (hur MA fruh dites)—meaning they produce sperm and eggs in the same body. Even though each worm has male and female reproductive structures, an individual worm can't fertilize its own eggs. Instead, it has to receive sperm from another earthworm in order to reproduce.

Marine Worms

More than 8,000 species of marine worms, or polychaetes, (PAH lee keets) exist, which is more than any other kind of annelid. Marine worms float, burrow, build structures, or walk along the ocean floor. Some polychaetes even produce their own light. Others, like the ice worms in **Figure 10**, are able to live 540 m deep. Polychaetes, like earthworms, have segments with setae. However, the setae occur in bundles on these worms. The word polychaete means “many bristles.”

Sessile, bottom-dwelling polychaetes, such as the Christmas tree worms shown in **Figure 11**, have specialized tentacles that are used for exchanging oxygen and carbon dioxide and gathering food. Some marine worms build tubes around their bodies. When these worms are startled, they retreat into their tubes. Free-swimming polychaetes, such as the bristleworm shown in **Figure 11**, have a head with eyes; a tail; and parapodia (per uh POH dee uh). Parapodia are paired, fleshy outgrowths on each segment, which aid in feeding and locomotion.

Christmas tree worms

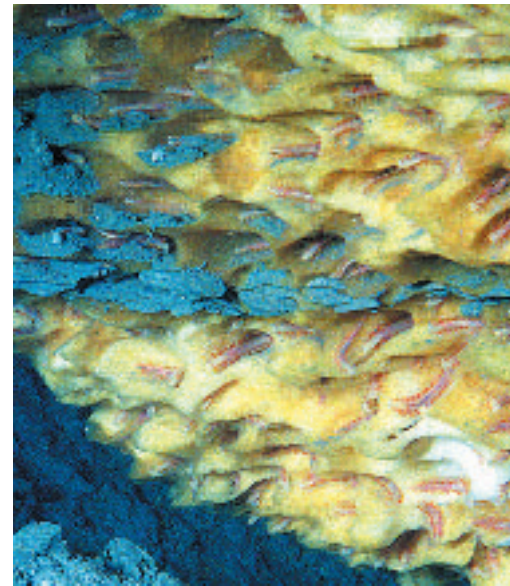


Figure 10 Ice worms, a type of marine polychaete, were discovered first in 1997 living 540 m deep in the Gulf of Mexico.

Figure 11 These Christmas tree worms filter microorganisms from the water to eat. This bristleworm swims backwards and forwards, so it has eyes at both ends of its body.



Bristleworm



Topic: Beneficial Leeches

Visit bookc.msscience.com for Web links to information about the uses of chemicals from leech saliva.

Activity Describe a possible use for leech saliva, and design a 30-second commercial on how you might sell it.

Leeches

A favorite topic for scary movies is leeches. If you've ever had to remove a leech from your body after swimming in a fresh-water pond, lake, or river, you know it isn't fun. Leeches are segmented worms, but their bodies are not as round or as long as earthworms are, and they don't have setae. They feed on the blood of other animals. A sucker at each end of a leech's body is used to attach itself to an animal. If a leech attaches to you, you probably won't feel it. Leeches produce many chemicals, including an anesthetic (a nus THEH tihk) that numbs the wound so you don't feel its bite. After the leech has attached itself, it cuts into the animal and sucks out two to ten times its own weight in blood. Even though leeches prefer to eat blood, they can survive by eating aquatic insects and other organisms instead.



Reading Check

Why is producing an anesthetic an advantage to a leech?

Leeches and Medicine

Sometimes, leeches are used after surgery to keep blood flowing to the repaired area, as shown in **Figure 12**. For example, the tiny blood vessels in the ear quickly can become blocked with blood clots after surgery. To keep blood flowing in such places, physicians might attach leeches to the surgical site. As the leeches feed on the blood, chemicals in their saliva prevent the blood from coagulating. Besides the anti-clotting chemical, leech saliva also contains a chemical that dilates blood vessels, which improves the blood flow and allows the wound to heal more quickly. These chemicals are being studied to treat patients with heart or circulatory diseases, strokes, arthritis, or glaucoma.

Figure 12 Medical leeches are used sometimes to prevent blood from clotting or accumulating in damaged skin.

Explain how a leech can prevent blood clots.



Value of Segmented Worms

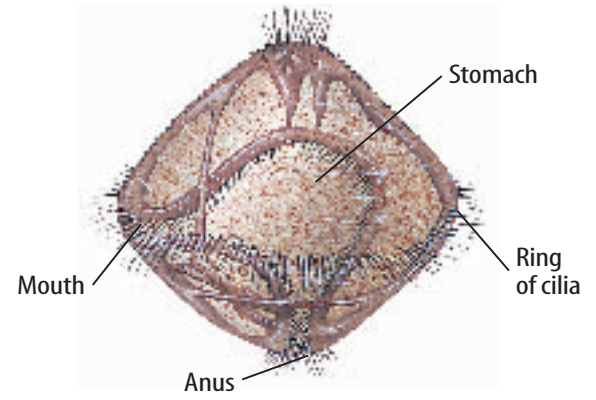
Different kinds of segmented worms are helpful to other animals in a variety of ways. Earthworms help aerate the soil by constantly burrowing through it. By grinding and partially digesting the large amount of plant material in soil, earthworms speed up the return of nitrogen and other nutrients to the soil for use by plants.

Researchers are developing drugs based on the chemicals that come from leeches because leech saliva prevents blood clots. Marine worms and their larvae are food for many fish, invertebrates, and mammals.

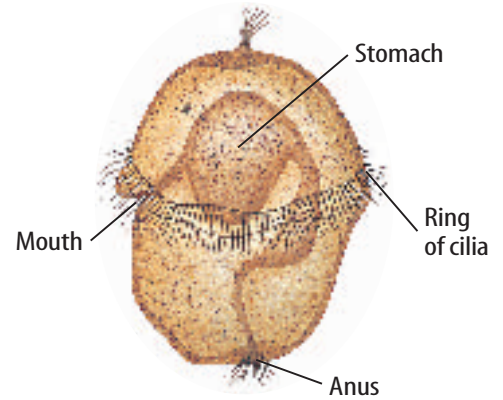
Origin of Segmented Worms

Some scientists hypothesize that segmented worms evolved in the sea. The fossil record for segmented worms is limited because of their soft bodies. The tubes of marine worms are the most common fossils of the segmented worms. Some of these fossils date back about 620 million years.

Similarities between mollusks and segmented worms suggest that they could have a common ancestor. These groups were the first animals to have a body cavity with space for body organs to develop and function. Mollusks and segmented worms have a one-way digestive system with a separate mouth and anus. Their larvae, shown in **Figure 13**, are similar and are the best evidence that they have a common ancestor.



Mollusk larva



Annelid larva

Figure 13 Some mollusk larvae have many structures that are similar to those of some annelid larvae.

section 2 review

Summary

Segmented Worm Characteristics

- Segmented worms have tube-shaped bodies divided into many segments, bilateral symmetry, a body cavity with organs, and two body openings.
- Earthworms have a definite anterior and posterior end, a closed circulatory system, a small brain, and eat organic matter in the soil. Most segments have four pairs of setae.
- Polychaetes are marine worms with many setae occurring in bundles.
- Leeches are segmented worms that feed on the blood of other animals. They have no setae, but a sucker at each end of the body.

