

# Sponges, Cnidarians, Flatworms, and Roundworms

### What You'll Learn

- You will identify and compare and contrast the characteristics of sponges, cnidarians, flatworms, and roundworms.
- You will describe and evaluate the significance of sponge, cnidarian, flatworm, and roundworm adaptations.

### Why It's Important

Sponges and cnidarians are important to aquatic biomes. Flatworms and roundworms include many species that carry or cause diseases that affect both plants and animals.

### Understanding the Photo

Marine flatworms, like this *Thysanozoon nigropapillosum*, move by rhythmic contractions of their longitudinal muscles. The colors and pigment patterns of marine flatworm species vary. This flatworm lives in the Red Sea, which is between the Arabian peninsula and northeast Africa.



### Biology Online

Visit [bdol.glencoe.com](http://bdol.glencoe.com) to

- study the entire chapter online
- access Web Links for more information and activities on sponges, cnidarians, flatworms, and roundworms
- review content with the Interactive Tutor and self-check quizzes

# Section 26.1

## SECTION PREVIEW

### Objectives

**Relate** the sessile life of sponges to their food-gathering adaptations.

**Describe** the reproductive adaptations of sponges.

### Review Vocabulary

**sessile:** permanently attached to a surface (p. 674)

### New Vocabulary

filter feeding  
hermaphrodite  
external fertilization  
internal fertilization

# Sponges



**Sponges** Make the following Foldable to help you learn the characteristics of sponges.

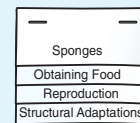
**STEP 1 Collect** 2 sheets of paper and layer them about 1.5 cm apart vertically. Keep the edges level.



**STEP 2 Fold** up the bottom edges of the paper to form 4 equal tabs.



**STEP 3 Fold** the papers and crease well to hold the tabs in place. Staple along the fold. **Label** each tab.



**Organize Information** As you read Section 26.1, list information on each tab about that sponge characteristic.

## Word Origin

**porifera** from the Greek word *poros*, meaning “passage,” and the Latin word *ferre*, meaning “to carry”; Phylum Porifera includes animals with pores that allow water to flow through their bodies.

## What is a sponge?

Sponges are asymmetrical aquatic animals that have a variety of colors, shapes, and sizes. Many are bright shades of red, orange, yellow, and green. Some sponges are ball shaped; others have many branches. Sponges can be smaller than a quarter or as large as a door. Although sponges do not resemble more familiar animals, they carry on the same life processes as all animals. *Figure 26.1* shows a natural sponge harvested from the ocean.

## Sponges are pore-bearers

Sponges are classified in the invertebrate phylum Porifera, which means “pore bearer.” More than 5000 species of sponges have been described. Most live in marine biomes, but about 150 species can be found in freshwater environments.

Sponges are mainly sessile organisms. Because most adult sponges can't travel in search of food, they get their food by a process called filter feeding. **Filter feeding** is a method in which an organism feeds by filtering small particles of food from water that pass by or through some part of the organism. How does a sponge get rid of its wastes?

**Figure 26.1**

This bath sponge is dark brown or black in its natural habitat. After harvest, it is washed and dried in sunlight. The living material dies and is rinsed away. Only the sponge's pale, lightweight framework remains.



## A Sponge

**Figure 26.2**

Sponges have no tissues, organs, or organ systems. The body plan of a sponge is simple, being made up of only two layers of cells with no body cavity. Between these two layers is a jellylike substance that contains other cells as well as the components of the sponge's internal support system. Sponges have specialized cells that perform all the functions necessary to keep them alive. **Critical Thinking** *Why are sponges classified as animals?*



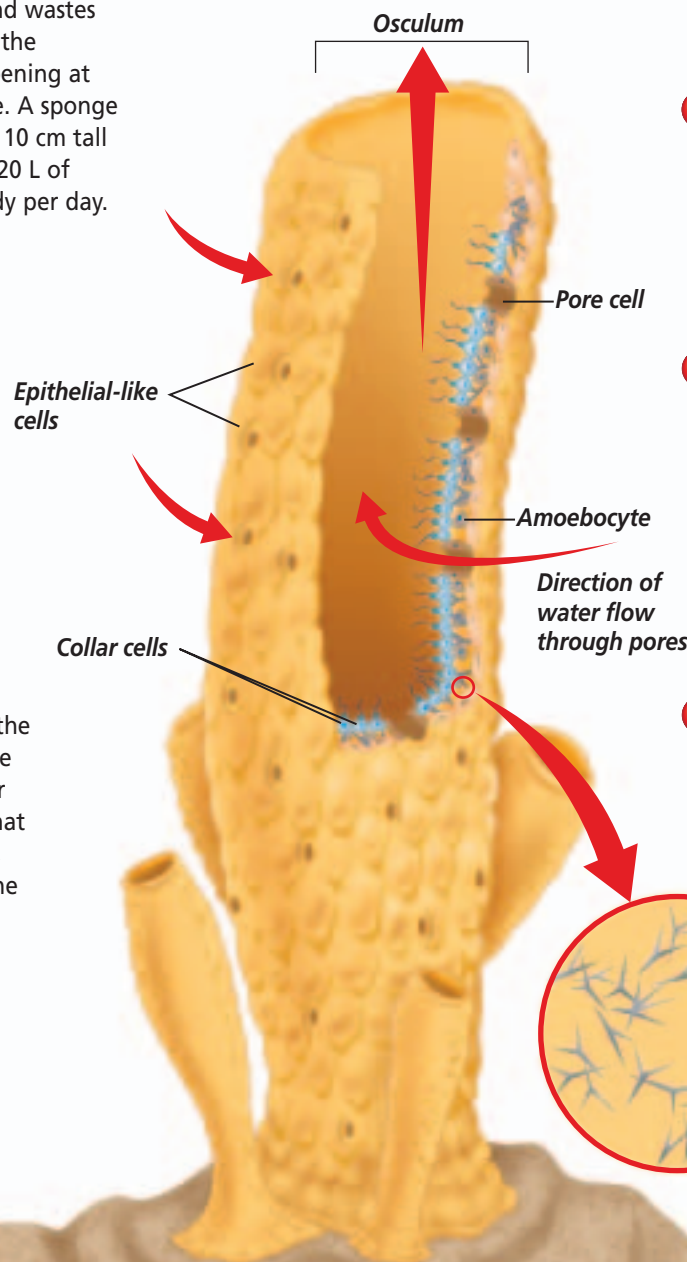
Orange tube sponges

Fred McComaughy/Photo Researchers

**A Osculum** Water and wastes are expelled through the osculum, the large opening at the top of the sponge. A sponge 1 cm in diameter and 10 cm tall can move more than 20 L of water through its body per day.

**B Epithelial-like cells** These cells are thin and flat. They contract in response to touch or to irritating chemicals. In so doing, they close pores in the sponge.

**C Collar cell** Lining the interior of sponges are collar cells. Each collar cell has a flagellum that whips back and forth, drawing water into the sponge.



**D Pore cell** Surrounding each pore is a pore cell. Pore cells allow water carrying food and oxygen into the sponge's body.

**E Amoebocytes** Located between the two cell layers of a sponge, amoebocytes carry nutrients to other cells, aid in reproduction, and produce chemicals that help make up the spicules of sponges.

**F Spicules** They are produced by cells derived from amoebocytes, and form the hard support systems of sponges. The small, needlelike structures located between the cell layers of a sponge are called spicules.

## Cell organization in sponges

Like all animals, sponges are multicellular, as shown in *Figure 26.2* on the opposite page. Their cells are differentiated to perform functions that help the animal survive. Read the *Problem-Solving Lab* on this page to find out how sponges survive in different environments. The functions of the different cell types are coordinated in a sponge, but sponges do not have tissues like those found in other animals. Tissues are groups of cells that are derived from the ectoderm, endoderm, and mesoderm in the embryo. Sponge embryos do not develop endoderm or mesoderm, so they do not have cells organized into tissues.

For some sponge species, if you took a living sponge and put it through a sieve, not only would the sponge's cells be alive and separated out, but these cells would come together to form new sponges. It can take several weeks for the sponge's cells to reorganize themselves.

Many biologists hypothesize that sponges evolved directly from colonial, flagellated protists, such as *Volvox*, described in Chapter 19. More importantly, sponges exhibit a major step in the evolution of animals—the change from a unicellular life to a division of labor among groups of organized cells.

## Reproduction in sponges

Sponges can reproduce asexually and sexually. Depending on the species, asexual reproduction can be by budding, fragmentation, or the formation of gemmules. An external growth, called a bud, can form on a sponge. If a bud drops off, it can float away, settle, and grow into a sponge. Sometimes, buds do not break off. When this occurs, a colony of sponges forms, as shown in *Figure 26.3*. Often, fragments of a sponge break off and grow into new sponges.

## Problem-Solving Lab 26.1

### Apply Concepts

**Why are there more species of marine sponges than freshwater sponges?** Most sponges live in a marine biome. Is there an advantage for sponges to live in a marine biome rather than in a freshwater environment? A series of statements is provided below. Read them, then answer the questions that follow.

### Solve the Problem

- The internal tissues of marine organisms are isotonic with their surroundings.
- Oceans do not have rapid changes in the velocity (rate of flow) of water.
- Young marine animals often spend the early part of their life cycles as free-floating organisms.

### Thinking Critically


- Describe** Based on statement A, how might a freshwater environment vary? How might this be a disadvantage for freshwater sponges?
- Describe** Based on statement B, how might a freshwater environment vary? How might this be a disadvantage for freshwater sponges?
- Infer** Using your collective answers, explain why few sponge species are found in freshwater environments.

**Figure 26.3**

Sponge colonies can form by asexual reproduction. **Infer** *How would these sponges compare genetically? Could they be considered clones?*



Some freshwater sponges produce seedlike particles, called gemmules, in the fall when waters cool. The adult sponges die over the winter, but the gemmules survive and grow into new sponges in the spring when waters warm.

 **Reading Check** **Compare and contrast** budding and the formation of gemmules.

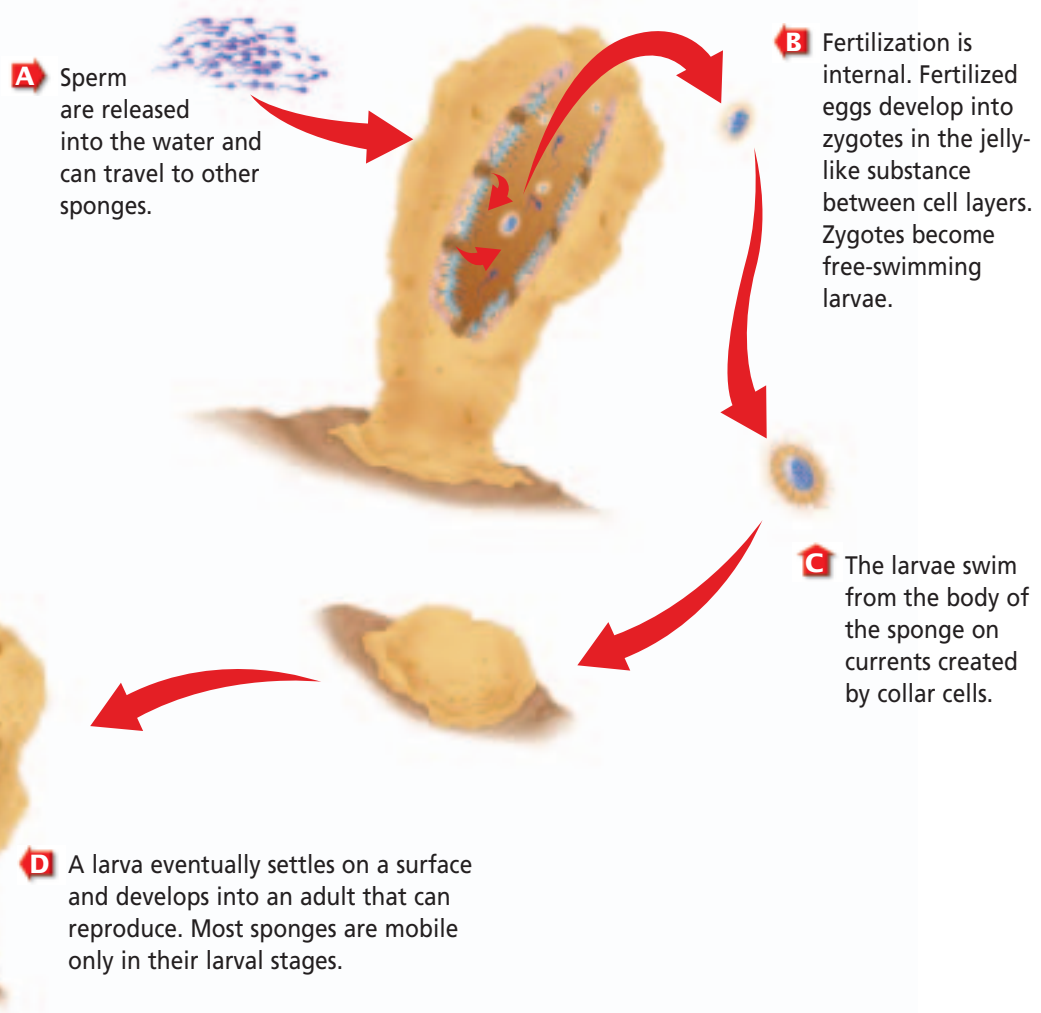
Most sponges reproduce sexually. Some sponges have separate sexes, but most sponges are hermaphrodites. A **hermaphrodite** (hur MAF ruh dite) is an animal that can produce both eggs and sperm. Hermaphroditism increases the likelihood that fertilization will occur in sessile or slow-moving animals. Eggs and sperm form from

amoebocytes. During reproduction, sperm released from one sponge can be carried by water currents to another sponge, where fertilization can occur.

Fertilization in sponges may be either external or internal. A few sponges have **external fertilization**—fertilization that occurs outside the animal's body. Most sponges have **internal fertilization**, in which eggs inside the animal's body are fertilized by sperm carried into the sponge with water. In sponges, the collar cells collect and transfer sperm to amoebocytes. The amoebocytes then transport the sperm to ripe eggs. Fertilization occurs and the result is the development of free-swimming, flagellated larvae, shown in *Figure 26.4*.

**Figure 26.4**

In sponges, part of the sexual reproductive process is the release of sperm to the surrounding water.





**A**

**Figure 26.5**

The spicules of freshwater sponges, such as these lake sponges **(A)**, protect them from predators. Spicules of the deep-water glass sponges form a rigid framework **(B)**.



**B**

### Support and defense systems in sponges

Sponges are soft-bodied invertebrates, that can be found at depths to about 8500 m. Their internal structure gives them support and can help protect them from predators. Some sponges have sharp, hard spicules located between the cell layers. Spicules may be made of glasslike material or of calcium carbonate. Some species, such as the lake sponges shown in *Figure 26.5*, have thousands of tiny, sharp, needlelike spicules that make them hard for animals to eat. Other

sponges have an internal framework made of silica or of spongin, a fibrous protein-like material. Sponges can be classified according to the shape and makeup of their spicules and/or frameworks.

Besides sharp spicules, some sponges may have other methods of defense. Some sponges contain chemicals that are toxic to fishes and to other predators. Scientists are studying sponge toxins to identify those that possibly could be used as medicines.

## Section Assessment

### Understanding Main Ideas

1. Explain how a sponge obtains food.
2. Explain how epithelial-like cells control filter feeding in sponges.
3. Compare and contrast sexual and asexual reproduction of sponges.
4. Describe the functions of amoebocytes in sponges.
5. Infer why hermaphroditism is a reproductive advantage for sessile organisms.

### Thinking Critically

6. Compare and evaluate the adaptations of multicellular organisms, such as sponges, and unicellular organisms for obtaining food.

### SKILL REVIEW

7. **Make and Use Tables** Make a table listing cell types and other sponge structures along with their functions. For more help, refer to *Make and Use Tables* in the **Skill Handbook**.



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CONTENTS

# Section 26.2

## SECTION PREVIEW

### Objectives

**Analyze** the relationships among the classes of cnidarians.

**Sequence** the stages in the life cycle of a cnidarian.

**Evaluate** the adaptations of cnidarians for obtaining food.

### Review Vocabulary

**endocytosis:** a process where a cell engulfs materials with a portion of the cell's plasma membrane and releases the contents inside the cell (p. 200)

### New Vocabulary

polyp  
medusa  
nematocyst  
gastrovascular cavity  
nerve net

# Cnidarians

## Settlers and Floaters

**Finding Main Ideas** On a piece of paper, construct an outline about cnidarian characteristics, such as those of the corals shown here. Use the red and blue titles in this section as a guideline. As you read the paragraphs that follow the titles, add important information and vocabulary words to your outline.



Orange clump coral,  
*Tubastrea aurea*

### Example:

- I. What is a cnidarian?
  - A. Body structure
    1. Radially symmetrical with one opening and two layers of cells
    2. Gas exchange occurs directly between cells and water
  - B. Body form
    1. Polyp form has a tube-shaped body with a mouth surrounded by tentacles.

Use your outline to help you answer questions in the Section Assessment on page 705. For more help, refer to *Outline* in the **Skill Handbook**.

## What is a cnidarian?

Cnidarians (ni DARE ee uns) are a group of invertebrates made up of more than 9000 species of jellyfishes, corals, sea anemones, and hydras. They can be found worldwide, and all but a few cnidarians live in marine biomes.

### Body structure

Cnidarians are a diverse group of organisms but all have the same basic body structure, as shown in *Figure 26.6*. A cnidarian's body is radially symmetrical. It has one body opening and is made up of two layers of cells. The protective outer layer of cells develops from the ectoderm of the cnidarian embryo. The endoderm of the cnidarian embryo develops into the inner layer of cells. The two cell layers are organized into tissues with specific functions. For example, the inner layer is adapted mainly to assist in digestion.

Because a cnidarian's body is only two layers of cells, no cell is ever far from water. Oxygen dissolved in water can diffuse directly into body cells. Carbon dioxide and other wastes can move out of a cnidarian's body cells directly into the surrounding water.

### Word Origin

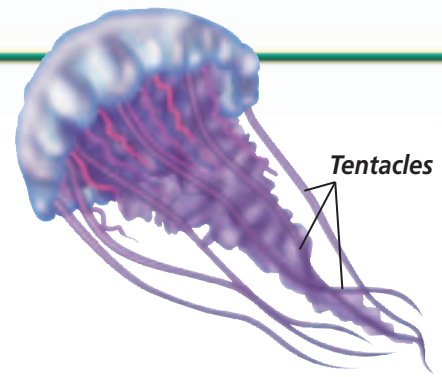
**cnidarian** from the Greek word *knide*, meaning "nettle," a plant with stinging hairs; Cnidarians have stinging cells in their tentacles.

## A Cnidarian

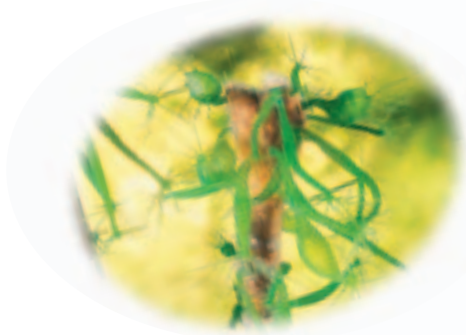
**Figure 26.6**

Cnidarians display a remarkable variety of colors, shapes and sizes. Some can be as small as the tip of a pencil. The flowerlike forms of sea anemones are often brilliant shades of red, purple, and blue. Most cnidarians have two distinct body forms during their life cycles. **Critical Thinking** *How is having poisonous stinging cells an advantage for a sessile organism?*

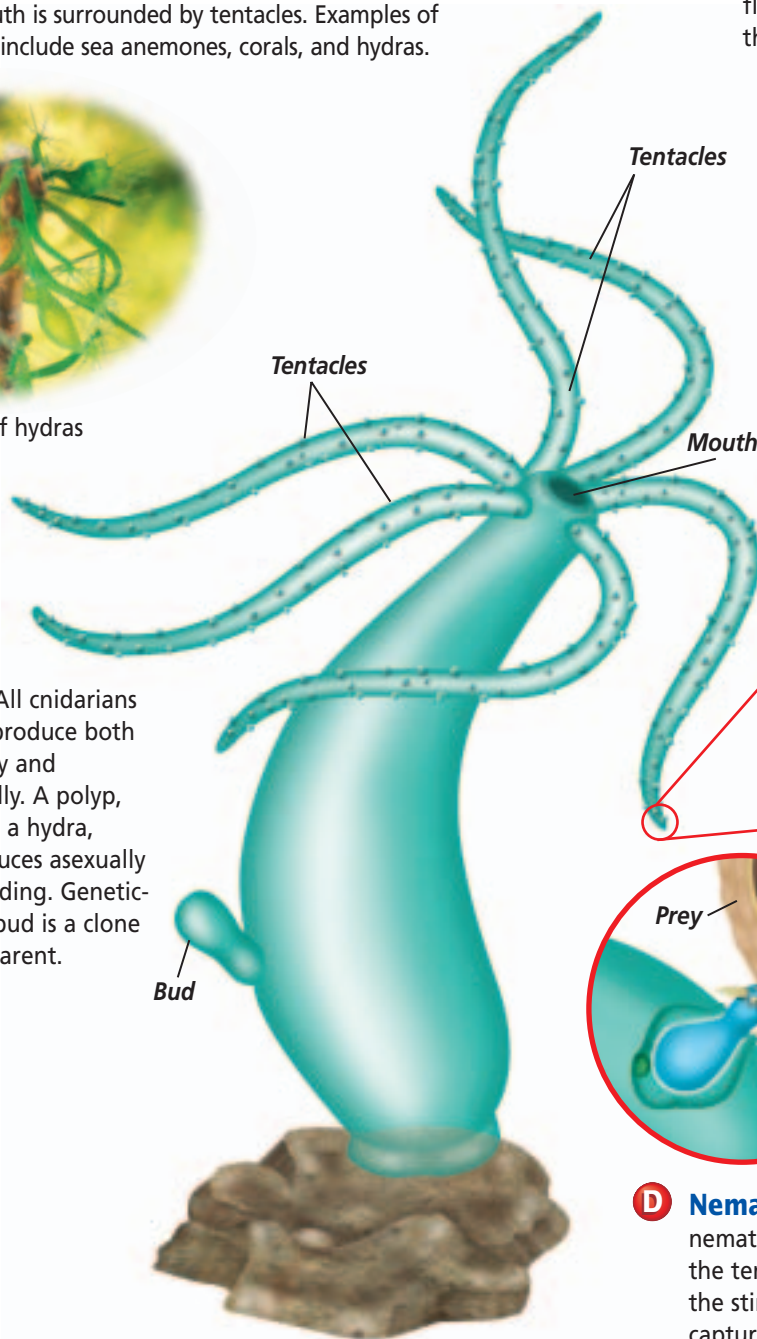
**A Polyp** A polyp is the sessile form of a cnidarian. Its mouth is surrounded by tentacles. Examples of polyps include sea anemones, corals, and hydras.



**B Medusa** A medusa is the free-swimming form of a cnidarian. It possesses an umbrella-shaped, floating body, called a bell, with the mouth on its underside.



A colony of hydras



**C Tentacles** A ring of flexible, tubelike structures called tentacles surrounds the mouth of a cnidarian. Tentacles are used to capture food and vary greatly in length from several meters, like those of some jellyfishes, to a few millimeters, like those of hydras.

**E Bud** All cnidarians can reproduce both sexually and asexually. A polyp, such as a hydra, reproduces asexually by budding. Genetically, a bud is a clone of its parent.

**D Nematocysts** Stinging cells that contain nematocysts are located primarily at the tips of the tentacles. When prey touches the tentacles, the stinging cells discharge nematocysts that capture or paralyze the prey.



## Body form

Most cnidarians undergo a change in body form during their life cycles. There are two body forms, the polyp and the medusa, as shown in **Figure 26.7**. A **polyp** (PAH lup) has a tube-shaped body with a mouth surrounded by tentacles. A **medusa** (mih DEW suh) has an umbrella-shaped body, called a bell, with tentacles that hang down. Its mouth is on the underside of the bell.

In cnidarians, one body form may be more observable than the other. In jellyfishes, the medusa is the body

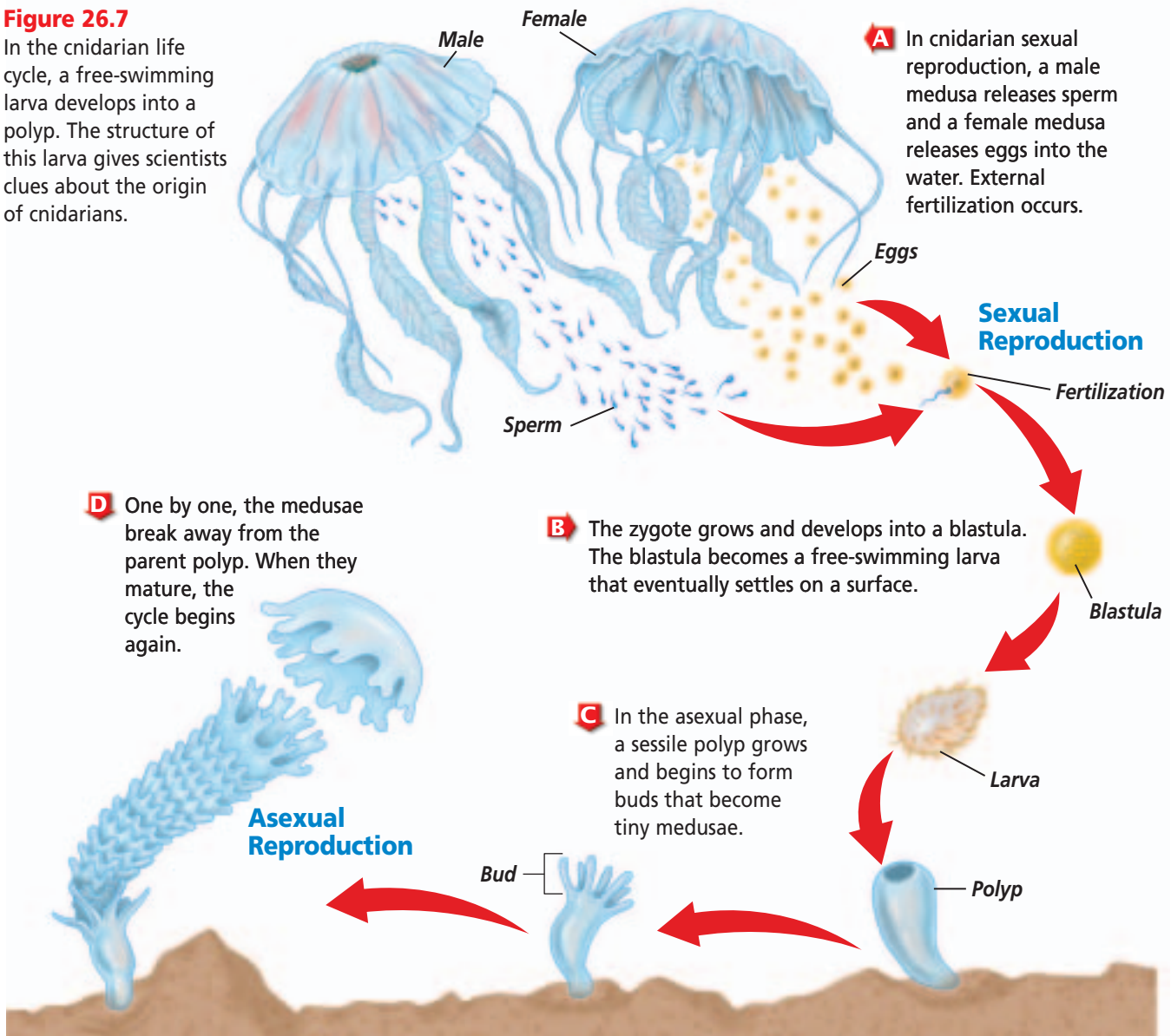
form usually observed. The jellyfish polyp is small and not easily seen. The polyp is the familiar body form of hydras. Its medusa form is small and delicate. Corals and sea anemones have only polyp forms.

## Reproduction in cnidarians

All cnidarians have the ability to reproduce sexually and asexually. Sexual reproduction occurs in only one phase of the life cycle. It usually occurs in the medusa stage, unless there is no medusa stage then the polyp can reproduce sexually.

**Figure 26.7**

In the cnidarian life cycle, a free-swimming larva develops into a polyp. The structure of this larva gives scientists clues about the origin of cnidarians.





**A**

**B**

**Figure 26.8**

The main form of reproduction in polyps is budding. During this process, small buds grow as extensions of the body wall (A). In some species, such as corals (B), a colony develops as the buds break away and settle nearby.

The most common form of reproduction in cnidarians can be illustrated by the life cycle of a jellyfish, as shown in **Figure 26.7**. As you can see, the sexual medusa stage alternates with the asexual polyp stage, from generation to generation. Male medusae release sperm, and female medusae release eggs into the water where fertilization occurs. The resulting zygotes develop into embryos, and then into larvae. Recall that a larva is an intermediate stage in animal development. The free-swimming larva eventually settles and grows into a polyp that reproduces asexually to form new medusae. Even though these two stages alternate in a cnidarian's life cycle, this form of reproduction is not alternation of generations as in plants. In plants, one generation is diploid and the other is haploid. However, both cnidarian medusae and polyps are diploid animals.

Asexual reproduction can occur in either the polyp or medusa stage. Polyps reproduce asexually by a process known as budding, as shown in **Figure 26.8**. Cnidarians that remain in the polyp stage, such as hydras, corals and sea anemones, also can reproduce sexually as polyps.

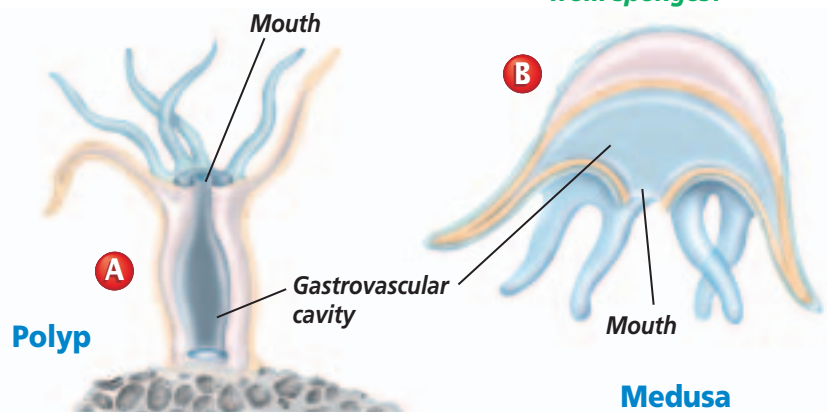
### Digestion in cnidarians

Cnidarians are predators that capture or poison their prey using nematocysts. A **nematocyst** (nih MA tuh sihst) is a capsule that contains a coiled, threadlike tube. The tube may be sticky or barbed, and it may contain toxic substances. Nematocysts are located in stinging cells that are on tentacles. In response to touch or chemicals in the environment, nematocysts are discharged like toy popguns, but much faster. Prey organisms are then taken in for digestion.

The origins of a digestive process, which is similar to that of animals that evolved later, are found in cnidarians.

**Figure 26.9**

In addition to digestion, the gastrovascular cavity in a polyp (A) and a medusa (B) also function in circulation and gas exchange. Compare **How is this different from sponges?**



## MiniLab 26.1

### Observe

**Watching Hydra Feed** Hydras are freshwater cnidarians. They have the typical polyp body plan and radial symmetry. Observe how they capture their food.

### Procedure

- 1 Use a dropper to place a hydra into a watch glass filled with water. Wait several minutes for the animal to adapt to its new surroundings.  
**CAUTION: Use caution when handling a microscope and glassware.**
- 2 Observe the hydra under low-power magnification.
- 3 Form a hypothesis as to how this animal obtains its food and/or catches its prey.
- 4 Place brine shrimp in a petri dish of freshwater to avoid introducing salt into the watch glass.
- 5 Add a drop of brine shrimp to the watch glass while continuing to observe the hydra through the microscope.
- 6 Note which structures the hydra uses to capture food.
- 7 Wash your hands after completing this investigation.



Hydra eating copepod

### Analysis

1. **Describe** How does a hydra capture food?
2. **Explain** Was your hypothesis supported or rejected?
3. **Sequence** List the events that take place when a hydra captures and feeds upon its prey.
4. **Conclude** Do your observations support the fact that hydras have both nervous and muscular systems? Explain.

Once captured by nematocysts, prey is brought to the mouth by contraction of the tentacles.

As shown in *Figure 26.9* on the previous page, the inner cell layer of cnidarians surrounds a space called a **gastrovascular cavity** (gas troh VAS kyuh lur) **cavity**. Cells adapted for digestion line the gastrovascular cavity and release enzymes over captured prey. Any undigested materials are ejected back out through the mouth. You can observe a cnidarian feeding in the *MiniLab* on this page. Cnidarians are classified into groups partly based on whether or not there are divisions within the gastrovascular cavity, and if there are, how many divisions are present.

### Nervous system in cnidarians

A cnidarian has a simple nervous system without a control center, such as a brain like that of other animals. In cnidarians, the nervous system consists of a **nerve net** that conducts impulses to and from all parts of the body. The impulses from the nerve net cause contractions of musclelike cells in the two cell layers. For example, the movement of tentacles when a cnidarian captures prey is the result of contractions of these musclelike cells.

## Diversity of Cnidarians

There are four classes of cnidarians: Hydrozoa, Scyphozoa, Cubozoa, and Anthozoa. Cubozoans once were classified as scyphozoans.

### Most hydrozoans form colonies

The class Hydrozoa includes two groups—the hydroids, such as hydra, and the siphonophores, including the Portuguese man-of-war. Most hydroids are marine animals that consist of branching polyp colonies formed

### Figure 26.10

*Physalia* colonies are found primarily in tropical waters, but they sometimes drift into temperate waters where they can be washed up on shore.



by budding, and are found attached to pilings, shells, and other surfaces. The siphonophores include floating colonies that drift about on the ocean's surface. Hydrozoans have open gastrovascular cavities with no internal divisions.

It's difficult to understand how the organism shown in **Figure 26.10** could be a closely associated group of individual animals. The Portuguese man-of-war, *Physalia*, is an example of a siphonophore hydrozoan colony. Each individual in a *Physalia* colony has a function that helps the entire organism survive. For example, just one individual forms a large, blue, gas-filled float. Regulation of gases in the float allows the colony to sink to lower depths or rise to the water's surface. Other polyps hanging from the float have functions, such as reproduction and feeding. The polyps all function together for the survival of the colony.

### Scyphozoans are the jellyfishes

Have you ever seen a jellyfish like the one shown in **Figure 26.11**? The fragile and sometimes luminescent bodies of jellyfishes can be beautiful. Some jellyfishes are transparent, but others are pink, blue, or orange. The medusa form is the dominant stage in this class.

The gastrovascular cavity of scyphozoans has four internal divisions. Like other cnidarians, scyphozoans have musclelike cells in their outer cell layer that can contract. When these cells contract together, the bell contracts, which propels the animal through the water.

Jellyfishes can be found everywhere in the oceans, from arctic to tropical waters. They have been seen at depths of more than 3000 m. Swimmers should avoid jellyfishes because of their painful stings.



### Most anthozoans build coral reefs

Anthozoans are cnidarians that exhibit only the polyp form. All anthozoans have many incomplete divisions in their gastrovascular cavities.

Sea anemones are anthozoans that live as individual animals, and are thought to live for centuries. They can be found in tropical, temperate, and arctic seas. Some tropical sea anemones may have a diameter of more than a meter.

Corals are anthozoans that live in colonies of polyps in warm ocean waters around the world. They secrete protective, cuplike calcium carbonate shelters around their soft bodies. Colonies of many coral species build the beautiful coral reefs that provide food and shelter for many other marine species. Corals that form reefs are known as hard corals. Other corals are known as soft corals because they do not build such structures. When a coral polyp dies, its shelter is left behind, which adds to the coral reef's structure.

#### Figure 26.11

The jellyfish *Chrysaora hysoscella* has the common name compass jellyfish due to the radiating brown lines on its bell.

## Problem-Solving Lab 26.2

### Interpret Data

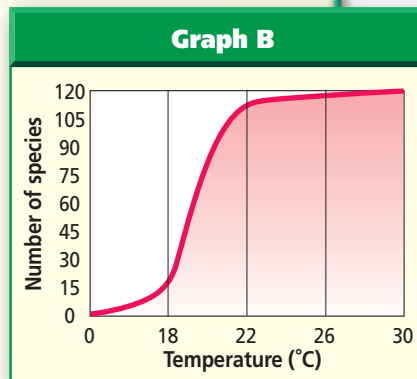
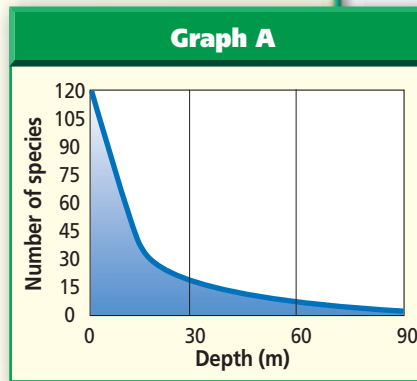
**What ocean conditions limit the number of coral species?** All corals that build reefs have a mutualistic symbiotic relationship with zooxanthellae. Zooxanthellae within the coral carry on photosynthesis and provide some nutrients to the coral. Animals caught by the coral provide some nutrients to these protists.

### Solve the Problem

Graph A shows the number of species present in coral reefs at certain depths. Graph B shows the number of species present at different temperatures. The effects of abiotic factors on organisms are usually related. For example, temperature and levels of illumination in an ocean vary with depth.

### Thinking Critically

- 1. Identify** What abiotic and biotic factors were studied in this ocean environment?
- 2. Explain** In Graph A, what seems to be the correlation between number of coral species present and depth? Use actual numbers from the graph in your answers.
- 3. Explain** In Graph B, what seems to be the correlation between number of species present and the temperature? