Section 27–3

1 FOCUS

Objectives

27.3.1 ***Describe*** the defining features of annelids.
27.3.2 ***Identify*** the characteristics of the classes of annelids.
27.3.3 ***Describe*** the ecology of annelids.

Guide for Reading

Vocabulary Preview

Call on volunteers to pronounce each of the Vocabulary words aloud. Correct any mispronunciations, and note any words that students with limited English proficiency have special trouble pronouncing.

Reading Strategy

Advise students to compare the labeled diagram in Figure 27–16 with that in Figure 27–3 in Section 27–1.

2 INSTRUCT

What Is an Annelid?

Use Visuals

Figure 27–12 Divide the class into pairs, and give each pair three different-colored blocks of clay. Then, ask students to make three models, beginning with one that matches the cross section of the annelid shown in this figure. After that is completed, students should make similar models of the cross sections shown in Figures 27–1 and 27–7. L2

Build Science Skills

Using Models To help students visualize a digestive tract inside a body wall, give each student or group a long sock with the toe cut off. Tell students to turn the sock halfway inside out to form a tube-within-a-tube. Explain that the inner layer of the sock represents the digestive tract, and the outer layer represents the body wall. L1

27–3 Annelids

Guide for Reading

Key Concepts
- What are the defining features of annelids?
- What are the characteristics of the three classes of annelids?

Vocabulary
septum • seta
crop • gizzard
closed circulatory system
gill • nephridium
clitellum

Reading Strategy: Using Visuals Before you read, preview **Figure 27–16.** How does this animal seem to differ from the other worms you have already studied? Briefly summarize any differences you notice.

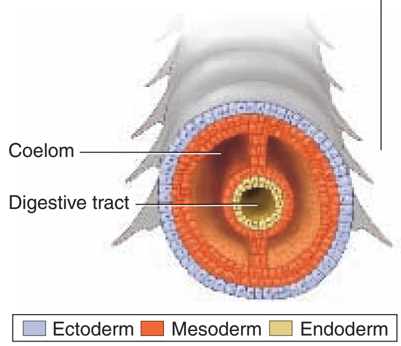
If you have ever dug in a garden in the spring, you have probably seen earthworms wriggling through the soil. Earthworms are annelids, members of the phylum Annelida. Other annelids include exotic seafloor worms and parasitic, blood-sucking leeches. Because their bodies are long and narrow, some annelids look a bit like flatworms or roundworms. However, the annelids are a distinct group that is probably more closely related to clams and snails. One piece of evidence for this relationship is the fact that annelids, clams, and snails all share a similar larval stage.

What Is an Annelid?

The name Annelida (uh-NEL-ih-duh) is derived from the Latin word *annellus*, which means "little ring." The name refers to the ringlike appearance of annelids' body segments. The body of an annelid is divided into segments that are separated by **septa** (singular: septum), which are internal walls between each segment. Most segments are similar to one another, although they may be modified to perform special functions. Some body segments may carry one or more pairs of eyes, several pairs of antennae, and other sense organs. Other segments may be specialized for functions such as respiration. In many annelids, bristles called **setae** (SEE-tee; singular: seta) are attached to each segment.

Annelids are worms with segmented bodies. They have a true coelom that is lined with tissue derived from mesoderm. These structures are shown in **Figure 27–12.** Recall that flatworms have no coelom, whereas roundworms have a pseudocoelom. Like the roundworms, annelids have a tube-within-a-tube digestive tract that food passes through from the mouth to the anus.

CHECKPOINT *What are some functions performed by specialized segments?*



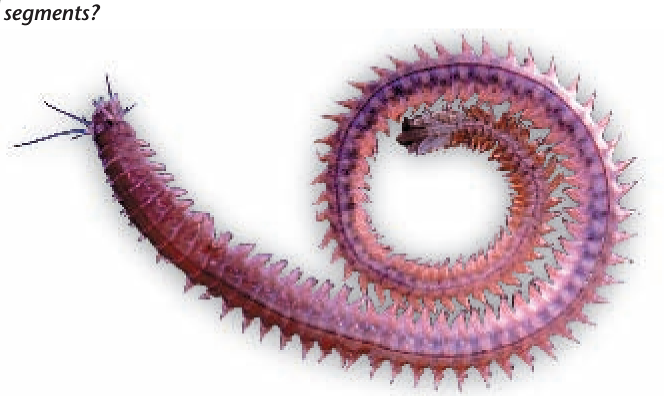


Figure 27–12 Annelids are among the simplest animals to have a true coelom that is lined with mesoderm. Annelids are also called segmented worms because the body is divided into many similar segments. The photo shows a marine annelid.