Self Check

1. **Define** setae and state their function.
2. **Describe** how an earthworm takes in and digests its food.
3. **Compare and contrast** how earthworms and marine worms exchange oxygen and carbon dioxide.
4. **Think Critically** What advantages do marine worms with tubes have over free-swimming polychaetes?

Applying Math

5. **Use Proportions** Suppose you find six earthworms in 10 cm^3 of soil. Based on this sample, calculate the number of earthworms you would find in 10 m^3 of soil.

Arthropods

as you read

What You'll Learn

- **Determine** the characteristics that are used to classify arthropods.
- **Explain** how the structure of the exoskeleton relates to its function.
- **Distinguish** between complete and incomplete metamorphosis.

Why It's Important

Arthropods, such as those that carry diseases and eat crops, affect your life every day.

Review Vocabulary

venom: toxic fluid injected by an animal

New Vocabulary

- appendage
- exoskeleton
- molting
- spiracle
- metamorphosis

Characteristics of Arthropods

There are more than a million different species of arthropods, (AR thruh pahdz) making them the largest group of animals. The word *arthropoda* means “jointed foot.” The jointed **appendages** of arthropods can include legs, antennae, claws, and pincers. Arthropod appendages are adapted for moving about, capturing prey, feeding, mating, and sensing their environment. Arthropods also have bilateral symmetry, segmented bodies, an exoskeleton, a body cavity, a digestive system with two openings, and a nervous system. Most arthropod species have separate sexes and reproduce sexually. Arthropods are adapted to living in almost every environment. They vary in size from microscopic dust mites to the large, Japanese spider crab, shown in **Figure 14**.

Segmented Bodies The bodies of arthropods are divided into segments similar to those of segmented worms. Some arthropods have many segments, but others have segments that are fused together to form body regions, such as those of insects, spiders, and crabs.

Exoskeletons All arthropods have a hard, outer covering called an **exoskeleton**. It covers, supports, and protects the internal body and provides places for muscles to attach. In many land-dwelling arthropods, such as insects, the exoskeleton has a waxy layer that reduces water loss from the animal.

An exoskeleton cannot grow as the animal grows. From time to time, the exoskeleton is shed and replaced by a new one in a process called **molting**. While the animals are molting, they are not well protected from predators because the new exoskeleton is soft. Before the new exoskeleton hardens, the animal swallows air or water to increase its exoskeleton's size. This way the new exoskeleton allows room for growth.

Figure 14 The Japanese spider crab has legs that can span more than 3 m.



Insects

More species of insects exist than all other animal groups combined. More than 700,000 species of insects have been classified, and scientists identify more each year. Insects have three body regions—a head, a thorax, and an abdomen, as shown in **Figure 15**. However, it is almost impossible on some insects to see where one region stops and the next one begins.



Head An insect's head has a pair of antennae, eyes, and a mouth. The antennae are used for touch and smell. The eyes are simple or compound. Simple eyes detect light and darkness. Compound eyes, like those in **Figure 16**, contain many lenses and can detect colors and movement. The mouthparts of insects vary, depending on what the insect eats.

Thorax Three pairs of legs and one or two pairs of wings, if present, are attached to the thorax. Some insects, such as silverfish and fleas, don't have wings, and other insects have wings only for part of their lives. Insects are the only invertebrate animals that can fly. Flying allows insects to find places to live, food sources, and mates. Flight also helps them escape from their predators.

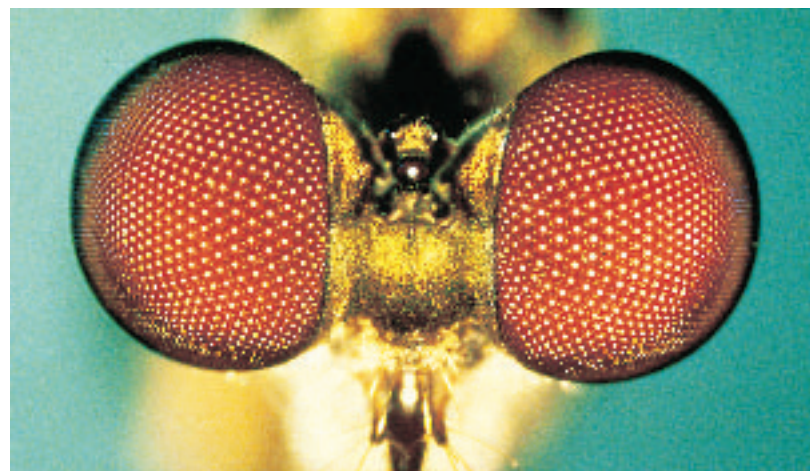
 **Reading Check** How does flight benefit insects?

Abdomen The abdomen has neither wings nor legs but it is where the reproductive structures are found. Females lay thousands of eggs, but only a fraction of the eggs develop into adults. Think about how overproduction of eggs might ensure that each insect species will continue.

Insects have an open circulatory system that carries digested food to cells and removes wastes. However, insect blood does not carry oxygen because it does not have hemoglobin. Instead, insects have openings called **spiracles** (SPIHR ih kulz) on the abdomen and thorax through which air enters and waste gases leave the insect's body.

Figure 15 One of the largest types of ants is the carpenter ant. Like all insects, it has a head, thorax, and abdomen.

Figure 16 Each compound eye is made up of small lenses that fit together. Each lens sees a part of the picture to make up the whole scene. Insects can't focus their eyes. Their eyes are always open and can detect movements.



Stained LM Magnification:400×

Mini LAB

Observing Metamorphosis

Procedure

1. Place a 2-cm piece of ripe banana in a jar and leave it open.
2. Check the jar every day for two weeks. When you see fruit flies, cover the mouth of the jar with cheesecloth.
3. Identify, describe, and draw all the stages of metamorphosis that you observe.

