# **34 FLATWORMS, ROUNDWORMS, AND ROTIFERS**

Many of the internal organs of this rotifer are visible through its transparent body wall. (L<u>M 675×</u>)

**SECTION 1** Platyhelminthes **SECTION 2** Nematoda and Rotifera

# **PLATYHELMINTHES**

The phylum Platyhelminthes (PLAT-ee-hel-MINTH-eez) includes organisms called flatworms. Their bodies develop from three germ layers and are more complex than those of sponges, cnidarians, and ctenophores. Flatworms have bilaterally symmetrical bodies, with dorsal and ventral surfaces, right and left sides, and anterior and posterior ends.

# STRUCTURE AND FUNCTION OF FLATWORMS

Flatworms are the simplest animals with bilateral symmetry. The tissues in bilaterally symmetrical animals develop from three germ layers: ectoderm, mesoderm, and endoderm. In flatworms, the three germ layers are pressed against one another to form a solid body. Because flatworms do not have a hollow body cavity between the endoderm and the mesoderm, they are acoelomates.

The acoelomate body plan gives flatworms the thin, dorsoventrally flattened bodies for which they are named. This body shape ensures that no cell in a flatworm is very far from the animal's external environment. Thus, the cells can exchange oxygen and carbon dioxide directly with the environment through diffusion, allowing flatworms to survive without a circulatory system or respiratory system. Like cnidarians, most flatworms have a gastrovascular cavity, which is a gut with a single opening, and a mouth. Food is taken in and digested in the gastrovascular cavity, and any undigested material is eliminated through the same opening. Most of the sensory organs and nerve cells of flatworms, such as the marine species shown in Figure 34-1, are located at the anterior end of the body. This characteristic is known as *cephalization*.

The classification of Platyhelminthes has undergone many recent changes. Currently, the more than 20,000 species of flatworms are divided into four classes: Turbellaria, Trematoda, Monogenea, and Cestoda. Trematodes, monogeneans, and cestodes (SES-tohdz) live as parasites on or inside other animals. Almost all turbellarians are nonparasitic, free-living organisms found in marine and freshwater habitats and in moist terrestrial environments. Parasitic flatworms probably evolved from free-living organisms. As parasites evolved, some organs that were advantageous to free-living became modified for parasitism, while other organs were lost entirely.

# **SECTION 1**

## **OBJECTIVES**

- Summarize the distinguishing characteristics of flatworms.
- **Describe** the anatomy of a planarian.
- Compare free-living and parasitic flatworms.
- Diagram the life cycle of a fluke.
- **Describe** the life cycle of a tapeworm.

# **VOCABULARY**

pharynx flame cell cerebral ganglion eyespot fluke tegument primary host intermediate host schistosomiasis scolex proglottid cyst



#### FIGURE 34-1

Many of the sensory organs in this marine flatworm, of the genus *Eurylepta*, are concentrated in the two tentacles at the anterior end of its body. This characteristic is an example of cephalization.



#### **Word Roots and Origins**

pharynx

from the Greek *pharynx,* meaning "throat"

#### FIGURE 34-2

The organ systems of a planarian allow it to maintain its free-living existence. (a) The digestive system consists of the pharynx and gastrovascular cavity, which has many branches. (b) In the excretory system, flame cells collect excess water, which travels through excretory tubules to pores on the surface of the body. (c) The nervous system is a ladderlike arrangement of nerves with two cerebral ganglia at the anterior end. (d) Since planarians are hermaphrodites, their reproductive system includes both testes and ovaries.

# **CLASS TURBELLARIA**

The majority of the approximately 4,500 species in the class Turbellaria live in the ocean. However, the most familiar turbellarian is the freshwater planarian *Dugesia*, shown in Figure 34-2. Planarians have a spade-shaped anterior end and a tapered posterior end. They move through the water by swimming with a wave-like motion of their body. Over solid surfaces, planarians glide on a layer of mucus that they secrete, propelled by the cilia that cover their bodies.

#### **Digestion and Excretion in Planarians**

Planarians feed by scavenging for bits of decaying plant or animal matter. They also prey on smaller organisms, such as protozoa. Food is ingested through a muscular tube called the **pharynx** (FAR-eenks), which the planarian extends from the middle of its body. As Figure 34-2a indicates, the pharynx leads to the highly branched gastrovascular cavity. Cells lining the cavity secrete digestive enzymes and absorb nutrients and small pieces of food. The nutrients then diffuse to other body cells.

Organisms that live in fresh water must deal with the water that constantly enters their bodies by osmosis. Planarians eliminate excess water through a network of excretory tubules that run the length of the body. Figure 34-2b shows that each tubule is connected to several **flame cells**, which are so named because they enclose tufts of beating cilia that resemble flickering candle flames. The beating of cilia in the flame cells draws in the excess water. The water is then transported through the tubules and excreted from numerous pores scattered over the body surface.