SECTION RESOURCES

Print:
- ***Teaching Resources,*** Lesson Plan 27–3, Adapted Section Summary 27–3, Adapted Worksheets 27–3, Section Summary 27–3, Worksheets 27–3, Section Review 27–3, Enrichment
- ***Reading and Study Workbook A,*** Section 27–3
- ***Adapted Reading and Study Workbook B,*** Section 27–3
- ***Issues and Decision Making,*** Issues and Decisions 28

Technology:
- ***iText,*** Section 27–3
- ***Transparencies Plus,*** Section 27–3

Quick Lab

How does an earthworm pump blood?

Materials earthworm; dropper pipette; nonchlorinated water; large, clear plastic soda straw; dissecting microscope; clock or watch with second hand

Procedure

1. Carefully insert an earthworm into a clear plastic straw. Do not force the worm into the straw. **CAUTION:** *Handle the earthworm carefully to avoid harming it. Wash your hands after handling the worm.*
2. Use a dropper pipette to add a drop or two of nonchlorinated water into the straw.
3. Examine the straw using a microscope. Direct light through the straw from below. Look near the front of the worm for the large ring blood vessels. Count how often these organs beat during a one minute period. Observe the rest of the circulatory system.

Analyze and Conclude

1. **Inferring** Did you see the worm breathing? Explain your answer. Why must the earthworm's skin be kept moist? How do your answers relate to how earthworms live in their environment?
2. **Observing** Is an earthworm's circulatory system open or closed? Explain your answer.

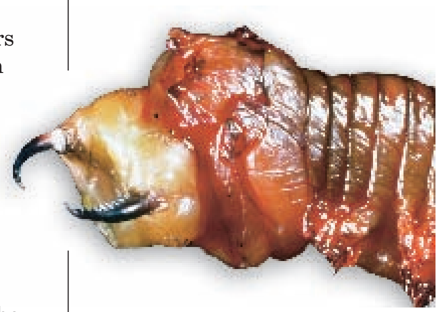
Form and Function in Annelids

Annelids have complex organ systems. Many of these systems are unique because of the segmented body plan of this group.

Feeding and Digestion Annelids range from filter feeders to predators. Many annelids get their food using a pharynx. In carnivorous species, such as the *Nereis* in **Figure 27–13,** the pharynx usually holds two or more sharp jaws that are used to attack prey. In annelids that feed on decaying vegetation, the pharynx is covered with sticky mucus. The worm collects food particles by extending its pharynx and pressing it against the surrounding sediments. Other annelids obtain nutrients by filter feeding. They fan water through tubelike burrows and catch food particles in a mucous bag.

In earthworms, the pharynx pumps food and soil into a tube called the esophagus. The food then moves through the **crop,** where it can be stored, and through the **gizzard,** where it is ground into smaller pieces. The food is absorbed farther along in the digestive tract, in an organ called the intestine.

Circulation Annelids typically have a **closed circulatory system,** in which blood is contained within a network of blood vessels. An earthworm's blood circulates through two major blood vessels that run from head to tail. Blood in the dorsal (top) vessel moves toward the head of the worm. Blood in the ventral (bottom) vessel runs from head to tail. In each body segment, a pair of smaller blood vessels connect the dorsal and ventral blood vessels and supply blood to the internal organs. The dorsal blood vessel functions like a heart because it contracts rhythmically and helps pump blood.



▲ **Figure 27–13** The annelid *Nereis* uses jaws to capture prey. When prey approaches, the worm lunges forward, rapidly extends its pharynx, and grabs the prey using its jaws. **Inferring** ***How is the structure of a* Nereis*'s jaws related to their function?***

Form and Function in Annelids

Quick Lab

Objective Students will be able to describe the structure and function of an earthworm's circulatory system.

