


27-1 Flatworms

When most people think of worms, they think of long, squiggly earthworms. But there are many other kinds of worms. Some are the length of your body or as thick as your arm. Others look like glowing, furry blobs. Worms can flutter and glide, or climb around with paddlelike bristles. Still others are very small and live in tubes cemented to rocks.

How is their body shape beneficial to worms? A long, slender body allows an animal to move about more rapidly than a radially symmetrical body, like that of a cnidarian. Worms can move forward in a single direction rather than remaining stationary or drifting in currents. In addition, the mouth, sense organs, and brain (if there is one) are usually located at the head, or anterior end, of the body. This arrangement allows worms to locate food and respond to stimuli as they move. Many groups of organisms have worm-shaped bodies. The familiar earthworm is a segmented worm, which you will read about later in this chapter. The unsegmented worms include flatworms and roundworms. The simplest of these are the flatworms.

What Is a Flatworm?

The phylum Platyhelminthes (plat-ih-hel-MIN-theez) consists of the flatworms. Most flatworms are no more than a few millimeters thick.  **Flatworms are soft, flattened worms that have tissues and internal organ systems. They are the simplest animals to have three embryonic germ layers, bilateral symmetry, and cephalization.**

Flatworms are known as **acoelomates** (ay-SEE-luh-mayts), meaning “without coelom.” A **coelom** (SEE-lum) is a fluid-filled body cavity that is lined with tissue derived from mesoderm. No coelom forms between the tissues of flatworms. **Figure 27-1** shows that the digestive cavity, which is lined with tissue derived from endoderm, is the only body cavity. Flatworms also have bilateral symmetry. This means that the animal has two well-formed sides that can be identified as left and right. Most flatworms exhibit enough cephalization to have what is called a head.



Guide for Reading

Key Concepts

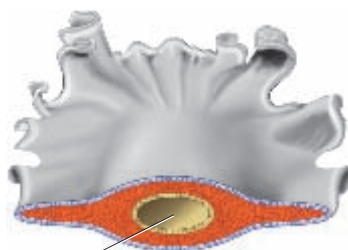
- What are the defining features of flatworms?
- What are the characteristics of the three groups of flatworms?

Vocabulary

acoelomate • coelom
pharynx • flame cell
ganglion • eyespot
hermaphrodite
fission • scolex
proglottid • testis

Reading Strategy:

Outlining Before you read, use the headings of the section to make an outline about the characteristics of flatworms. As you read, fill in subtopics where they apply in the outline. Add phrases after each subtopic to provide key information.



Digestive cavity



 Ectoderm  Mesoderm  Endoderm

Figure 27-1  Flatworms are the simplest animals to have three embryonic germ layers—ectoderm, endoderm, and mesoderm. Shown here is the tropical, free-living flatworm *Pseudobiceros gloriosus*.

Section 27-1

1 FOCUS

Objectives

- 27.1.1 Describe** the defining features of flatworms.
- 27.1.2 Identify** the characteristics of the groups of flatworms.

Guide for Reading

Vocabulary Preview

Direct students' attention to the words *acoelomate* and *coelom*. Explain that *coelom* is pronounced with a long *e* and that such is often the case when a word contains the letter combination *oe*. Then, explain that *coelom* is derived from a Greek word meaning “cavity” or “hollow.” A *coelomate* is an organism that has a body cavity. An *acoelomate* is an organism that lacks a body cavity, because the prefix *a-* means “without” or “not.”


Reading Strategy

Advise students to use the blue headings for the first level of heads in their outlines. For the second level, they should use the green subheads, found in the longer subsections.

2 INSTRUCT

What Is a Flatworm?