#### **Neural Control in Planarians**

The planarian nervous system is more complex than the nerve net of cnidarians, as Figure 34-2c illustrates. Two clusters of nerve cells at the anterior end, the **cerebral ganglia** (suh-REE-bruhl GAN-glee-uh), serve as a simple brain. They receive information from sensory cells and transmit signals to the muscles along a ladderlike arrangement of nerves. A planarian's nervous system gives it the ability to learn. For example, a planarian normally moves away from light, but it can be trained to remain still when illuminated.

Planarians sense the intensity and direction of light with two cup-shaped **eyespots** located near the cerebral ganglia. You can see the eyespots in Figure 34-2c. Other sensory cells respond to touch, water currents, and chemicals in the environment. These cells are distributed over the body, but most are concentrated at the anterior end.

#### **Reproduction in Planarians**

Because planarians are free-living and motile, they can encounter and mate with other individuals of the same species. As shown in Figure 34-2d, planarians are hermaphrodites—they have both male sex organs (testes) and female sex organs (ovaries). When two planarians reproduce sexually, they simultaneously fertilize each other. Their eggs are laid in protective capsules that stick to rocks or debris and hatch in two to three weeks.

Planarians also reproduce asexually, generally during the summer. During asexual reproduction, the body constricts just behind the pharynx. While the posterior part of the worm is attached to a solid surface, the anterior part moves forward until the worm splits in two. This type of asexual reproduction is known as *fission*. The two halves then regenerate their missing parts to produce two complete planaria. During regeneration, each part of the planarian retains information about its original orientation in the body. If a piece is cut from the middle of a planarian, the anterior end of the piece will always regenerate a head and the posterior end of the piece will regenerate a tail.

# CLASSES TREMATODA AND MONOGENEA

The classes Trematoda and Monogenea consist of parasitic **flukes**, leaf-shaped flatworms that parasitize many kinds of animals, including humans. Some flukes are endoparasites that live in the blood, intestines, lungs, liver, or other organs. Others are ectoparasites that live on the external surface of aquatic hosts, such as fish and frogs. Trematodes tend to parasitize a wide range of hosts, whereas monogeneans are mostly ectoparasites of fish and other aquatic animals.



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#### FIGURE 34-3

Suckers on this blood fluke, *Schistosoma mansoni*, attach the fluke to the blood vessels of its host. (SEM  $550 \times$ )

#### FIGURE 34-4

In the life cycle of schistosomes, fertilized eggs are released into the host's blood vessels. The eggs pass out of the primary host in feces or urine. In water, the eggs develop into ciliated larvae. The larvae burrow into certain species of snails, which serve as intermediate hosts. The larvae develop tails, escape from the snail, and swim about. The tailed larvae bore through the exposed skin of a person and settle in his or her blood vessels. There, the larvae develop into adults, and the cycle repeats.

#### **Structure of Flukes**

A fluke clings to the tissues of its host by an anterior sucker and a ventral sucker, which are shown in Figure 34-3. The anterior sucker surrounds the fluke's mouth, which draws the host's body fluids into the gastrovascular cavity. A fluke's nervous system is similar to a planarian's, but flukes have no eyespots and their other sensory structures are very simple. The external surface of a fluke is covered by a layer called the **tegument**. The outer zone of the tegument consists of a layer of proteins and carbohydrates that makes the fluke resistant to the defenses of the host's immune system. The tegument also protects the fluke against the enzymes secreted by the host's digestive tract.

#### **Reproduction and Life Cycle of Flukes**

Most flukes have highly developed reproductive systems and are hermaphroditic. Fertilized eggs are stored in a fluke's uterus, which is a long, coiled tube, until they are ready to be released. Each fluke may release tens of thousands of eggs at a time.

Flukes have complicated life cycles that involve more than one host species. A good example is provided by the trematode blood flukes of the genus *Schistosoma*, as shown in Figure 34-4. Adult schistosomes live inside human blood vessels. Therefore, a human is the schistosome's **primary host**, the host from which the adult parasite gets its nourishment and in which sexual reproduction occurs. Unlike most flukes, schistosomes have separate sexes. Eggs produced by the female are fertilized by the male. In step **1**, some of the fertilized eggs make their way to the host's intestine or bladder and are excreted with the feces or urine. Human feces and



urine often pollute freshwater supplies in regions with poor sewage control. In step **2**, the eggs that enter fresh water develop into ciliated larvae that swim. In step 3, if the larvae encounter a snail of a particular species, such as one of genus Oncomelania, within a few hours, they burrow into the snail's tissues and begin to reproduce asexually. The snail serves as the schistosome's **intermediate host.** the host from which the larvae derive their nourishment. 4 Eventually, the larvae develop tails and escape from the snail. **5** These tailed larvae swim through the water. If they find the bare skin of a human, they penetrate the skin, enter a blood vessel, and develop into adults. The cycle then begins again. Exposure to the larvae can happen when humans swim, bathe, wash clothes, or work in fresh water that contains the larvae.