Skill Focus **Observing, Inferring**

Materials earthworm, dropper pipette, nonchlorinated water, large and clear plastic straw, dissecting microscope

Time 15 minutes

Advance Prep Collect earthworms outdoors, or buy them from a bait shop. Pond water, aquarium water, and bottles of spring water are all acceptable forms of nonchlorinated water. Tap water can be dechlorinated by boiling and cooling overnight in an open container.

Safety Make sure students wash their hands with soap and warm water after handling the earthworms.

Strategies

- If students have trouble inserting the worm in a straw, try slitting the straw lengthwise.
- Students can also put the earthworm and a few drops of water in a petri dish cover, with the bottom of the petri dish inverted on top to hold the worm in place. Do not allow the worms to dry out.

Expected Outcomes Students should see the earthworm's dorsal vessel pulsating and that an earthworm has a closed circulatory system.

Analyze and Conclude

1. An earthworm has no breathing movements, because it exchanges gases through its skin. The earthworm's skin must be kept moist, because otherwise it will not be able to exchange gases. Earthworms live in moist soil.

2. The earthworm has a closed circulatory system, which means that blood never leaves the blood vessels.

ESL SUPPORT FOR ENGLISH LANGUAGE LEARNERS

Vocabulary: Science Glossary

Beginning Write *septum, seta, crop, gizzard* on the board. Underline the syllables as you lead the class in pronouncing each word. Define each word, and point to the corresponding structure in Figure 27–16. Have students then write the definitions of those terms in their own science glossaries. Students should draw and label their own diagrams next to the definitions. Then, in collaborative writing groups, students should write sentences using each word. L1

Intermediate Students can expand on the science-glossary activity by adding the other Vocabulary words: *closed circulatory system, gill, nephridium, clitellum.* Have the students form collaborative writing groups and write sentences for each word. Call on one student in each group to read the sentences aloud. L2

Answers to . . .

CHECKPOINT *Sample answer: sensing the environment, respiration*

Figure 27–13 *Hooks with sharp points are adapted to catch prey.*

27–3 (continued)

Build Science Skills

Observing Earthworms are among the most familiar of organisms, yet probably few students have taken the time to observe earthworms closely. To give students this opportunity, fill a clear plastic box with about 2 centimeters of sand. Place about 7 centimeters of loosely packed topsoil over the sand. Use pond water to slightly moisten the soil. (Add more water whenever the soil appears dry.) Place 6 to 12 earthworms on top of the soil. Cover the box with clear plastic wrap, and put a few air holes in the plastic wrap. Have students observe the earthworms for several days. Ask them to make labeled diagrams of the animals. Advise them to note especially how earthworms move through the soil. L2 L3

Use Community Resources

Contact a local environmental group, garden center, farming association, or garden club for a reference to a person in your area who uses earthworms to compost household organic garbage. Ask this person to speak to the class about how to set up such a system and what foods can and cannot be added to the earthworm habitat. Students might be surprised to learn that such a system can be clean and without unpleasant odors. It can not only dispose of organic wastes responsibly but also provide great soil for a garden. L2

▲ **Figure 27–14** These feather-duster worms exchange gases underwater using feathery gills. **Applying Concepts** *How do land-dwelling annelids exchange gases?*

Respiration Aquatic annelids often breathe through gills. A **gill** is an organ specialized for the exchange of gases underwater. In feather-duster worms, shown in **Figure 27–14,** feathery structures that function as gills protrude from the opening of the worm's burrow or tube. Land-dwelling annelids, such as earthworms, take in oxygen and give off carbon dioxide through their moist skin. These annelids secrete a thin protective coating of mucus, which keeps their skins moist.

Excretion Like other animals, annelids produce two kinds of waste. Digestive waste passes out through the anus at the end of the digestive tract. Cellular waste containing nitrogen is eliminated by **nephridia** (nee-FRID-ee-uh; singular: nephridium), which are excretory organs that filter fluid in the coelom.

Response Most annelids have a well-developed nervous system consisting of a brain and several nerve cords. However, the sense organs are best developed in free-living marine annelids. Many of these species have a variety of adaptations for detecting stimuli: sensory tentacles, chemical receptors, statocysts that help detect gravity, and two or more pairs of eyes.