Use Visuals

Figure 27-1 Review the three tissue, or germ, layers that develop in an animal embryo: the inner endoderm, the middle mesoderm, and the outer ectoderm. Then, direct students' attention to the cross section of a flatworm body. Ask: **Is there space between the three layers?** (There is no space between the layers.) **What is a coelom?** (A coelom is a fluid-filled body cavity lined with tissue derived from the mesoderm.) Emphasize that a flatworm does not have a fluid-filled body cavity lined with mesoderm. Ask: **What is an animal called that lacks a coelom?** (An acoelomate) 



SECTION RESOURCES

Print:

- **Teaching Resources**, Lesson Plan 27-1, Adapted Section Summary 27-1, Adapted Worksheets 27-1, Section Summary 27-1, Worksheets 27-1, Section Review 27-1
- **Reading and Study Workbook A**, Section 27-1
- **Adapted Reading and Study Workbook B**, Section 27-1

Technology:

- **iText**, Section 27-1
- **Transparencies Plus**, Section 27-1

27-1 (continued)

Form and Function in Flatworms

Build Science Skills

Applying Concepts Flatworms are the simplest animals that exhibit bilateral symmetry. Challenge students to find objects in and around the school that also exhibit bilateral symmetry. Examples include a basketball court, a sweater, the capital letters *A* and *D*, and chairs.

L2 L3

Address Misconceptions

When many students think of a “worm,” they automatically think of an earthworm. Point out that the familiar earthworm is actually a much more advanced animal than the worms students will study in this and the next section. Emphasize that flatworms and roundworms are unsegmented worms, meaning that their bodies are not divided into parts, or segments. Also, point out that many organisms commonly referred to as worms are not worms at all, but rather the larval stage of insects. L1



▲ **Figure 27-2** Blood flukes are parasitic flatworms that mature in the blood vessels of humans. Unlike free-living flatworms, parasitic worms take in nutrients from another organism. **Comparing and Contrasting** How do the internal structures of parasitic flatworms compare to those of free-living flatworms?

Form and Function in Flatworms

Because flatworms are thin and most of their cells are close to the external environment, materials can pass easily into and out of their bodies. All flatworms rely on diffusion for some essential body functions, such as respiration, excretion, and circulation. Other processes are carried out in different ways in different species. Free-living flatworms have organ systems for digestion, excretion, response, and reproduction.

Parasitic species of flatworms, such as the fluke in **Figure 27-2**, probably evolved from free-living ancestors. As the worms evolved into parasites, internal organs and other structures were modified or even lost. As a result, parasitic species are typically simpler in structure than their free-living relatives.

Feeding Free-living flatworms can be carnivores that feed on tiny aquatic animals, or they can be scavengers that feed on recently dead animals. Like cnidarians, flatworms have a digestive cavity with a single opening, or mouth, through which food and wastes pass. Near the mouth is a muscular tube called a **pharynx** (FAR-inks). Flatworms extend the pharynx out of the mouth. The pharynx then pumps food into the digestive cavity, or gut. Once inside, food is digested by cells of the gut, where digestion and nutrient absorption take place. Digested food diffuses from the digestive cavity into all other body tissues.

Parasitic worms feed on blood, tissue fluids, or pieces of cells within the host's body. Many parasitic worms obtain nutrients from foods that have already been digested by their host. Therefore, most parasitic worms do not need a complex digestive system. Many parasitic species have a digestive tract that is simpler than that of free-living forms. Some species have a pharynx that pumps food into a pair of dead-end intestinal sacs for digestion. Tapeworms, on the other hand, have no digestive tract at all. They live within the intestine of their host, such as a cow or a human, and simply absorb digested nutrients that are in their host's intestine.

Respiration, Circulation, and Excretion Because their bodies are so flat and thin, many flatworms do not need a circulatory system to transport materials. Instead, flatworms rely on diffusion to transport oxygen and nutrients to their internal tissues, and to remove carbon dioxide and other wastes from their bodies. Flatworms have no gills or other respiratory organs, and no heart, blood vessels, or blood.

Some flatworms have flame cells that function in excretion.

Flame cells are specialized cells that remove excess water from the body. They may also filter and remove metabolic wastes such as ammonia and urea. Many flame cells are joined together to form a network of tubes that empties into the outside environment through tiny pores in the animal's skin.



CHECKPOINT What is the function of flame cells?