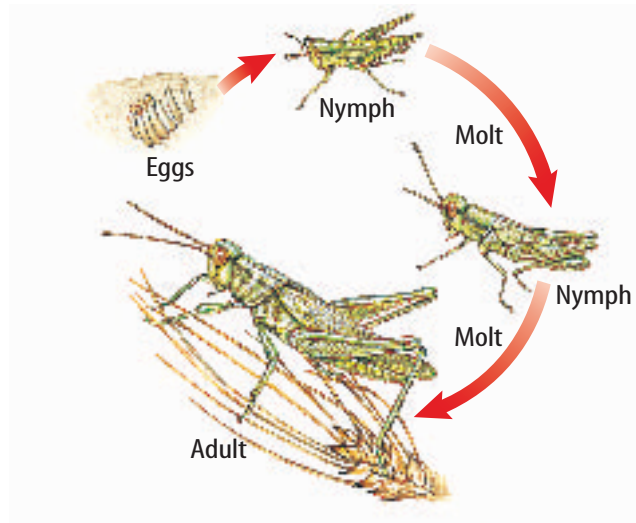
Analysis

1. What type of metamorphosis do fruit flies undergo?
2. In which stages are the flies the most active?

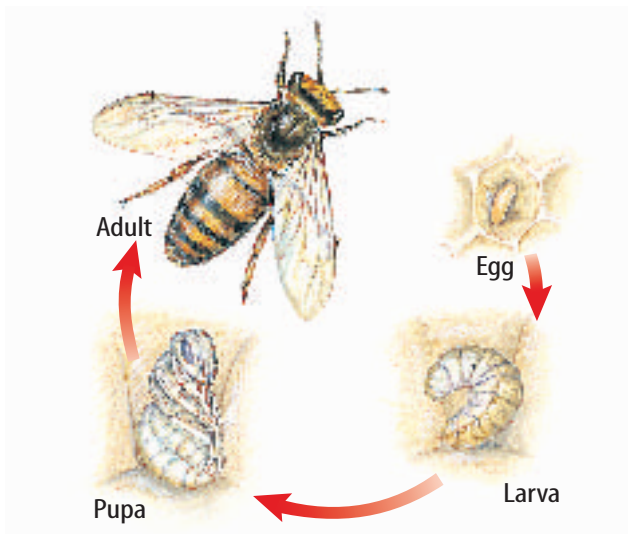
From Egg to Adult Many insects go through changes in body form as they grow. This series of changes is called **metamorphosis** (me tuh MOR fuh sihs). Grasshoppers, silverfish, lice, and crickets undergo incomplete metamorphosis, shown in **Figure 17**. The stages of incomplete metamorphosis are egg, nymph, and adult. The nymph form molts several times before becoming an adult. Many insects—butterflies, beetles, ants, bees, moths, and flies—undergo complete metamorphosis, also shown in **Figure 17**. The stages of complete metamorphosis are egg, larva, pupa, and adult. Caterpillar is the common name for the larva of a moth or butterfly. Other insect larvae are called grubs, maggots, or mealworms. Only larval forms molt.

Reading Check *When do grasshoppers molt?*

Figure 17 The two types of metamorphosis are shown here.



In incomplete metamorphosis, nymphs are smaller versions of their parents.



Many insects go through complete metamorphosis.

Figure 18 Feeding adaptations of insects include different mouthparts.



Grasshoppers have left and right mouthparts called mandibles that enable them to chew through tough plant tissues.



Butterflies and other nectar eaters have a long siphon that enables them to drink nectar from flowers.



Mosquitoes have mouths that are adapted for piercing skin and sucking blood.

Obtaining Food Insects feed on plants, the blood of animals, nectar, decaying materials, wood in houses, and clothes. Mouthparts of insects, such as those in **Figure 18**, are as diverse as the insects themselves. Grasshoppers and ants have large mandibles (MAN duh bulz) for chewing plant tissue. Butterflies and honeybees are equipped with siphons for lapping up nectar in flowers. Aphids and cicadas pierce plant tissues and suck out plant fluids. Praying mantises eat other animals. External parasites, such as mosquitoes, fleas, and lice, drink the blood and body fluids of other animals. Silverfish eat things that contain starch and some moth larvae eat wool clothing.

Insect Success Because of their tough, flexible, waterproof exoskeletons; their ability to fly; rapid reproductive cycles; and small sizes, insects are extremely successful. Most insects have short life spans, so genetic traits can change more quickly in insect populations than in organisms that take longer to reproduce. Because insects generally are small, they can live in a wide range of environments and avoid their enemies. Many species of insects can live in the same area and not compete with one another for food, because many are so specialized in what they eat.

Protective coloration, or camouflage, allows insects to blend in with their surroundings. Many moths resting on trees look like tree bark or bird droppings. Walking sticks and some caterpillars resemble twigs. When a leaf butterfly folds its wings it looks like a dead leaf.



Disease Carriers Some insects may carry certain diseases to humans. Some species of mosquitoes can carry malaria or yellow fever, and can cause problems around the world. Research to learn about one disease that is carried by an insect, where it is a problem, and the steps that are being taken for prevention and treatment. Make a bulletin board of all the information that you and your classmates gather.

Arachnids

Spiders, scorpions, mites, and ticks are examples of arachnids (uh RAK nudz). They have two body regions—a head-chest region called the cephalothorax (se fuh luh THOR aks) and an abdomen. Arachnids have four pairs of legs but no antennae. Many arachnids are adapted to kill prey with venom glands, stingers, or fangs. Others are parasites.

Scorpions Arachnids that have a sharp, venom-filled stinger at the end of their abdomen are called scorpions. The venom from the stinger paralyzes the prey. Unlike other arachnids, scorpions have a pair of well-developed appendages—pincers—with which they grab their prey. The sting of a scorpion is painful and can be fatal to humans.

Applying Math Use Percentages

SILK ELASTICITY A strand of spider's silk can be stretched from 65 cm to 85 cm before it loses its elasticity—the ability to snap back to its original length. Calculate the percent of elasticity of spider's silk.



Solution

- This is what you know:*
 - original length of silk strand = 65 cm
 - stretched length of silk strand = 85 cm
- This is what you need to find out:*

percent of elasticity
- This is the procedure you need to use:*
 - Find the difference between the stretched and original length. $85 \text{ cm} - 65 \text{ cm} = 20 \text{ cm}$
 - $$\frac{\text{difference in length}}{\text{original length}} \times 100 = \% \text{ of elasticity}$$
 - $$\frac{20 \text{ cm}}{65 \text{ cm}} \times 100 = 30.7 \% \text{ of elasticity}$$
- Check your answer:* Multiply 30.7% by 65 cm and you should get 20 cm.

Practice Problems

- A 40-cm strand of nylon can be stretched to a length of 46.5 cm before losing its elasticity. Calculate the percent of elasticity for nylon and compare it to that of spider's silk.
- Knowing the elasticity of spider's silk, what was the original length of a silk strand when the difference between the two strands is 44 cm?



For more practice, visit
[bookc.msscience.com/
math_practice](http://bookc.msscience.com/math_practice)

Spiders Because spiders can't chew their food, they release enzymes into their prey that help digest it. The spider then sucks the predigested liquid into its mouth.

Oxygen and carbon dioxide are exchanged in book lungs, illustrated in **Figure 19**. Openings on the abdomen allow these gases to move into and out of the book lungs.

Mites and Ticks Most mites are animal or plant parasites. However, some are not parasites, like the mites that live in the follicles of human eyelashes. Most mites are so small that they look like tiny specs to the unaided eye. All ticks are animal parasites. Ticks attach to their host's skin and remove blood from their hosts through specialized mouthparts. Ticks often carry bacteria and viruses that cause disease in humans and other animals. Diseases carried by ticks include Lyme disease and Rocky Mountain spotted fever.