Movement Annelids have two major groups of body muscles that function as part of a hydrostatic skeleton. Longitudinal muscles run from the front of the worm to the rear and can contract to make the worm shorter and fatter. Circular muscles wrap around each body segment and can contract to make the worm longer and thinner. The earthworm moves by alternately contracting these two sets of muscles, using its setae to prevent slipping. Burrowing annelids use their muscles to force their way through heavy sediment. Marine annelids have paddlelike appendages, or parapodia (singular: parapodium), on each segment, which they use for swimming and crawling.

Reproduction Most annelids reproduce sexually. Some species use external fertilization and have separate sexes. Other annelids are hermaphrodites. Individuals rarely fertilize their own eggs. Instead, two worms attach to each other, as shown in **Figure 27–15,** exchange sperm, and then store the sperm in special sacs. When eggs are ready for fertilization, a **clitellum** (kly-TEL-um), or band of thickened, specialized segments, secretes a mucous ring into which eggs and sperm are released. Fertilization takes place within this ring. The ring then slips off the worm's body and forms a protective cocoon. Young worms hatch weeks later.

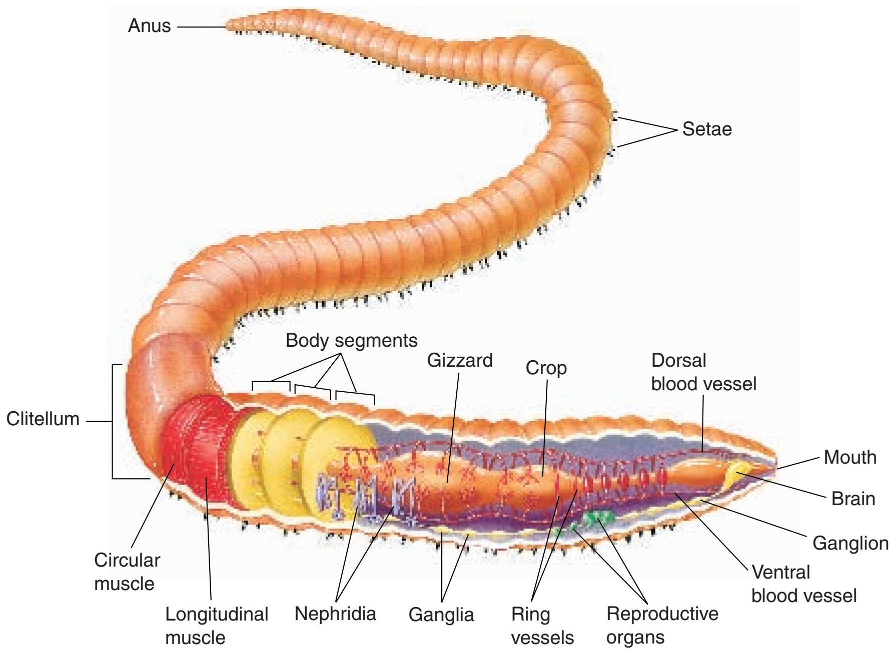
▶ **Figure 27–15** Some annelids, including these earthworms, are hermaphrodites. Each worm produces both eggs and sperm. During mating, the worms exchange sperm, which will eventually be used to fertilize egg cells. **Applying Concepts** *When are the eggs fertilized?*

BIO INSIGHTS

FACTS AND FIGURES

Slithering through the soil

Annelids move through soil and sediment by using the power of their muscles and the liquid inside their body segments—their hydrostatic skeleton. Each body segment is sealed off from the segment next to it, which means body fluids can't move from one segment to another. When the longitudinal muscles contract and make the worm shorter, each segment has to become wider. In a similar manner, when the circular muscles contract and make the worm longer, each segment must become narrower. When the earthworm moves forward, its first few body segments elongate while the segments just behind them hold their position. Then, the first few segments shorten and widen. Alternating contractions and elongations continue along the length of the worm's body, enabling it to move through soil or sediment.



Groups of Annelids

Because of their visible segmentation, all annelids show a basic similarity. Annelids are divided into three classes—oligochaetes, leeches, and polychaetes.