Not all schistosome eggs leave the human body, however. Many are carried by the blood to the lungs, intestines, bladder, and liver, where they may block blood vessels and cause irritation, bleeding, and tissue decay. The eggs may also penetrate the walls of veins and the small intestine or urinary bladder, where they can cause much tissue damage and bleeding. The resulting disease, called **schistosomiasis** (SHIS-tuh-soh-MIE-uh-suhs), can be fatal. It affects about 200 million people worldwide, mostly in Asia, Africa, and South America.

Other kinds of flukes cause less-serious diseases in humans. For example, a small brown fluke common in freshwater lakes of North America is responsible for swimmer's itch, a condition characterized by minor skin irritation and swelling.

# **CLASS CESTODA**

About 5,000 species of tapeworms make up the class Cestoda. Tapeworms can live in the intestines of almost all vertebrates. Humans may harbor any of seven different species. Tapeworms enter their host when the host eats raw or undercooked food containing eggs or larvae. A tapeworm infection may cause digestive problems, weight loss, lack of energy, and anemia, which is a decrease in the number of red cells in the blood.

#### **Structure of Tapeworms**

Like flukes, tapeworms are surrounded by a tegument that protects them from their host's defenses. As Figure 34-5 shows, at the anterior end of a tapeworm is a knob-shaped organ called the **scolex** (SKOH-leks), which has hooks and suckers that enable the worm to

attach to its host. A short neck connects the scolex with a long series of body sections called **proglottids** (proh-GLAHT-idz). As a tapeworm grows, it adds proglottids just behind the neck, pushing the older proglottids toward the rear. A single tapeworm may have 2,000 proglottids and exceed 10 m (33 ft) in length.

The excretory system and nervous system of a tapeworm are similar to those of other flatworms. However, tapeworms lack eyespots and other lightsensitive structures, and they have no mouth, gastrovascular cavity, or other digestive organs. They absorb nutrients directly from the host's digestive tract through their tegument. The tegument is highly folded, which increases the surface area available for absorption.

#### **Word Roots and Origins**

#### schistosomiasis

from the Greek *schizein*, meaning "to cleave or split," and *soma*, meaning "body," and *iasis*, meaning "process or condition"

#### FIGURE 34-5

A tapeworm grows by adding proglottids behind its scolex. Each proglottid contains both male and female reproductive organs.



#### FIGURE 34-6

Adult beef tapeworms live in the intestines of humans, their primary hosts. **1** Proglottids pass out of the primary host in feces, crawl onto vegetation, and release the tapeworm eggs. **2** A cow, the intermediate host, ingests the eggs when it eats the vegetation. The eggs hatch into larvae that form cysts in the cow's muscles. **3** When a person eats undercooked beef, the larvae in the beef develop into adult tapeworms in the person's intestine, and the cycle repeats.

#### **Reproduction and Life Cycle of Tapeworms**

Nearly all tapeworms are hermaphrodites. You can see in Figure 34-5 that each proglottid contains both male and female reproductive organs, but little else. As the proglottids move to the rear of the tapeworm, they grow, mature, and begin producing eggs. The oldest proglottids are almost completely filled with 100,000 or more eggs. Eggs in one proglottid are usually fertilized by sperm from a different proglottid, either in the same individual or a different individual if the host has more than one tapeworm.

The life cycle of the beef tapeworm, *Taenia saginatus*, is illustrated in Figure 34-6. Like the blood fluke, the beef tapeworm has two hosts. The primary host is a human. In the human intestine, mature proglottids break off from the adult and are eliminated with



the host's feces. If the feces are deposited on the ground, the proglottids crawl out of the feces and onto nearby vegetation. The eggs they release may remain alive for several months before the vegetation is eaten by a cow, the intermediate host. Inside the cow, the eggs develop into larvae that burrow through the cow's intestine and enter the bloodstream. The larvae then make their way to muscle tissue and form cysts, or dormant larvae surrounded by protective coverings. Humans become infected when they eat beef that has not been cooked well enough to kill the worms inside the cysts. Once a cyst enters the human intestine, the cyst wall dissolves and releases the worm. The worm then attaches to the intestinal wall and develops into an adult, beginning the cycle again.

Another tapeworm that infects humans is the pork tapeworm, *Taenia solium*. Its life cycle is similar to that of the beef tapeworm, except that a pig serves as the intermediate host.

#### **SECTION 1 REVIEW**

- 1. Why are flatworms called acoelomates?
- 2. What is a flame cell?
- **3.** Describe two ways in which a planarian shows cephalization.
- Summarize how the schistosome blood fluke affects the human body.
- Explain why tapeworms can survive without a digestive system.

#### **CRITICAL THINKING**

- **6. Recognizing Relationships** Why is it an adaptive advantage that a parasite not kill its host?
- 7. Analyzing Concepts How is asexual reproduction advantageous to a free-living flatworm?
- 8. Applying Concepts Considering the life cycle of the schistosome blood fluke, recommend an effective way of controlling the spread of schistosomiasis.

# NEMATODA AND Rotifera

Members of the phyla Nematoda (nee-muh-TOHD-uh) and Rotifera (roh-TIF-uhr-uh) have bilaterally symmetrical bodies that contain a fluid-filled space. This space holds the internal organs and serves as a storage area for eggs and sperm. It also supports the body and provides a structure against which the muscles can contract.

# **PHYLUM NEMATODA**

The phylum Nematoda is made up of **roundworms**, worms with long, slender bodies that taper at both ends. Roundworms are among several phyla of animals known as *pseudocoelomates*. Pseudocoelomates are so named because they have a pseudocoelom, which is a hollow, fluid-filled cavity that is lined by mesoderm on the outside and endoderm on the inside.

Roundworms range in length from less than 1 mm to 120 cm (4 ft). In contrast to cnidarians, ctenophores, and flatworms, which have a gastrovascular cavity with a single opening, round-worms have a digestive tract with two openings. Food enters the digestive tract through the mouth at the anterior end, and undigested material is eliminated from the anus (AY-nuhs) at the posterior end. A digestive tract represents a significant advancement over a gastrovascular cavity because food moves through the tract in only one direction. This allows different parts of the tract to be specialized for carrying out different functions, such as enzymatic digestion and absorption of nutrients. Most roundworms have separate sexes and are covered by a protective, noncellular layer called the **cuticle** (KYOO-ti-kuhl).

About 15,000 species of roundworms are known, but biologists estimate that there may be 500,000 or more species. The vast majority of roundworm species are free-living on land, in salt water, and in fresh water. One free-living roundworm, *Caenorhabditis elegans*, is a favorite organism of scientists studying developmental biology. However, more than 150 species of roundworms are parasites of plants and animals. These parasitic species damage plant crops and can harm livestock, pets, and humans. Humans are host to about 50 roundworm species. As you read about these roundworms, notice their adaptations for parasitism.

# **SECTION 2**

## **OBJECTIVES**

- Describe the body plan of a nematode.
- Outline the relationships between humans and parasitic roundworms.
- **Describe** the anatomy of a rotifer.

# **VOCABULARY**

roundworm cuticle hookworm trichinosis pinworm filarial worm elephantiasis rotifer mastax cloaca parthenogenesis



#### Roundworms for Your Garden—Just Add Water

Some garden supply companies now sell kits containing millions of microscopic roundworms. When released, these roundworms seek out and kill hundreds of varieties of insect pests, fleas, and ticks. Other types of soil-dwelling roundworms consume bacteria and fungi that attack plants. These roundworms are also known as *beneficial nematodes*.

However, not all roundworms are good for plants. Some species parasitize the roots of plants. Effective pest control with roundworms requires a knowledge of which species are harmful and which are beneficial.





FIGURE 34-7

This pig intestine is completely blocked by roundworms of the genus *Ascaris*.



#### Ascaris

Ascaris (AS-kuh-ris) is a genus of roundworm parasites that live in the intestines of pigs, horses, and humans. Ascarids feed on the food that passes through the intestines of their host. As Figure 34-7 shows, they can become so numerous that they completely block the host's intestines if left untreated. The adult female can reach lengths of up to 30 cm (1 ft). The smaller male has a hooked posterior end that holds the female during mating.

One ascarid female can produce up to 200,000 eggs every day. The fertilized eggs leave the host's body in feces. If they are not exposed to sunlight or high temperatures, they can remain alive in the soil for years. Ascarid eggs enter the body of another host when the host ingests contaminated food or water. The eggs develop into larvae in the intestines. The larvae bore their way into the bloodstream and are carried to the lungs and throat, where they develop further. They are coughed up, swallowed, and returned to the intestines, where they mature and mate, completing the life cycle. If the infection is severe, larvae in the lungs can block air passages and cause bleeding from small blood vessels.

#### Hookworms

**Hookworms** are another group of intestinal parasites. As you can see in Figure 34-8, a hookworm's mouth has cutting plates that clamp onto the intestinal wall. Hookworms feed on their host's blood. Because they remove much more blood than they need for food, a heavy hookworm infection can cause anemia. Hookworm infections in children can result in slowed mental and physical development.

Like ascarids, hookworms release their eggs in the host's feces. The eggs produce larvae in warm, damp soil, and the larvae enter new hosts by boring through the host's feet. They then travel through the blood to the lungs and throat. Swallowing takes them to the intestines, where they develop into adults. Hookworms infect about one billion people worldwide. Most infections occur in tropical and subtropical regions.



#### FIGURE 34-8

This SEM shows the hookworm *Ancyclostoma duodenale,* which uses its plates to cut into the host's intestine, releasing blood on which the hookworm feeds.

#### **Trichinella**

Roundworms of the genus *Trichinella* infect humans and a variety of other mammals, including pigs. Adult trichina worms live embedded in the walls of the host's intestine. They produce larvae that travel through the bloodstream to the muscles, where they form cysts. Figure 34-9 shows several such cysts. People become infected when they eat undercooked meat—usually pork—that is contaminated with cysts. After they are eaten, the cysts release the larvae, which burrow into the intestinal wall and mature into adults. Trichina infections are responsible for the disease **trichinosis** (TRIK-i-NOH-sis), which causes mus-



#### **Other Parasitic Roundworms**

The most common roundworm parasite of humans in the United States is the **pinworm**, *Enterobius*. School-age children have the highest infection rate, which in some areas is as many as 50 percent of children. Despite their high rate of infection, pinworms do not cause any serious disease. Adult pinworms are 5–10 mm (0.2–0.4 in.) in length and resemble white threads. They live and mate in the lower portion of the intestine. At night, the females migrate out of the intestine and lay eggs on the skin around the anus. When an infected person scratches during sleep, the eggs are picked up by the person's hands and spread to anything the person touches. Eggs that are ingested hatch in the intestine, where the worms develop into adults.

Filarial (fuh-LAR-ee-uhl) worms are disease-causing roundworms that infect over 250 million people in tropical countries. The most dangerous filarial worms live in the lymphatic system, a part of the circulatory system that collects excess fluid around cells and returns it to the blood. The adult worms can be as long as 100 mm (4 in.). The larvae they produce enter the blood and are picked up by mosquitoes that draw blood from an infected person. The larvae develop into an infective stage inside the mosquitoes and are injected into the blood of another person when the mosquitoes feed again. Inside the new host, the larvae complete their development and settle in the lymphatic system. When they are present in large numbers, filarial worms can block the lymphatic vessels, causing fluid to accumulate in the limbs. In severe cases, the limbs become extremely swollen and skin hardens and thickens, a condition known as elephantiasis (EL-uh-fuhn-TIE-uh-sis). Another type of filarial worm infects dogs and cats. Large numbers of Toxocara canis or T. cati live in the heart and large arteries of the lungs and are responsible for heartworm disease.



#### FIGURE 34-9

Larvae of the trichina roundworm coil up inside cysts in their hosts' muscle tissue. The cysts are stained blue in this light micrograph  $(100 \times)$ .



#### Comparing Flatworms and Roundworms

**Materials** living planarian, preserved specimens of tapeworms, male and female ascarids, hand lens or stereomicroscope

**Procedure** Examine specimens of tapeworms, ascarids, and the living planarian. Try to locate the following structures on each worm: anterior end, posterior end, mouth, eyespot, hooks, suckers, and anus. Draw each worm and label each of the features you located.

#### Analysis

- **1.** List the features found on the posterior and anterior end of each worm.
- **2.** Which worm has a separate mouth and an anus?
- **3.** Which worm "absorbs" digested nutrients?
- **4.** Which worm has a digestive tract?



#### **FIGURE 34-10**

Cilia surrounding the mouth of a rotifer sweep food into the animal's digestive tract.



# **PHYLUM ROTIFERA**

Another group of pseudocoelomates are the approximately 1,750 species in the phylum Rotifera. Members of this phylum are called **rotifers.** Most rotifers are transparent, free-living animals that live in fresh water, although some live in salt water and damp soil. They typically range in length from 100 to 500  $\mu$ m, with males being much smaller than females. Many rotifers can survive without water for long periods, during which they dry up and look like grains of sand. When wet conditions return, they absorb water and resume their activities. Although rotifers are tiny, they are truly multicellular and have specialized organ systems.

As Figure 34-10 illustrates, rotifers have a crown of cilia surrounding their mouth. Under a microscope, the crown with its beating cilia looks like a pair of rotating wheels. Rotifers use their cilia to sweep food-algae, bacteria, and protozoa-into their digestive tract. As shown in Figure 34-10, food moves from the mouth to the **mastax**, a muscular organ that breaks the food into smaller particles. The food is further digested in the stomach, and the nutrients are absorbed in the intestine. Indigestible material passes from the intestine to the cloaca (kloh-AY-kuh), a common chamber into which the digestive, reproductive, and excretory systems empty. Like planarians, rotifers use flame cells and excretory tubules to collect excess water in the body. The excess water, along with wastes from the intestine and eggs from the ovaries of females, leaves the cloaca through the anus. Rotifers exhibit cephalization, with a pair of cerebral ganglia and, in some species, two eyespots at the anterior end of the body.

Rotifer reproduction is unusual because some species of rotifers reproduce by parthenogenesis. In the process of **parthenogenesis** (PAHR-thuh-NOH-JEN-uh-sis), unfertilized eggs develop into adult females. Other species produce two types of eggs. Eggs of one type develop into small males that produce sperm. The sperm fertilizes eggs of the other type, which then form tough-coated zygotes that can survive poor conditions.

#### **SECTION 2 REVIEW**

- **1.** Identify two features of roundworms and rotifers that flatworms do not have.
- **2.** How are the roundworms of the genus *Ascaris* transmitted from one host to another?
- **3.** Describe one parasitic adaptation of a roundworm.
- 4. What is the function of the cilia found on the anterior end of a rotifer?

#### **CRITICAL THINKING**

- **5. Inferring Relationships** How are parasites able to recognize their hosts?
- 6. Applying Concepts Based on what you have learned about the life cycle of roundworms, recommend a method of preventing the transmission of parasitic roundworms.
- **7. Analyzing Graphics** Study Figure 34-10. Suggest a function of the projections at the posterior end of the rotifer.

### SECTION 1 Platyhelminthes

- The phylum Platyhelminthes is made up of flatworms, the simplest animals that have bilateral symmetry. Flatworms have three germ layers and are acoelomates.
- Most flatworms have a gut with a single opening, called a gastrovascular cavity. These cephalized animals also have excretory, nervous, and reproductive systems.
- The class Turbellaria consists mostly of nonparasitic flatworms, including the freshwater planarian. Planarians are sexually reproducing hermaphrodites that can also reproduce asexually by splitting in two and regenerating the missing parts.
- The classes Trematoda and Monogenea consist of parasitic flukes. Fluke life cycles include two types of hosts: a primary host, from which the adults derive their nourishment, and an intermediate host, from which the larvae derive their nourishment.
- The class Cestoda consists of parasitic tapeworms. Tapeworms do not have a digestive system, so they absorb nutrients through their body surface. Tapeworms have a series of body sections called proglottids, each of which contains reproductive structures. Tapeworm life cycles involve primary and intermediate hosts.

#### Vocabulary

pharynx (p. 690) flame cell (p. 690) cerebral ganglion (p. 691) **eyespot** (p. 691) **fluke** (p. 691) **tegument** (p. 692)

primary host (p. 692) intermediate host (p. 692) schistosomiasis (p. 693) scolex (p. 693) proglottid (p. 693) cyst (p. 694)

## SECTION 2 Nematoda and Rotifera

- The phylum Nematoda consists of roundworms. Most roundworms are free-living, but some are parasites of plants and animals.
- Nematodes are pseudocoelomates. They have a hollow, fluid-filled cavity called a pseudocoelom between the mesoderm and the endoderm. They also have a digestive tract with an anterior mouth and posterior anus.
- Ascarid worms infect people who consume food or water containing eggs of the genus *Ascaris*. The eggs develop into larvae that migrate through the body and mature in the intestines.
- Hookworm larvae in the soil burrow through a person's feet. The larvae migrate through the body and mature in the intestines.

- Trichina worms infect people who consume undercooked meat containing cysts of the genus *Trichinella*. The cysts release larvae that burrow into the intestinal wall and develop into adults.
- Pinworms live in the lower intestine and lay eggs on the skin around the anus. After being transmitted by the hands to other objects, the eggs may be ingested. They then hatch in the intestine, where the worms mature.
- Filarial worms include species that live in the human lymphatic system. Their larvae are transmitted between hosts by mosquitoes.
- Rotifers are pseudocoelomates, and most rotifers are free-living in fresh water. The cilia surrounding a rotifer's mouth sweeps food into its digestive tract.

#### Vocabulary

roundworm (p. 695) cuticle (p. 695) hookworm (p. 696) trichinosis (p. 697) pinworm (p. 697) filarial worm (p. 697) elephantiasis (p. 697) rotifer (p. 698) mastax (p. 698) cloaca (p. 698) parthenogenesis (p. 698)



# **USING VOCABULARY**

- **1.** For each pair of terms, explain how the meanings of the terms differ.
  - a. *tegument* and *cuticle*
  - b. primary host and intermediate host
  - c. schistosomiasis and trichinosis
  - d. anus and cloaca
  - e. scolex and mastax
- 2. Choose the term that does not belong in the following group, and explain why it does not belong: *eyespot, flame cell, gastrovascular cavity,* and *proglottid.*
- **3.** Explain the relationship between *proglottid* and *cyst*.
- **4.** Word Roots and Origins The word part *roti*means "wheel," and the suffix *-fera* means "bearer." Using this information, explain why *Rotifera* is a good name for the phylum of organisms it describes.

# **UNDERSTANDING KEY CONCEPTS**

- **5. Explain** how a flatworm can survive without a circulatory system or a respiratory system.
- 6. **Describe** the nervous system of a planarian.
- 7. Summarize reproduction in planarians.
- **8. Sequence** the following steps in the schistosome life cycle in the correct order, beginning with the first step after sexual reproduction.
  - a. Tailed larvae swim through the water.
  - b. Ciliated larvae swim through the water.
  - c. Larvae penetrate the skin of a human.
  - d. Larvae reproduce asexually in the intermediate host.
  - e. Larvae burrow into a snail.
  - f. Larvae enter a blood vessel and develop into adults.
  - g. Fertilized eggs leave the primary host in the feces or urine.
- 9. Compare a primary host to an intermediate host.
- **10. Identify** some adaptations of flukes to a parasitic way of life.
- **11. Explain** how tapeworms are specialized for a parasitic way of life.
- **12. Relate** how a person can avoid becoming infected by a beef tapeworm.
- **13. Compare** the body plan of a nematode to that of a flatworm.
- **14. Name** some features shared by roundworms and rotifers.

- **15. Describe** feeding and digestion in a rotifer.
- **16. CONCEPT MAPPING** Use the following terms to create a concept map that shows the major characteristics of the phylum Nematoda: *roundworms, pseudocoelomates, digestive tract, cuticle, free-living, water, parasites, separate sexes,* and eggs.

# **CRITICAL THINKING**

- **17. Applying Information** The Aswan High Dam across the Nile River in Egypt was completed in 1970. The dam was built to increase the supply of irrigation water, control major flooding, and provide a source of hydroelectric power. Since the dam was built, however, there has been an increase in the incidence of schistosomiasis in the region. Why do you think this has happened?
- **18.** Distinguishing Relevant Information A person infected with a tapeworm may show symptoms such as tiredness, loss of weight, and anemia, which could indicate any number of diseases. How might a doctor be certain that the symptoms are caused by a tapeworm?
- **19. Recognizing Relationships** Hookworm infections are extremely common in China, where rice is grown in paddies that are periodically flooded. Considering what you know about how hookworms invade the human body, why do you think hookworm infections are so common in this part of the world?
- **20. Analyzing Patterns** Some rotifers can survive being dried out for as long as four years. When they are placed in water again, they revive. For what kind of environment might this characteristic be adaptive?
- **21. Interpreting Graphics** Identify the animal in the photograph below. Give reasons for your choice.





**DIRECTIONS:** Choose the letter that best answers the question.

- **1.** What does a planarian use its pharynx for?
  - **A.** feeding
  - **B.** movement
  - **C.** reproduction
  - **D.** to respond to light
- **2.** Where do blood flukes of the genus *Schistosoma* reproduce asexually?
  - **F.** in water
  - **G.** inside a snail
  - $\ensuremath{\textbf{H}}\xspace$  inside a cow's intestine
  - J. inside a human's blood vessels
- 3. What does a tapeworm use its scolex for?
  - A. to reproduce
  - **B.** to attach itself to its host
  - **C.** to eliminate excess water
  - $\boldsymbol{D}\!\!\!\!$  to force food into its mouth
- **4.** Which of the following is true of most rotifers?
  - **F.** They are parasitic.
  - **G.** They live in the soil.
  - $\ensuremath{\textbf{H}}\xspace$  . They feed with the help of cilia.
  - J. They have a gastrovascular cavity.

**INTERPRETING GRAPHICS:** The figure below shows the internal structure of a planarian of the genus *Dugesia*. Use the figure to answer the questions that follow.



- What type of animal is shown in the figure?
  A. flatworm
  - **B.** tapeworm
  - **C.** roundworm
  - **D.** rotifer
- **6.** What is the structure labeled *X*?
  - **F.** the brain
  - $\boldsymbol{\mathsf{G}}.$  the mouth
  - $\boldsymbol{\mathsf{H}}\xspace$  an eyespot
  - J. a nerve cord
- **7.** What is the structure labeled *Y*?
  - $\boldsymbol{\mathsf{A}}.$  the mouth
  - $\textbf{B.} a \ flame \ cell$
  - **C.** an eyespot
  - $\boldsymbol{D}\!.$  the gastrovascular cavity

**DIRECTIONS:** Complete the following analogy.

- 8. fluke : schistosomiasis :: filarial worm :
  - **F.** trichinosis
  - **G.** elephantiasis
  - **H.** encysted meat
  - J. swimmer's itch

**INTERPRETING GRAPHICS:** The figure below shows the internal structure of a rotifer. Use the figure to answer the question that follows.



- **9.** Which structures are involved in excretion? **A.** K and L
  - **A.** K and L **B.** L and O
  - **B.** L and O **C.** M and N
  - **D.** M and P

#### SHORT RESPONSE

Planarians and rotifers eliminate water through a network of excretory structures that run the length of the body.

Explain why the excretory structures in planarians and rotifers are called flame cells.

#### **EXTENDED RESPONSE**

Parasitic flatworms have life cycles that include primary and intermediate hosts.

- *Part A* Distinguish between primary and intermediate hosts in flatworms.
- *Part B* Sequence the life cycle of a beef tapeworm. Identify the primary and intermediate hosts.

**Test TIP** Take the time to read each question completely on a standardized test, including all the answer choices. Consider each possible choice before determining which answer is correct.



# **INQUIRY LAB**

# **Observing Flatworm Responses to Stimuli**

#### OBJECTIVES

- Observe the feeding behavior of flatworms.
- Study the response of flatworms to different stimuli.

#### PROCESS SKILLS

- observing
- predicting
- experimenting
- collecting data
- analyzing data

#### MATERIALS

- Dugesia
- culture dish
- stereomicroscope
- blunt probe
- test tube
- test-tube rack
- aluminum foil
- wax pencil
- medicine dropper
- cork stopper
- stopwatch or clock
- sheet of white paper
- raw liver
- small flashlight

#### Background

- **1.** What are some characteristics of the phylum Platyhelminthes?
- **2.** *Dugesia*, a planarian, is a nonparasitic flatworm belonging to the class Turbellaria. What are some characteristics of this class?
- **3.** What is meant by cephalization, and why is it an important evolutionary advance?
- **4.** What structures does a planarian have that enable it to sense light? Where are these structures located?

#### **PART A** Observing a Flatworm

- 1. CAUTION You will be working with a live animal. Be sure to treat it gently and to follow directions carefully. Use a medicine dropper to transfer one flatworm to a small culture dish. Gently cover the flatworm with water from the culture jar. Why should you use water from the culture jar instead of tap water?
- 2. Examine the flatworm under the low-power setting of the stereomicroscope. Notice the shape of its body. What kind of symmetry does it have? What structural features demonstrate this symmetry? Does the flatworm appear to have a distinct head and tail? How can you tell?
- **3.** Observe how the flatworm moves. Look at the surface of the flatworm under high power. Can you see any structures that could account for its movement?

#### **PART B** Response to Touch

- **4.** In your lab report, make a data table like the one shown. Predict the behavior you think will occur to each type of stimulus. As you complete the following steps, record your observations of the flatworm in your data table.
- **5. CAUTION Touch the flatworm gently.** Using a blunt probe, gently touch the posterior end of the flatworm. Notice its response. Now gently touch its anterior end. How does the response compare? What can you conclude from your observations?





#### **PART C** Feeding Behavior

- **6.** Place a tiny piece of raw liver in the culture dish. Observe the flatworm for several minutes and describe its feeding response in your data table. Why is it important to use flatworms that have not been recently fed?
- **7.** After several minutes, use the probe to gently turn the flatworm over. What do you observe? If you have time, watch as the flatworm eats the liver. Where do you think the undigested waste will come out?

#### **PART D** Response to Gravity

- **8.** With a wax pencil, draw a line around the middle of a test tube.
- **9.** Fill the test tube almost full with water from the culture jar. Then use a medicine dropper to transfer one flatworm to the test tube. Seal the test tube with a stopper.
- **10.** Hold the test tube horizontally and move it slowly back and forth until the flatworm is centered on the line you drew.
- **11.** To test whether the flatworm can sense gravity, place the test tube vertically in the test-tube rack. Which way should the flatworm move to show a positive response to gravity? Observe the flatworm for several minutes. Use a stopwatch to measure the amount of time the flatworm spends above the line and below the line. Record the times in your data table.

#### **PART E** Response to Light

- **12.** Check the lighting in the room. The light must be low and even during this part of the investigation.
- **13.** Using a piece of aluminum foil, make a cover that is big enough to fit over the bottom half of the test tube

you used in Part D. Set the cover aside. Place the test tube horizontally on a white sheet of paper. Make sure the test tube is level. Why is it important for the test tube to be level in this experiment?

- **14.** Position the flashlight so that it will shine directly on the test tube, but do not turn it on.
- **15.** Wait for the flatworm to move to the center line. Then gently place the foil cover over the bottom half of the test tube, and turn the flashlight on. Which way should the flatworm move to show a positive response to light? Observe the movements of the flatworm. Use the stopwatch to measure the amount of time the flatworm spends in each half of the test tube. Record the times in your data table.
- **16.** Return the flatworm to the culture jar. Then clean up your materials, and wash your hands before leaving the lab.

#### **Analysis and Conclusions**

- **1.** What evidence does the flatworm show of cephalization?
- **2.** The flatworm has an incomplete digestive system and no circulatory system. How do you think a flatworm's food gets to the cells after it is digested?
- **3.** How does the flatworm respond to gravity? Is the response positive or negative?
- **4.** How does the flatworm respond to light? Is the response positive or negative?
- **5.** Are the flatworm's anterior and posterior ends equally sensitive to light?

#### **Further Inquiry**

Design an experiment to study the responses of flatworms to other stimuli, such as vibrations or sound.

Behavior	Predictions	Observations
Response to touch with blunt probe		
Feeding behavior		
Response to gravity		
Response to light		

#### **OBSERVATIONS OF FLATWORM BEHAVIOR**