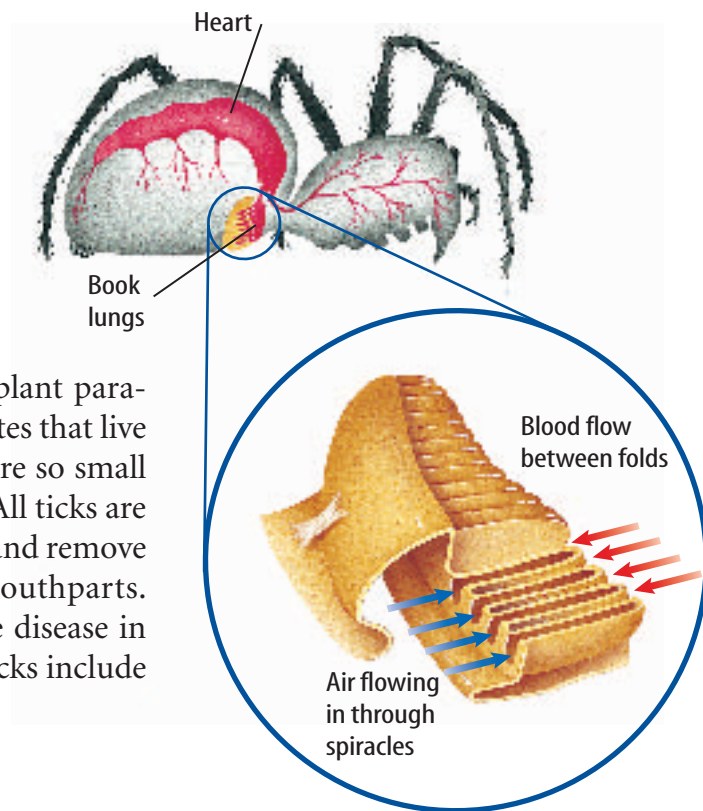


Figure 19 Air circulates between the moist folds of the book lungs bringing oxygen to the blood.

Centipedes and Millipedes

Two groups of arthropods—centipedes and millipedes—have long bodies with many segments and many legs, antennae, and simple eyes. They can be found in damp environments, including in woodpiles, under vegetation, and in basements. Centipedes and millipedes reproduce sexually. They make nests for their eggs and stay with them until the eggs hatch.

Compare the centipede and millipede in **Figure 20**. How many pairs of legs does the centipede have per segment? How many pairs of legs does the millipede have per segment? Centipedes hunt for their prey, which includes snails, slugs, and worms. They have a pair of venomous claws that they use to inject venom into their prey. Their pinches are painful to humans but usually aren't fatal. Millipedes feed on plants and decaying material and often are found under the damp plant material.

Figure 20 Centipedes are predators—they capture and eat other animals. Millipedes eat plants or decaying plant material.

Centipede



Millipede

Figure 21

Some 600 million years ago, the first arthropods lived in Earth's ancient seas. Today, they inhabit nearly every environment on Earth. Arthropods are the most abundant and diverse group of animals on Earth. They range in size from nearly microscopic mites to spindly, giant Japanese spider crabs with legs spanning more than 3 m.



▲ **LOBSTER** Like crabs, lobsters are crustaceans that belong to the group called Decapoda, which means "ten legs." It's the lobster's tail, however, that interests most seafood lovers.



◀ **GRASS SPIDER** Grass spiders spin fine, nearly invisible webs just above the ground.



◀ **GOOSENECK BARNACLE** Gooseneck barnacles typically live attached to objects that float in the ocean. They use their long, feathery setae to strain tiny bits of food from the water.

▼ **MONARCH BUTTERFLY** Monarchs are a common sight in much of the United States during the summer. In fall, they migrate south to warmer climates.



◀ **HISSING COCKROACH** Most cockroaches are considered to be pests by humans, but hissing cockroaches, such as this one, are sometimes kept as pets.

▶ **HORSESHOE CRAB** Contrary to their name, horseshoe crabs are not crustaceans. They are more closely related to spiders than to crabs.



▶ **CENTIPEDE** One pair of legs per segment distinguishes a centipede from a millipede, which has two pairs of legs per body segment.



Crustaceans

Crabs, crayfish, shrimp, barnacles, pill bugs, and water fleas are crustaceans. Crustaceans and other arthropods are shown in **Figure 21**. Crustaceans have one or two pairs of antennae and mandibles, which are used for crushing food. Most crustaceans live in water, but some, like the pill bugs shown in **Figure 22**, live in moist environments on land. Pill bugs are common in gardens and around house foundations. They are harmless to humans.

Crustaceans, like the blue crab shown in **Figure 22**, have five pairs of legs. The first pair of legs are claws that catch and hold food. The other four pairs are walking legs. They also have five pairs of appendages on the abdomen called swimmerets. They help the crustacean move and are used in reproduction. In addition, the swimmerets force water over the feathery gills where the oxygen and carbon dioxide are exchanged. If a crustacean loses an appendage, it will grow back, or regenerate.

Value of Arthropods

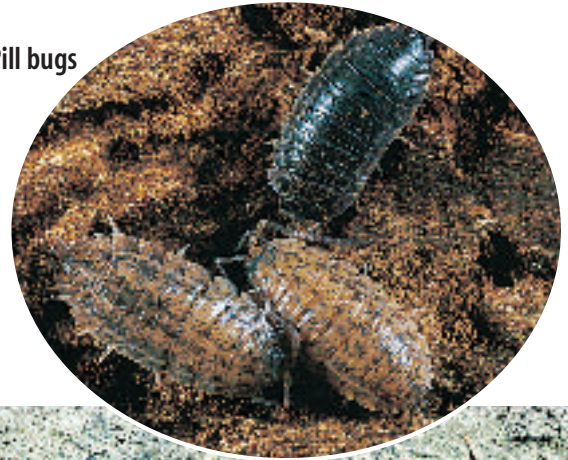
Arthropods play several roles in the environment. They are a source of food for many animals, including humans. Some humans consider shrimp, crab, crayfish, and lobster as food delicacies. In Africa and Asia, many people eat insect larvae and insects such as grasshoppers, termites, and ants, which are excellent sources of protein.

Agriculture would be impossible without bees, butterflies, moths, and flies that pollinate crops. Bees manufacture honey, and silkworms produce silk. Many insects and spiders are predators of harmful animal species, such as stableflies. Useful chemicals are obtained from some arthropods. For example, bee venom is used to treat rheumatic arthritis.

Not all arthropods are useful to humans. Almost every cultivated crop has some insect pest that feeds on it. Many arthropods—mosquitoes, tsetse flies, fleas, and ticks—carry human and other animal diseases. In addition, weevils, cockroaches, carpenter ants, clothes moths, termites, and carpet beetles destroy food, clothing, and property.

Insects are an important part of the ecological communities in which humans live. Removing all of the insects would cause more harm than good.

Pill bugs



Crab



Figure 22 The segments in some crustaceans, such as this crab, aren't obvious because they are covered by a shieldlike structure. Pill bugs—also called roly polys—are crustaceans that live on land.

Compare and contrast pill bugs to centipedes and millipedes.



Figure 23 More than 15,000 species of trilobites have been classified. They are one of the most recognized types of fossils.

Controlling Insects One common way to control problem insects is by insecticides. However, many insecticides also kill helpful insects. Another problem is that many toxic substances that kill insects remain in the environment and accumulate in the bodies of animals that eat them. As other animals eat the contaminated animals, the insecticides can find their way into human food. Humans also are harmed by these toxins.

Different types of bacteria, fungi, and viruses are being used to control some insect pests. Natural predators and parasites of insect pests have been somewhat successful in controlling them. Other biological controls include using sterile males or naturally occurring chemicals that interfere with the reproduction or behavior of insect pests.