Oligochaetes The class Oligochaeta, or oligochaetes (AHL-ih-goh-keets), contains earthworms and their relatives. **Oligochaetes are annelids that typically have streamlined bodies and relatively few setae compared to polychaetes. Most oligochaetes live in soil or fresh water.** Earthworms, such as the one shown in **Figure 27–16,** are long, pinkish-brown worms that are common in woods, fields, and gardens. Tubifex worms—another common oligochaete—are red, threadlike aquatic worms that are sold in pet stores as food for tropical fish.

Although earthworms spend most of their lives hidden underground, you may find evidence of their presence above ground in the form of squiggles of mud known as castings. Recall that an earthworm—which swallows just about anything it can get into its mouth—uses its pharynx to suck a mixture of detritus and soil particles into its mouth. As the mixture of food and soil passes through the intestine, part of it is digested and absorbed. Sand grains, clay particles, and indigestible organic matter pass out through the anus in large quantities, producing castings. Some tropical earthworms produce enormous castings—as large as 18 centimeters long and 2 centimeters in diameter!

CHECKPOINT *What are earthworm castings?*

▲ **Figure 27–16 Earthworms are oligochaetes that live in soil.** Earthworms carry out essential functions using digestive, circulatory, excretory, nervous, and reproductive systems. Many organs, including nephridia and blood vessels, repeat in nearly every body segment.

Word Origins

Oligochaete comes from the Greek words *oligos*, meaning "few" or "small," and *chaite*, meaning "hair." **If *poly-* means "many," what is a characteristic of the group of annelids known as polychaetes?**

Groups of Annelids

Use Visuals

Figure 27–16 Have students study the diagram of the oligochaete. Point out that this worm has body segments—annelids are worms with segmented bodies. Then, as you point out different labeled parts, call on students to describe the feeding, circulation, respiration, and response of an oligochaete. Ask: **Where does fertilization take place in an oligochaete?** *(In the clitellum)* L2

Build Science Skills

Inferring Divide the class into small groups, and provide each group with an earthworm, a type of oligochaete. Students should examine the worm with a hand lens and try to locate the setae. Have groups formulate a hypothesis to explain the function of the setae. Then, have students place the earthworm on a smooth surface, such as a glass dish or the shiny side of a piece of aluminum foil, as well as on a rougher surface, such as a damp paper towel. Students should compare the worm's movements on the two surfaces and infer the function of the setae. *(Students should infer that setae enable an earthworm to grip a surface as it moves.)* L2 L3

Word Origins

The annelids of the class Polychaeta have "many hairs." L2

TEACHER TO TEACHER

Have students in groups of four observe live earthworm movements under different conditions, such as dry, wet, cold, or warm, and on different surfaces, such as felt, glass, wood, plastic wrap, or gauze. Students record their observations, and each group reports to the class.

Students can use different tuning forks to see how earthworms react to different vibrations. Have groups decide how this information could be used to "hunt" for earthworms.

—*Keith Orgeron*
Biology Teacher
Carenero High School
Lafayette, LA

Answers to . . .

CHECKPOINT *Earthworm castings are a mixture of sand, clay, and undigested food that an earthworm expels from its anus.*

Figure 27–14 *Land-dwelling annelids exchange gases through their moist skin.*

Figure 27–15 *Eggs are fertilized after eggs and sperm are released into the mucous ring secreted by the clitellum.*

27–3 (continued)

Make Connections

Health Science Encourage interested students to contact a large, local teaching hospital and inquire about whether leeches are used in any surgical procedures at that hospital. If so, have students find out how the leeches are collected and the conditions in which they are kept while waiting for use in surgery. In addition, have students find out about the natural environment in which such leeches live and describe an artificial setup in which leeches could be kept for use in medical procedures. L3

Build Science Skills

Classifying Divide the class into small groups, and ask each group to make up 10 to 20 questions for a game called Annelid Worms—Which Class? The idea of the game is for the question to be a statement about one group of annelids. The question is answered by classifying the statement in the annelid class to which it applies. For example: "These worms spend most of their lives underground—which class?" The answer is Oligochaeta. When all groups have finished writing, pool the questions and eliminate any duplicates. Place the remaining questions in a box for students to draw at random. L2

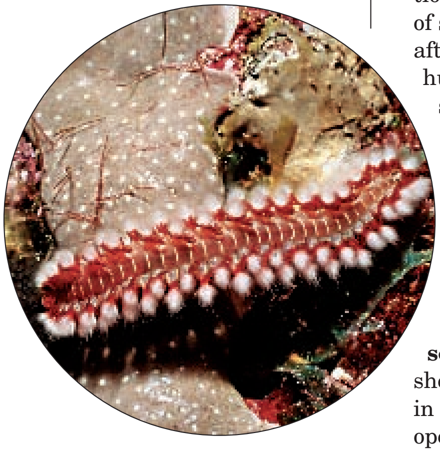
Figure 27–17 **Most leeches are external parasites.** Medicinal leeches, such as the one below, were once used routinely to attempt to treat conditions ranging from headaches to mental illness to obesity. Doctors believed that diseases were caused by an excess of blood, so they applied leeches to the patient's skin to remove blood from the body. Here, a man who lived in the Middle Ages has become so fat that he has been confined to a room and covered with leeches.

Leeches The class Hirudinea (hir-yoo-DIN-ee-uh) contains the leeches, most of which live in moist habitats in tropical countries. **Leeches are typically external parasites that suck the blood and body fluids of their host.** Roughly one fourth of all leeches are carnivores that feed on soft-bodied invertebrates such as snails, worms, and insect larvae.

Leeches have powerful suckers at both ends of their bodies that help them cling to their hosts. The posterior sucker can also anchor a leech to rocks or leaves as it waits for a host to pass. Some leeches force a muscular extension called a proboscis (proh-BAHS-is) into the tissue of their host. Others slice into the skin with a razor-sharp pair of jaws. Once a wound has been made, the leech uses its pharynx to suck blood from the area. Some leeches also release a substance that anesthetizes the wound—keeping the host from knowing it has been bitten.

Leeches were once commonly used to treat medical conditions. Today the use of medicinal leeches is undergoing a revival of sorts. Doctors are finding that leeches can reduce swelling after surgery. After surgeries in which a body part is reattached, hungry leeches are applied to the area. These leeches can suck several milliliters of blood at a time—up to five times their own weight! They also secrete a fluid that prevents blood from clotting. This anti-clotting mechanism helps relieve pressure and congestion in the healing tissues.

▼ **Figure 27–18** **Polychaetes are marine annelids.** The bearded fireworm is a polychaete that lives in coral reefs. It is best known for its method of defense—its setae, or bristles, break off when touched and cause irritation and burning.



Polychaetes The class Polychaeta, or polychaetes (PAHL-ih-keets), contains sandworms, bloodworms, and their relatives. **Polychaetes are marine annelids that have paired, paddlelike appendages tipped with setae.** The setae are the brushlike structures on the worm shown in **Figure 27–18.** Polychaetes live in cracks and crevices in coral reefs; in sand, mud, and piles of rocks; or even out in the open water. Some burrow through or crawl over sediment.

BIO INSIGHTS

HISTORY OF SCIENCE

Leeching to health

For centuries, the medicinal leech *Hirudo medicinalis* was used for bloodletting—a treatment thought to cure a wide range of illnesses. Shortly after the Civil War, more than 1.5 million leeches per year were used in the United States alone. When in contact with a host, the leech attaches itself and draws out blood by a pumping action. At the same time, the leech's salivary glands secrete hirudin, a substance that dilutes the host's blood, prevents blood from clotting, and acts as an anesthetic. A leech may eat up to five times its own body mass in blood before it drops off, and it may not need to feed again for 30 weeks. The leech is now scarce due to overcollecting and habitat destruction. It is still in demand, though, for hirudin, which is used as an anticoagulant for some heart patients and in some surgical procedures.

Ecology of Annelids

The importance of earthworms in nature was noted as far back as ancient Greece, when Aristotle called them "the intestines of the earth." Charles Darwin was impressed enough with earthworms that he devoted years—and an entire book—to their study. Earthworms, like the one shown in **Figure 27–19,** and many other annelids spend their lives burrowing through soil, aerating it, and mixing it to depths of 2 meters or more. Their tunnels provide passageways for plant roots and water and allow the growth of beneficial, oxygen-requiring soil bacteria. Earthworms pull plant matter down into the soil and pass it through the gut. There, they grind it, partially digest it, and mix it with bacteria that help the plant matter decompose. Worms also "mine" minerals from deeper soil layers, bringing them up to the surface. Earthworm feces (castings) are rich in nitrogen, phosphorus, potassium, micronutrients, and beneficial bacteria.

You've probably seen a bird struggling to pull an earthworm out of the ground. Earthworms are an important part of the diet of many birds, such as robins. Moles, skunks, toads, and snakes also prey on earthworms.

In the sea, annelids participate in a wide range of food chains. Many marine annelids have free-swimming larvae that are part of the animal plankton that is consumed by fishes and other plankton feeders. As adults, some marine annelids are mud-dwelling filter feeders that are common in areas where sediment is disturbed or large amounts of organic material are present. These worms are especially numerous where pollution from sewage promotes the growth of bacteria and algae. As any fisher knows, many bottom-dwelling polychaetes are important in the diets of fishes. Crustaceans, such as crabs and lobsters, also include annelids in their diets.

▲ **Figure 27–19** Some annelids, including this earthworm, burrow through soil, mixing it as they go. **Predicting** ***What might happen to a garden if all the annelids in the soil were killed?***

27–3 Section Assessment

1. **Key Concept** What features distinguish annelids from roundworms?
2. **Key Concept** List the defining characteristics for each class of annelid.
3. Describe the feeding strategies of earthworms and leeches.
4. **Critical Thinking** **Inferring** An earthworm has more light-sensitive cells in its anterior and posterior segments than in other parts of its body. Explain how this is advantageous for the worm.

Focus on the BIG Idea

Interdependence in Nature Review what you learned about food chains in Chapter 3. Then, draw a possible food chain involving an annelid. The food chain should include at least three levels.

Ecology of Annelids

Make Connections

Earth Science Explain that good soil contains sediment particles, humus (organic matter), water, and air. The air is especially important, because if the soil is too compact, plants have a difficult time growing. Ask students: **How do earthworms help to mix air into soil?** *(By moving through the soil, they break up particles and make tunnels. These actions provide space for air to move throughout the soil. The movement of earthworms aerates the soil.)* L2

3 ASSESS

Evaluate Understanding

Call on students at random to provide characteristics and examples of the three classes of annelids: oligochaetes, leeches, and polychaetes.

Reteach

To help students understand and remember how annelids' bodies carry out the essential life functions, refer to Figure 27–16. As you review each function as described in the text, have students point out the organs involved in performing that function.

Focus on the BIG Idea

The details of the food chain students draw will vary. A typical food chain might include plant matter eaten by an earthworm, which is then eaten by a bird.

Interactive Textbook

If your class subscribes to the iText, use it to review the Key Concepts in Section 27–3.

27–3 Section Assessment

1. Unlike roundworms, annelids have segmented bodies and a true coelom that is lined with mesoderm.
2. Oligochaetes typically have fewer setae than polychaetes and live in soil or fresh water. Leeches are typically external parasites that suck the blood and body fluids of their host. Polychaetes are marine annelids that have paired, paddlelike appendages tipped with setae.
3. Earthworms use their pharynxes to suck soil and detritus into their esophagus. Leeches suck the blood and body fluids of their host.
4. Having more light-sensitive cells in the front and back ends is advantageous, because the animal moves forward and may be attacked by a predator from the rear.

Answer to . . .

Figure 27–19 *If all the annelids were killed, the soil would not be mixed and aerated, and it would lack passageways for roots, decomposed plant matter, soil bacteria, and minerals from deeper soil layers. As a result, the flowers and vegetables planted in the garden would fail to thrive.*

ISSUES in Biology

After students have read the feature, lead a class discussion of the problems caused by zebra mussels and other exotic species. Then, encourage students to further investigate the zebra mussel problem and prepare a report to the class. You might divide the class into small groups and assign each group one aspect of the problem, including zebra mussels' life cycle and feeding habits, problems caused by zebra mussels to power plants and other facilities, the threat to native mussel populations and other species, and methods previously tried to eradicate the zebra mussels. After groups have reported their findings, have students discuss what they think should be done to address this problem.

Research and Decide

1. Most students will suggest that the advantage of eradication would be that the zebra mussels would no longer cause problems. The disadvantages would include cost and the possibility of harming other species by the methods used to destroy the mussels. An advantage of control and prevention might be a lower cost. A disadvantage might be a lack of effectiveness and continued damage caused by zebra mussels.
2. A thoughtful response will reflect a realistic assessment of the problem and the difficulty in finding a solution. The measures chosen by students will vary. Whichever measure is judged most effective, it should be described in detail with a reasoned assessment of its chances for success.

Go Online PHSchool.com

Students can research population growth and control of zebra mussels on the site developed by authors Ken Miller and Joe Levine.

ISSUES in Biology

What Can Be Done About the Zebra Mussel?

Zebra mussels *(Dreissena polymorpha)* were introduced into the United States from Eastern Europe and Asia when ships from the areas emptied their ballast tanks. They were first spotted in the Great Lakes in the mid-1980s. Zebra mussels have few natural enemies here and reproduce very rapidly. They have already colonized the entire Great Lakes region and have spread to rivers in more than ten states.

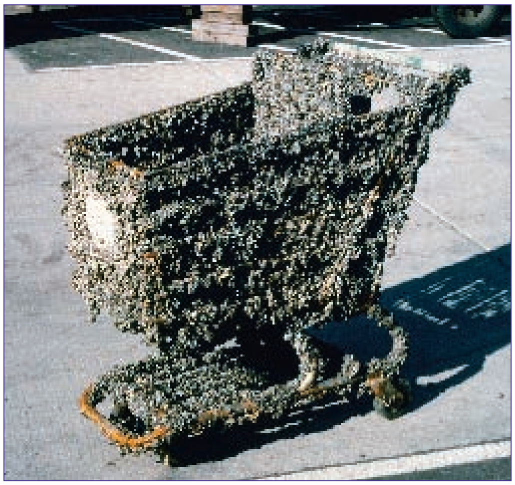
Zebra mussels live attached to almost any surface—from shopping carts to fiberglass boats—and can form layers up to 20 centimeters thick. They have caused serious structural damage and have clogged water supply lines to power plants and water treatment facilities. One paper company, for example, spent over a million dollars to remove zebra mussels that were clogging its cooling pipes.

Zebra mussels also threaten the ecology of aquatic communities. They can tolerate a wide range of temperatures and light intensities. In some habitats, they have displaced native mollusks, almost making them extinct. Zebra mussels have also depleted the food of many fish species. What can be done to control zebra mussels and other exotic (nonnative) species and prevent new ones from arriving?

The Viewpoints

Control and Prevention

Many scientists believe that there is no way to remove zebra mussels and many other established exotic species. Instead, these scientists attempt to control the growth of populations and prevent the transfer of exotic species to new areas. One regulation, for example, could require boaters to filter and chemically clean all ballast water. Another approach would be to find beneficial uses for zebra mussels. Scientists are already exploring the ability of zebra mussels to filter large volumes of waste water.



Eradication

Other groups contend that zebra mussels should be eradicated. Engineers, for example, are developing robotic submarines that can remove mussels from pipelines. Chemists are testing chemicals for the potential to destroy or disrupt the life cycle of zebra mussels. Other scientists are adding chemicals to paints and plastics to prevent mussels from attaching to new surfaces.

Research and Decide

1. **Analyzing the Viewpoints** To make an informed decision, learn more about this issue by consulting library or Internet resources. Then, determine the advantages and disadvantages of each proposed solution to the problems caused by zebra mussels.
2. **Forming Your Opinion** What measures do you think would be most effective in dealing with exotic species?

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BIO INSIGHTS **BACKGROUND**

Clogged pipes cause problems

A mussel is a bivalve that permanently attaches itself to an underwater surface by means of anchor lines called byssal threads. These threads are secreted as a liquid by the byssal gland in the animal's foot. The liquid flows down a groove in the foot, sticks to the rock or other surface, and hardens. Then, the foot is withdrawn, with the thread permanently in place. In this way, zebra mussels attach themselves to the insides of water-intake pipes. A zebra mussel is only about 2 centimeters in length, and a few of them in a pipe doesn't cause concern. But Detroit Edison reported that on a single water-intake screen, there were 700,000 mussels per square meter. In the winter of 1988, ice combined with mussels blocked water intake to Detroit Edison, resulting in power outages. During the 1990s, billions of dollars were spent around the Great Lakes cleaning and refitting pipes.