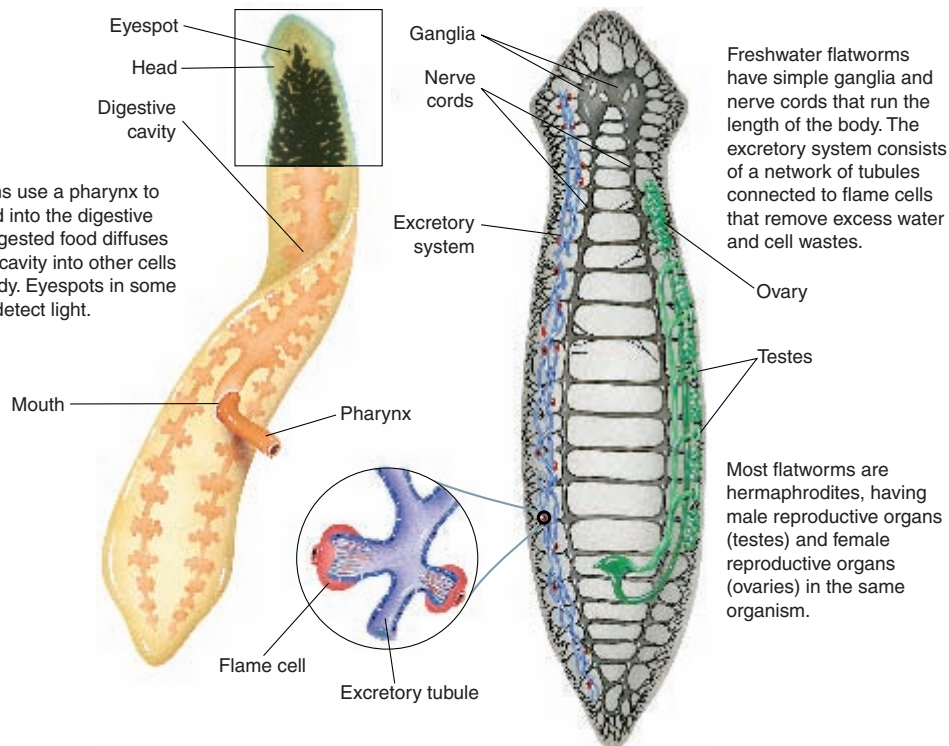
UNIVERSAL ACCESS

Less Proficient Readers

Relate the new term *flame cells* to students' past experience. Explain that the cells that filter and remove excess water from the body have the name “flame cells” because their action is reminiscent of the flame of a fire. Within the flame cells, tufts of cilia “flicker.” When the excess tissue fluid moves into the flame cells, the flickering of the cilia drives the fluid down the tubule system to the outside of the organism. L1

Advanced Learners

Have interested students further investigate the diseases associated with flukes and tapeworms, including method of transmission, symptoms, treatment, and prevention. For flukes, have students investigate *Schistosoma*. For tapeworms, have students investigate the beef tapeworm, *Taenia saginata*, and the pork tapeworm, *Taenia solium*. L3



Response Most flatworms have more complex structures for detecting and responding to external stimuli than those of cnidarians or sponges. In free-living flatworms, a head encloses several **ganglia** (singular: ganglion), or groups of nerve cells, that control the nervous system. These ganglia are not complex enough to be called a brain. Two long nerve cords run from the ganglia along both sides of the body. Locate these nerve cords in **Figure 27-3**. Observe that shorter nerve cords run across the body, like the rungs of a ladder. Parasitic flatworms interact little with their external environment and typically have a less complex nervous system.

Many free-living flatworms have what look like eyes near the anterior end of their body. Each “eye” is actually an **eyespot**, or group of cells that can detect changes in the amount of light in their environment. In addition to having eyespots, most flatworms have specialized cells that detect external stimuli, such as chemicals found in food or the direction in which water is flowing. These cells are usually scattered throughout the body.

The nervous systems of free-living flatworms allow them to gather information from their environment. They use this information to locate food and to find dark hiding places beneath stones and logs during the day.

▲ **Figure 27-3** All flatworms, including this planarian, have organ systems that perform essential life functions. The digestive cavity (left) is branched throughout the body and opens to the outside through the pharynx. The diagram on the right shows the excretory system, nervous system, and reproductive system. The excretory system (in purple) consists of many flame cells (in red) that maintain water balance and may remove waste. The nervous system (in dark gray) consists of ganglia and two nerve cords that run the length of the body. The reproductive system (in green) has both testes and ovaries along both sides of the body. **Inferring** How is a branched digestive cavity advantageous to a flatworm?

Use Visuals

Figure 27-3 Have students list some of the important organs present in flatworms. For example, students might mention the pharynx, anterior ganglia, and nerve cords. Point out that although the flatworm does not have a respiratory system or circulatory system, it does have a digestive system and a nervous system. **L2**

Build Science Skills

Designing Experiments Divide the class into small groups, and ask each group to design an experiment that would investigate how sensitive a free-living flatworm’s eyespot is. Advise students that they should first write a hypothesis that can be tested. A group’s experiment should designate an independent variable, a dependent variable, and a control, as well as a plan to collect and evaluate data. **L2 L3**



FACTS AND FIGURES

Getting rid of wastes with flame cells

Freshwater turbellaria have an organ system that regulates the volume and salt concentration of their body fluid. This system depends on one or more units called protonephridia. Each unit of protonephridia consists of branched tubules that extend from a pore at the body surface to many

cup-shaped flame cells in the body tissues. Within the flame cells, tufts of cilia flicker—thus the name flame cells. When excess tissue fluid moves into the flame cells, the flickering of the cilia drives the fluid down the tubule system to the outside of the organism.

Answers to . . .

CHECKPOINT Flame cells are specialized cells that remove excess water from the body. They may also function in the removal of metabolic wastes such as ammonia and urea.

Figure 27-2 The internal structures of parasitic flatworms are generally simpler than those of free-living flatworms.

Figure 27-3 The branched cavity aids in more efficient digestion because branches reduce the distance that nutrients must diffuse.

27-1 (continued)

Groups of Flatworms

Build Science Skills

Using Tables and Graphs Have students make a compare/contrast table to organize the information they learn about groups of flatworms. The table title should be “Groups of Flatworms,” and column heads could include Class, Description, Environment, and Examples. Encourage students to include as many details as possible in their table. **L2**

Use Visuals

Figure 27-4 Have students compare the two turbellarians shown in the figure. Ask: **How are the two species different?** (Students might first mention color and form. Some students might also note that the two likely move differently.) **In what sort of environments would you find these turbellarian species?** (The species on the left lives in shallow ocean water near coral reefs, while the species on the right lives on the floor of tropical forests.) **Would you classify either as a parasitic species?** (No; both are free-living flatworms.) **Are all turbellarians free-living?** (No, but most are.) **L1 L2**

Figure 27-4 🌊 Free-living flatworms are called turbellarians. Turbellarians vary in size, shape, coloration, and habitat. The species at left is feeding on a coral reef, and the species at right lives in the leaf litter in a tropical forest.



Movement Free-living flatworms typically move in two ways. Cilia on their epidermal cells help them glide through the water and over the bottom of a stream or pond. Muscle cells controlled by the nervous system allow them to twist and turn so that they are able to react rapidly to environmental stimuli.

Reproduction Most free-living flatworms are hermaphrodites that reproduce sexually. A **hermaphrodite** (hur-MAF-roh-dyt) is an individual that has both male and female reproductive organs. During sexual reproduction, two worms join in a pair. The worms in the pair deliver sperm to each other. The eggs are laid in clusters and hatch within a few weeks.

Asexual reproduction is common in free-living flatworms. It takes place by **fission**, in which an organism splits in two, and each half grows new parts to become a complete organism. In some species, a worm simply “falls to pieces,” and each piece grows into a new worm. Parasitic flatworms often have complex life cycles that involve both sexual and asexual reproduction.

✓ **CHECKPOINT** What method of asexual reproduction is common in flatworms?

Groups of Flatworms

Flatworms are an enormously diverse group with many different forms. The three main groups of flatworms are turbellarians, flukes, and tapeworms. Most turbellarians are free-living. Most other flatworm species are parasites.

Turbellarians Free-living flatworms belong to the class Turbellaria (tur-buh-LAYR-ee-uh). 🗝️ **Turbellarians are free-living flatworms. Most live in marine or fresh water.** Most species are bottom dwellers, living in the sand or mud under stones and shells. The most familiar flatworms of this group are the planarians, the “cross-eyed” freshwater worms. Turbellarians can vary greatly in color, form, and size, as shown in **Figure 27-4**.

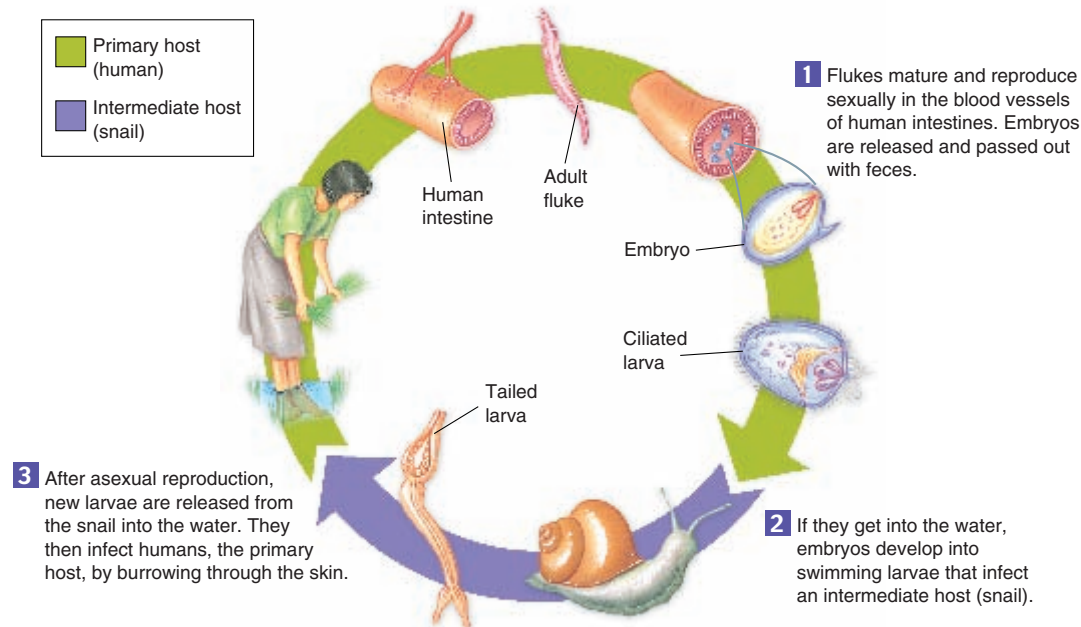


FACTS AND FIGURES

Did flatworms evolve from cnidarians?

Scientists have discovered that the simplest turbellaria and the larval stages of flukes and tapeworms resemble the planula of the cnidarian life cycle. Planulae are formed from zygotes as part of the cnidarian reproductive process; eventually they grow into polyps. This similarity between flatworms and planulae has led some scientists to hypothesize that ancient bilateral animals evolved

from ancestors that were much like planulae. This may have occurred through increased cephalization and the emergence of tissues derived from the mesoderm. If this theory is accurate, then planulalike organisms may have given rise to most groups of complex animals. So far, this theory has not been proven, but there is much evidence to support it.



Flukes Members of the class Trematoda (trem-uh-TOH-duh) are known as flukes. **Flukes are parasitic flatworms.** Most flukes infect the internal organs of their host. They can infect the blood or virtually any internal organ of the host. Some flukes are external parasites that live on the skin, mouth, gills, or other outside parts of a host.

The blood fluke *Schistosoma mansoni* has a life cycle that is typical of parasitic flukes and of many parasites in general. As shown in **Figure 27-5**, the fluke lives in multiple hosts. Its primary host, the organism in which it reproduces sexually, is a human. Blood flukes infect humans by burrowing through exposed skin. Once inside, they are carried to the tiny blood vessels of the intestine. There, the flukes mature into adults, reproduce sexually, and release embryos into the intestine. The embryos are passed out of the body in feces.

If the embryos reach water, they develop into swimming larvae and infect freshwater snails, the intermediate host. An intermediate host is an organism in which a parasite reproduces asexually. Larvae that result from asexual reproduction are eventually released to begin the cycle again.

The *Schistosoma* fluke causes schistosomiasis (shis-tuh-soh-MY-uh-sis) in humans. Schistosomiasis is a serious disease in which the *Schistosoma* eggs clog blood vessels, causing swelling and tissue decay in the lungs, liver, spleen, or intestines. Schistosomiasis affects millions of people worldwide. It is particularly widespread in tropical areas that lack proper sewage systems, where human wastes are tossed into streams or used as fertilizer. There, the parasites are transmitted to intermediate hosts and back to humans with deadly efficiency.

▲ **Figure 27-5** Flukes usually infect the internal organs of their host. The life cycle of the blood fluke *Schistosoma mansoni* involves two hosts: humans and snails.

Go Online

For: Links on flukes
Visit: www.SciLinks.org
Web Code: cbn-8271

Use Visuals

Figure 27-5 Ask students: **What disease is caused by the blood fluke?** (*Schistosomiasis*) **How does the life cycle of the blood fluke point to the need for effective sewage treatment?** (*The eggs are released in the feces of infected humans. Proper treatment of sewage destroys eggs before they hatch into swimming larvae and infect an intermediate host.*) **What is the difference between an intermediate host and a primary host?** (*A primary host is an organism in which the parasite reproduces sexually. An intermediate host is an organism in which the parasite reproduces asexually.*) **L1 L2**

Build Science Skills

Interpreting Graphics Reinforce students' understanding of the blood fluke life cycle shown in Figure 27-5 by having them sequence the following events. Write the events on the board, and ask students to rewrite them in the proper sequence, beginning with number 1.

1. Human becomes infected while standing in shallow water.
2. Fluke eggs hatch into swimming larvae.
3. Adult flukes produce eggs.
4. Snail releases tailed larvae.
5. Flukes mature in blood vessels of human intestine.
6. Human eliminates solid wastes containing fluke eggs.
7. Swimming larvae infect an intermediate host (snail).

(Proper sequence: 1, 5, 3, 6, 2, 7, 4)
L1 L2

Go Online

Download a worksheet on flukes for students to complete, and find additional teacher support from NSTA SciLinks.



FACTS AND FIGURES

Flukes and planarians

As parasites, flukes exhibit many differences and some similarities when compared with free-living planarians. Unique to the fluke is the thick outer layer of cells called the tegument. The tegument protects flukes from being digested by their hosts. Unlike free-living worms, flukes don't have

muscles or cilia for movement. Instead, they have suckers that they use to attach themselves to their hosts. Flukes also lack specialized sense organs. Flukes are similar to planarians in that they have similar excretory systems. They are also like planarians in that they are hermaphrodites.

Answer to . . .

CHECKPOINT Fission

27-1 (continued)

Use Visuals

Figure 27-6 Ask students: What are proglottids? (The segments that make up most of a tapeworm's body) When a mature proglottid breaks off, what is the result? (Eggs are released that pass out of the host in feces.) In a tapeworm's life cycle, what is the primary host, and what is the secondary host? (The primary host is the human. The secondary host is another animal, such as a cow or fish.) How does a human become infected with a tapeworm? (A human eats incompletely cooked meat that contains a tapeworm cyst.) L2

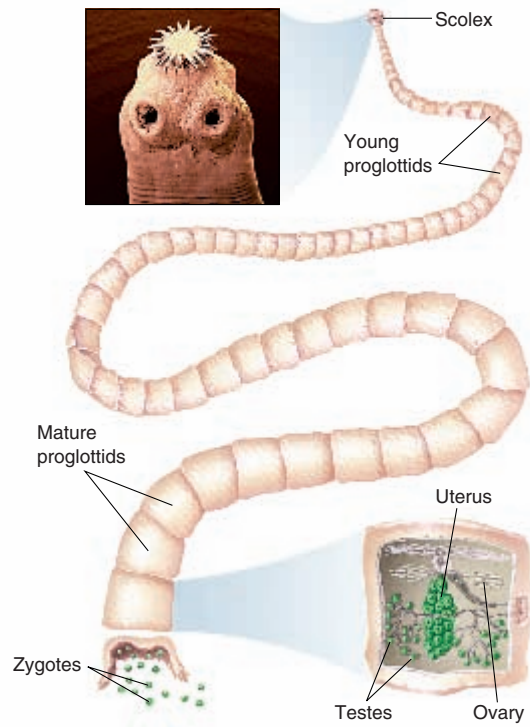
3 ASSESS

Evaluate Understanding

Call on students at random to explain feeding, respiration, circulation, excretion, response, movement, and reproduction in flatworms.

Reteach

Have students review the life cycle of a fluke in Figure 27-5. Then, point out that the life cycle of a tapeworm is described in the text on page 688. Help students use this description to illustrate the life cycle of a tapeworm in a way similar to that in Figure 27-5.



▲ **Figure 27-6** Tapeworms are parasitic flatworms that live in the intestines of their host. A tapeworm attaches to the host using hooks or suckers on its scolex. A single tapeworm is made of many proglottids. The youngest proglottids are at the anterior (head) end, and the largest and most mature proglottids are at the posterior (tail) end. After eggs have been fertilized, proglottids break off and release zygotes that are then passed out of the host in feces.

Tapeworms Members of the class Cestoda (ses-TOHD-uh) are called tapeworms.

Tapeworms are long, flat, parasitic worms that are adapted to life inside the intestines of their hosts. There, they are surrounded by food that has already been digested, so it can be absorbed directly through their body walls. They have no digestive tract.

Figure 27-6 shows the structure of a tapeworm. The head of an adult tapeworm, called a **scolex** (SKOH-leks), is a structure that can contain suckers or hooks. The tapeworm uses its scolex to attach to the intestinal wall of its host, where it absorbs nutrients from the host's intestine. Behind the scolex is a narrow region that divides to produce many **proglottids** (proh-GLAHT-idz), which are the segments that make up most of the worm's body. Mature proglottids contain both male and female reproductive organs. Sperm produced by the **testes** (singular: testis), or male reproductive organs, can fertilize eggs of other tapeworms or of the same individual. After the eggs are fertilized, proglottids break off and burst to release the fertilized eggs, or zygotes. These zygotes are passed out of the host in feces.

If food or water contaminated with tapeworm zygotes is consumed by cows, fishes, or other intermediate hosts, the eggs enter the host and hatch into larvae. These larvae grow and then burrow into the muscle tissue of the intermediate host. There they form a dormant protective stage called a cyst. If a human eats incompletely cooked meat containing these cysts, the larvae become active and grow into adult worms within the human's intestines, beginning the cycle again.

Writing in Science

Students should construct a Venn diagram that shows both free-living and parasitic flatworms as being unsegmented worms with the defining features listed on page 683. The Venn diagram should show that free-living flatworms have organ systems for several physiological processes (while parasitic flatworms don't), and they are typically larger than parasitic flatworms. Other differences, including how nutrients are obtained, should be noted. After constructing the Venn diagram, students should write a well-organized paragraph that describes similarities and differences.

27-1 Section Assessment

- Key Concept** What is a flatworm?
- Key Concept** List the three groups of flatworms and give an example of each.
- How do the feeding methods of parasitic and free-living flatworms relate to their specific environments?
- Describe the life cycle of the blood fluke, *Schistosoma mansoni*.
- Critical Thinking Applying Concepts** How do a turbellarian's nervous system and digestive system work together to provide the food that the worm's body needs?

Writing in Science

Compare-Contrast Paragraph

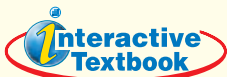
Write a paragraph comparing free-living and parasitic flatworms. Be sure to explain how these worms are alike as well as how they are different. *Hint:* Before you write, construct a Venn diagram to organize your ideas.

27-1 Section Assessment

- A flatworm is a soft, flattened worm with tissues, organ systems, three germ layers, bilateral symmetry, and cephalization.
- Turbellaria: planarian; Trematoda: fluke; Cestoda: tapeworm
- Many parasitic flatworms obtain nutrients from their host's body. Free-living flatworms capture and digest food.
- S. mansoni* matures and reproduces sexually in the blood vessels of human intestines.

Embryos are released with feces and hatch into swimming larvae that infect a snail, where they reproduce asexually. Larvae released from the snail into water can infect humans.

- The nervous system allows the worm to gather information about its environment, including the location of food. The digestive system digests and absorbs the food.



If your class subscribes to the iText, use it to review the Key Concepts in Section 27-1.