Origin of Arthropods Because of their hard body parts, arthropod fossils, like the one in **Figure 23**, are among the oldest and best-preserved fossils of many-celled animals. Some are more than 500 million years old. Because earthworms and leeches have individual body segments, scientists hypothesize that arthropods probably evolved from an ancestor of segmented worms. Over time, groups of body segments fused and became adapted for locomotion, feeding, and sensing the environment. The hard exoskeleton and walking legs allowed arthropods to be among the first successful land animals.

section 3 review

Summary

Characteristics of Arthropods

- All arthropods have jointed appendages, bilateral symmetry, a body cavity, a digestive system, a nervous system, segmented bodies, and an exoskeleton.

Arthropod Types

- Insects have three body segments—head, thorax, and abdomen—a pair of antennae, and three pairs of legs. They go through complete or incomplete metamorphosis.
- Arachnids have two body segments—a cephalothorax and an abdomen—four pairs of legs, and no antennae.
- Centipedes and millipedes have long bodies with many segments and legs.
- Crustaceans have five pairs of legs and five pairs of appendages called swimmerets.

Self Check

1. **Infer** the advantages and disadvantages of an exoskeleton.
2. **Compare and contrast** the stages of complete and incomplete metamorphosis.
3. **List** four ways arthropods obtain food.
4. **Evaluate** the impact of arthropods.
5. **Concept Map** Make an events-chain concept map of complete metamorphosis and one of incomplete metamorphosis.
6. **Think Critically** Choose an insect you are familiar with and explain how it is adapted to its environment.

Applying Math

7. **Make a Graph** Of the major arthropod groups, 88% are insects, 7% are arachnids, 3% are crustaceans, 1% are centipedes and millipedes, and all others make up 1%. Show this data in a circle graph.

Observing a Crayfish

A crayfish has a segmented body and a fused head and thorax. It has a snout and eyes on movable eyestalks. Most crayfish have pincers.

Real-World Question

How does a crayfish use its appendages?

Goals

- **Observe** a crayfish.
- **Determine** the function of pincers.

Materials

crayfish in a small aquarium
uncooked ground beef
stirrer

Safety Precautions



Procedure

1. Copy the data table and use it to record all of your observations during this lab.

Crayfish Observations		
Body Region	Number of Appendages	Function
Head		
Thorax	Do not write in this book.	
Abdomen		

2. Your teacher will provide you with a crayfish in an aquarium. Leave the crayfish in the aquarium while you do the lab. Draw your crayfish.



3. Gently touch the crayfish with the stirrer. How does the body feel?
4. **Observe** how the crayfish moves in the water.
5. **Observe** the compound eyes. On which body region are they located?
6. Drop a small piece of ground beef into the aquarium. Observe the crayfish's reaction. Wash your hands.
7. Return the aquarium to its proper place.

Conclude and Apply

1. **Infer** how the location of the eyes is an advantage for the crayfish.
2. **Explain** how the structure of the pincers aids in getting food.
3. **Infer** how the exoskeleton provides protection.

Communicating Your Data

Compare your observations with those of other students in your class. For more help, refer to the **Science Skill Handbook**.

Echinoderms

as you read

What You'll Learn

- **List** the characteristics of echinoderms.
- **Explain** how sea stars obtain and digest food.
- **Discuss** the importance of echinoderms.

Why It's Important

Echinoderms are a group of animals that affect oceans and coastal areas.

Review Vocabulary

epidermis: outer, thinnest layer of skin

New Vocabulary

- water-vascular system
- tube feet

Echinoderm Characteristics

Echinoderms (ih KI nuh durm) are found in oceans all over the world. The term *echinoderm* is from the Greek words *echinos* meaning “spiny” and *derma* meaning “skin.” Echinoderms have a hard endoskeleton covered by a thin, bumpy, or spiny epidermis. They are radially symmetrical, which allows them to sense food, predators, and other things in their environment from all directions.

All echinoderms have a mouth, stomach, and intestines. They feed on a variety of plants and animals. For example, sea stars feed on worms and mollusks, and sea urchins feed on algae. Others feed on dead and decaying matter called detritus (de TRI tus) found on the ocean floor.

Echinoderms have no head or brain, but they do have a nerve ring that surrounds the mouth. They also have cells that respond to light and touch.

Water-Vascular System A characteristic unique to echinoderms is their water-vascular system. It allows them to move, exchange carbon dioxide and oxygen, capture food, and release wastes. The **water-vascular system**, as shown in **Figure 24**, is a network of water-filled canals with thousands of tube feet connected to it. **Tube feet** are hollow, thin-walled tubes that each end in a suction cup. As the pressure in the tube feet changes, the

animal is able to move along by pushing out and pulling in its tube feet.

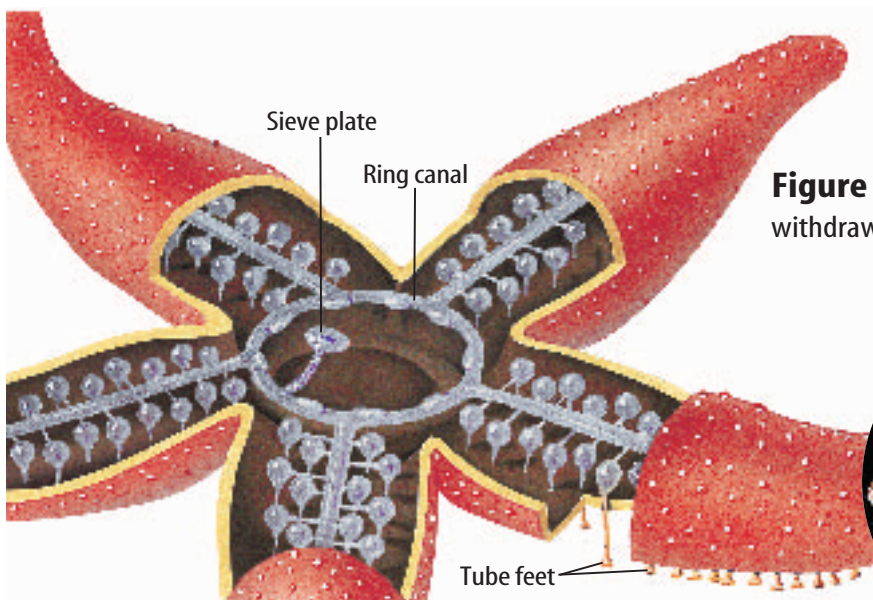


Figure 24 Sea stars alternately extend and withdraw their tube feet, enabling them to move.



Types of Echinoderms

Approximately 6,000 species of echinoderms are living today. Of those, more than one-third are sea stars. The other groups include brittle stars, sea urchins, sand dollars, and sea cucumbers.

Sea Stars Echinoderms with at least five arms arranged around a central point are called sea stars. The arms are lined with thousands of tube feet. Sea stars use their tube feet to open the shells of their prey. When the shell is open slightly, the sea star pushes its stomach through its mouth and into its prey. The sea star's stomach surrounds the soft body of its prey and secretes enzymes that help digest it. When the meal is over, the sea star pulls its stomach back into its own body.



Reading Check

What is unusual about the way that sea stars eat their prey?

Sea stars reproduce sexually when females release eggs and males release sperm into the water. Females can produce millions of eggs in one season.

Sea stars also can repair themselves by regeneration. If a sea star loses an arm, it can grow a new one. If enough of the center disk is left attached to a severed arm, a whole new sea star can grow from that arm.

Brittle Stars Like the one in **Figure 25**, brittle stars have fragile, slender, branched arms that break off easily. This adaptation helps a brittle star survive attacks by predators. While the predator is eating a broken arm, the brittle star escapes. Brittle stars quickly regenerate lost parts. They live hidden under rocks or in litter on the ocean floor. Brittle stars use their flexible arms for movement instead of their tube feet. Their tube feet are used to move particles of food into their mouth.



Figure 25 A brittle star's arms are so flexible that they wave back and forth in the ocean currents. They are called brittle stars because their arms break off easily if they are grabbed by a predator.

Mini LAB

Modeling the Strength of Tube Feet

Procedure

1. Hold your arm straight out, palm up.
2. Place a **heavy book** on your hand.
3. Have your partner time how long you can hold your arm up with the book on it.

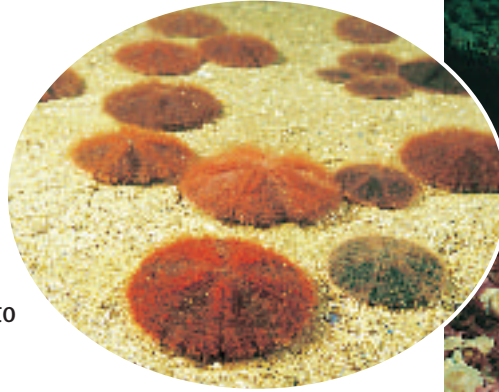
Analysis

1. Describe how your arm feels after a few minutes.
2. If the book models the sea star and your arm models the clam, infer how a sea star successfully overcomes a clam to obtain food.



Figure 26 Like all echinoderms, sand dollars and sea urchins are radially symmetrical.

Sand dollars live on ocean floors where they can burrow into the sand.



Sea urchins use tube feet and their spines to move around on the bottom of the ocean.



Sea Urchins and Sand Dollars Another group of echinoderms includes sea urchins, sea biscuits, and sand dollars. They are disk- or globe-shaped animals covered with spines. They do not have arms, but sand dollars have a five-pointed pattern on their surface. **Figure 26** shows living sand dollars, covered with stiff, hairlike spines, and sea urchins with long, pointed spines that protect them from predators. Some sea urchins have sacs near the end of the spines that contain toxic fluid that is injected into predators. The spines also help in movement and burrowing. Sea urchins have five toothlike structures around their mouth.

Sea Cucumbers The animal shown in **Figure 27** is a sea cucumber. Sea cucumbers are soft-bodied echinoderms that have a leathery covering. They have tentacles around their mouth and rows of tube feet on their upper and lower surfaces. When threatened, sea cucumbers may expel their internal organs. These organs regenerate in a few weeks. Some sea cucumbers eat detritus, and others eat plankton.



Reading Check

What makes sea cucumbers different from other echinoderms?

Figure 27 Sea cucumbers have short tube feet, which they use to move around.

Describe the characteristics of sea cucumbers.



Value of Echinoderms

Echinoderms are important to the marine environment because they feed on dead organisms and help recycle materials. Sea urchins control the growth of algae in coastal areas. Sea urchin eggs and sea cucumbers are used for food in some places. Many echinoderms are used in research and some might be possible sources of medicines. Sea stars are important predators that control populations of other animals. However, because sea stars feed on oysters and clams, they also destroy millions of dollars' worth of mollusks each year.



Figure 28 *Ophiopinna elegans* was a brittle star that lived about 165 million years ago.

Explain the origins of echinoderms.

Origin of Echinoderms Like the example in **Figure 28**, a good fossil record exists for echinoderms. Echinoderms date back more than 400 million years. The earliest echinoderms might have had bilateral symmetry as adults and may have been attached to the ocean floor by stalks. Many larval forms of modern echinoderms are bilaterally symmetrical.

Scientists hypothesize that echinoderms more closely resemble animals with backbones than any other group of invertebrates. This is because echinoderms have complex body systems and an embryo that develops the same way that the embryos of animals with backbones develop.

section 4 review

Summary

Echinoderm Characteristics

- Echinoderms have a hard endoskeleton and are covered by thin, spiny skin.
- They are radially symmetrical. They have no brain or head, but have a nerve ring, and respond to light and touch.
- They have a specialized water-vascular system, which helps them move, exchange gases, capture food, and release wastes.

Types of Echinoderms

- The largest group of echinoderms is sea stars.
- Other groups include brittle stars, sea urchins and sand dollars, and sea cucumbers.

Self Check

1. **Explain** how echinoderms move and get their food.
2. **Infer** how sea urchins are beneficial.
3. **List** the methods of defense that echinoderms have to protect themselves from predators.
4. **Think Critically** Why would the ability to regenerate lost body parts be an important adaptation for sea stars, brittle stars, and other echinoderms?

Applying Skills

5. **Form a Hypothesis** Why do you think echinoderms live on the ocean floor?
6. **Communicate** Choose an echinoderm and write about it. Describe its appearance, how it gets food, where it lives, and other interesting facts.

What do worms eat?

Goals

- **Construct** five earthworm habitats.
- **Test** different foods to determine which ones earthworms eat.

Materials

orange peels
apple peels
banana skin
kiwi fruit skin
watermelon rind
**skins of five different fruits*
widemouthed jars (5)
potting soil
water
humus
**peat moss*
earthworms
black construction paper (5 sheets)
masking tape
marker
rubber bands (5)
**Alternate materials*

Safety Precautions



WARNING: Do not handle earthworms with dry hands. Do not eat any materials used in the lab.

Real-World Question

Earthworms are valuable because they improve the soil in which they live. There can be 50,000 earthworms living in one acre. Their tunnels increase air movement through the soil and improve water drainage. As they eat the decaying material in soil, their wastes can enrich the soil. Other than decaying material, what else do earthworms eat? Do they have favorite foods?



Procedure

1. Pour equal amounts of soil into each of the jars. Do not pack the soil. Leave several centimeters of space at the top of each jar.
2. Sprinkle equal amounts of water into each jar to moisten the soil. Avoid pouring too much water into the jars.
3. Pour humus into each of your jars to a depth of 2 cm. The humus should be loose.
4. Add watermelon rinds to the first jar, orange peels to the second, apple peels to the third, kiwi fruit skins to the fourth, and a banana peel to the fifth jar. Each jar should have 2 cm of fruit skins on top of the layer of humus.



Using Scientific Methods

5. Add five earthworms to each jar.
6. Wrap a sheet of black construction paper around each jar and secure it with a rubber band.
7. Using the masking tape and marker, label each jar with the type of fruit it contains.
8. Copy the data table below in your Science Journal.
9. Place all of your jars in the same cool, dark place. Observe your jars every other day for a week and record your observations in your data table.



Fruit Wastes					
Date	Watermelon rind	Orange peels	Apple peels	Kiwi skins	Banana peels

Do not write in this book.

Analyze Your Data

1. **Record** the changes in your data table.
2. **Compare** the amount of skins left in each jar.
3. **Record** which fruit skin had the greatest change. The least?

Conclude and Apply

1. **Infer** the type of food favored by earthworms.
2. **Infer** why some of the fruit skins were not eaten by the earthworms.
3. **Identify** a food source in each jar other than the fruit skins.
4. **Predict** what would happen in the jars over the next month if you continued the experiment.

Communicating Your Data

Use the results of your experiment and information from your reading to help you write a recipe for an appetizing dinner that worms would enjoy. Based on the results of your experiment, add other fruit skins or foods to your menu you think worms might like.

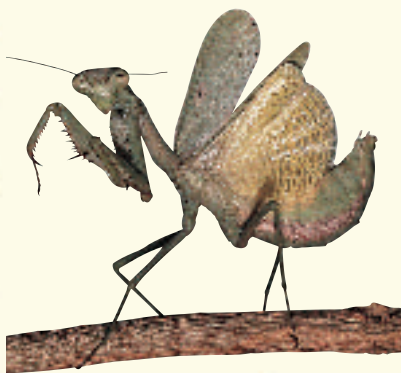
from “The Creatures on My Mind”

by Ursula K. Le Guin

When I stayed for a week in New Orleans... I had an apartment with a balcony... But when I first stepped out on it, the first thing I saw was a huge beetle. It lay on its back directly under the light fixture. I thought it was dead, then saw its legs twitch and twitch again. Big insects horrify me. As a child I feared moths and spiders, but adolescence cured me, as if those fears evaporated in the stew of hormones. But I never got enough hormones to make me easy with the large, hard-shelled insects: wood roaches, June bugs, mantises, cicadas. This beetle was a couple of inches long; its abdomen was ribbed, its legs long and jointed; it was dull reddish brown; it was dying. I felt a little sick seeing it lie there twitching, enough to keep me from sitting out on the balcony that first day... And if I



had any courage or common sense, I kept telling myself, I'd... put it out of its misery. We don't know what a beetle may or may not suffer...



Understanding Literature

Personal Experience Narrative In this passage, the author uses her personal experience to consider her connection to other living things. In this piece, the author recounts a minor event in her life when she happens upon a dying beetle. The experience allows the author to pose some important questions about another species and to think about how beetles might feel when they die. How do you think the beetle is feeling?

Respond to the Reading

1. How do you suppose the beetle injured itself?
2. From the author's description, in what stage of development is the beetle?
3. **Linking Science and Writing** Write about a personal experience that caused you to think about an important question or topic in your life.



The author names several arthropod species in the passage, including insects and an arachnid. Beetles, June bugs, mantises, cicadas, and moths are all insects. The spider is an arachnid. Of the arthropods the author names, can you tell which ones go through a complete metamorphosis?

Reviewing Main Ideas

Section 1 Mollusks

1. Mollusks are soft-bodied invertebrates that usually are covered by a hard shell. They move using a muscular foot.
2. Mollusks with one shell are gastropods. Bivalves have two shells. Cephalopods have an internal shell and a foot that is divided into tentacles.

Section 2 Segmented Worms

1. Segmented worms have tube-shaped bodies divided into sections, a body cavity that holds the internal organs, and bristlelike structures called setae to help them move.
2. An earthworm's digestive system has a mouth, crop, gizzard, intestine, and anus. Polychaetes are marine worms. Leeches are parasites that attach to animals and feed on their blood.

Section 3 Arthropods

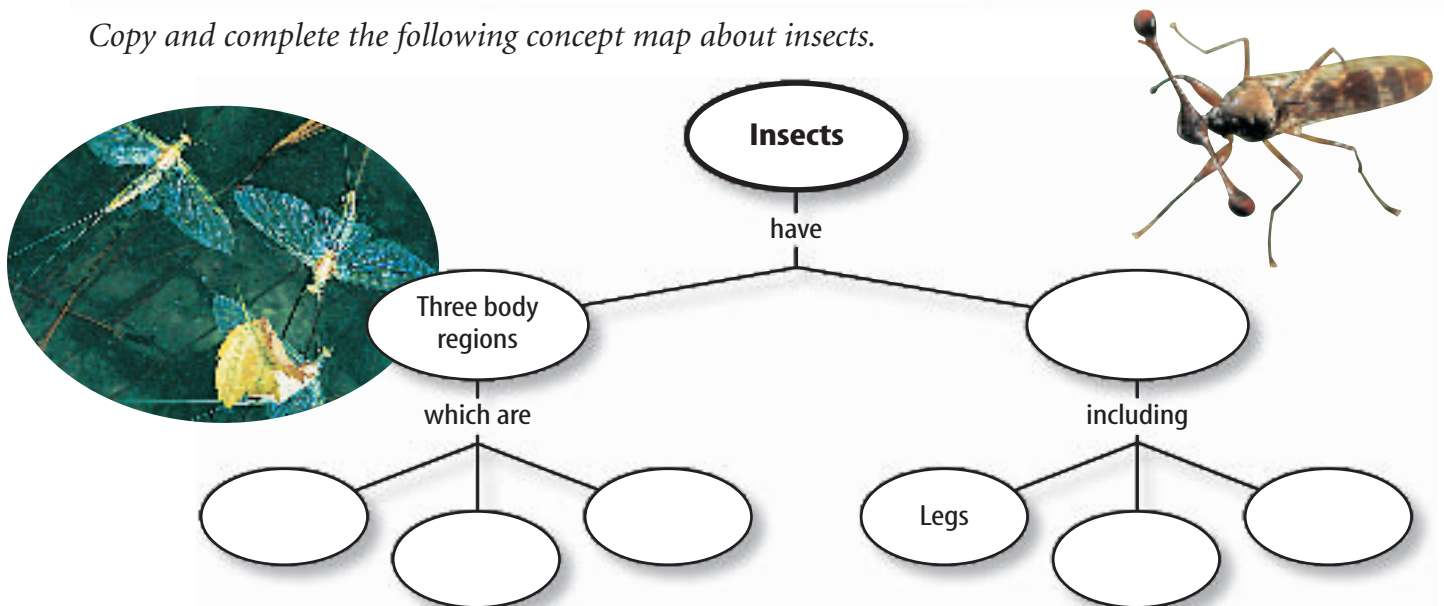
1. More than a million species of arthropods exist, which is more than any other group of animals. Most arthropods are insects.
2. Arthropods are grouped by number of body segments and appendages. Exoskeletons cover, protect, and support arthropod bodies.
3. Young arthropods develop either by complete metamorphosis or incomplete metamorphosis.

Section 4 Echinoderms

1. Echinoderms have a hard, spiny exoskeleton covered by a thin epidermis.
2. Most echinoderms have a water-vascular system that enables them to move, exchange carbon dioxide and oxygen, capture food, and give off wastes.

Visualizing Main Ideas

Copy and complete the following concept map about insects.



Using Vocabulary

appendage p.48	molting p.48
closed circulatory system p.40	open circulatory system p.38
crop p.44	radula p.39
exoskeleton p.48	setae p.43
gill p.38	spiracle p.49
gizzard p.44	tube feet p.58
mantle p.38	water-vascular system p.58
metamorphosis p.50	

Fill in the blanks with the correct vocabulary word or words.

- Mollusk shells are secreted by the _____.
- As earthworms move through soil using their _____, they take in soil, which is stored in the _____.
- The _____ covers and protects arthropod bodies.
- Insects exchange oxygen and carbon dioxide through _____.
- _____ act like suction cups and help sea stars move and feed.
- Snails use a(n) _____ to get food.
- The blood of mollusks moves in a(n) _____.

Checking Concepts

Choose the word or phrase that best answers the question.

- What structure covers organs of mollusks?

A) gills	C) mantle
B) food	D) visceral mass
- What structures do echinoderms use to move and to open shells of mollusks?

A) mantle	C) spines
B) calcium plates	D) tube feet

- Which organism has a closed circulatory system?

A) earthworm	C) slug
B) octopus	D) snail
- What evidence suggests that arthropods might have evolved from annelids?

A) Arthropods and annelids have gills.
B) Both groups have species that live in salt water.
C) Segmentation is present in both groups.
D) All segmented worms have setae.

Use the photo below to answer questions 12 and 13.



- Which of the following correctly describes the arthropod pictured above?

A) three body regions, six legs
B) two body regions, eight legs
C) many body segments, ten legs
D) many body segments, one pair of legs per segment
- What type of arthropod is this animal?

A) annelid	C) insect
B) arachnid	D) mollusk
- Which is an example of an annelid?

A) earthworm	C) slug
B) octopus	D) snail
- Which sequence shows incomplete metamorphosis?

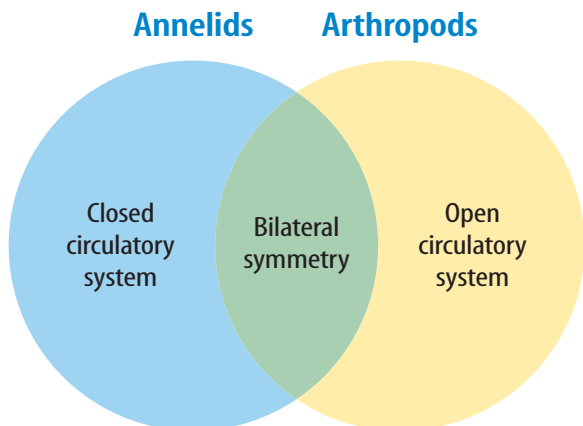
A) egg—larvae—adult
B) egg—nymph—adult
C) larva—pupa—adult
D) nymph—pupa—adult

Thinking Critically

Use the photo below to answer question 16.



16. **Describe** how this animal obtains food.
17. **Compare** the ability of clams, oysters, scallops, and squid to protect themselves.
18. **Compare and contrast** an earthworm gizzard to teeth in other animals.
19. **Explain** the evidence that mollusks and annelids may share a common ancestor.
20. **Infer** how taking in extra water or air after molting, but before the new exoskeleton hardens, helps an arthropod.
21. **Classify** the following animals into arthropod groups: *spider, pill bug, crayfish, grasshopper, crab, silverfish, cricket, wasp, scorpion, shrimp, barnacle, tick, and butterfly.*
22. **Compare and Contrast** Copy and complete this Venn diagram to compare and contrast arthropods to annelids.



23. **Recognize Cause and Effect** If all the earthworms were removed from a hectare of soil, what would happen to the soil? Why?
24. **Research Information** The suffix *-ptera* means “wings.” Research the meaning of the prefix listed below and give an example of a member of each insect group.

Diptera	Homoptera
Orthoptera	Hemiptera
Coleoptera	

Performance Activities

25. **Construct** Choose an arthropod that develops through complete metamorphosis and construct a three-dimensional model for each of the four stages.

Applying Math

Use the table below to answer questions 26 and 27.

Described Species	
Type of Organism	Number of Described Species
Arthropods	1,065,000
Land plants	270,000
Fungi	72,000
Mollusks	70,000
Nematodes	25,000
Birds	10,000
Mammals	5,000
Bacteria	4,000
Other	145,000

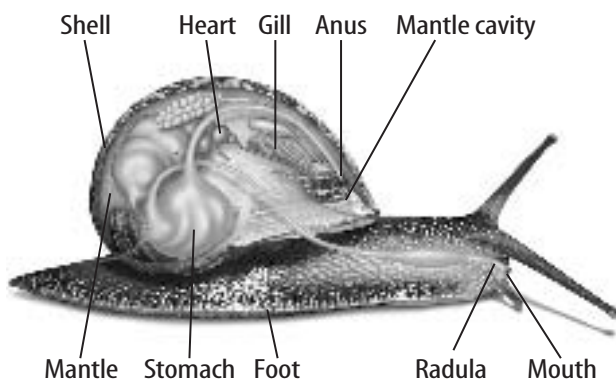
26. **Arthropods** Using the table above, what percentage of organisms are arthropods? Mollusks?
27. **Species Distribution** Make a bar graph that shows the number of described species listed in the table above.

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1. Which of the following is not a mollusk?
 A. clam C. crab
 B. snail D. squid

Use the illustration below to answer questions 2 and 3.



2. This mollusk uses which of the following to exchange carbon dioxide with oxygen from the water?
 A. radula
 B. gill
 C. mantle
 D. shell
3. Which structure covers the body organs of this mollusk?
 A. radula
 B. gill
 C. mantle
 D. shell
4. Which is the largest group of mollusks?
 A. cephalopods C. monovalves
 B. bivalves D. gastropods
5. Which openings allow air to enter an insect's body?
 A. spiracles C. thorax
 B. gills D. setae

Use the photo below to answer questions 6 and 7.



6. This organism is an example of what type of mollusk?
 A. gastropod C. cephalopod
 B. bivalve D. monovalve
7. How do these animals move?
 A. a muscular foot
 B. tentacles
 C. contraction and relaxation
 D. jet propulsion
8. What does the word annelid mean?
 A. segmented C. little rings
 B. bristled D. worms
9. What are bristlelike structures on the outside of each body segment of annelids called?
 A. crops C. radula
 B. gizzards D. setae
10. What is the largest group of animals?
 A. arthropods C. gastropods
 B. cephalopods D. annelids
11. What is it called when an arthropod loses its exoskeleton and replaces it with a new one?
 A. shedding C. manging
 B. molting D. exfoliating

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

12. Describe how a sea star captures and consumes its prey.
13. Explain how sea stars repair or replace lost or damaged body parts.
14. Describe how gastropods, such as snails and garden slugs, eat.

Use the photo below to answer questions 15 and 16.



15. Describe this animal's vascular system. How is it used?
16. This animal has a unique method of movement. What is it and how does it work?
17. Describe the type of reproductive system found in earthworms.
18. What is an open circulatory system? Give three examples of animals that have an open circulatory system.
19. How are pearls formed in clams, oysters, and some other gastropods?

Part 3 Open Ended

Record your answers on a sheet of paper.

Use the photo below to answer questions 20 and 21.



20. Name and describe the phylum that this sea star belongs to.
21. This animal has a vascular system that is unique. Describe it.
22. What structures allow an earthworm to move? Describe its locomotion.
23. There are more species of insects than all other animal groups combined. In all environments, they have to compete with one another for survival. How do so many insects survive?
24. Insect bodies are divided into three segments. What are these three segments and what appendages and organs are in/on each part?

Test-Taking Tip

Show Your Work For constructed-response questions, show all of your work and any calculations on your answer sheet.

Question 22 Write out all of the adaptations that insects have for survival and determine which are the most beneficial to the success of the group.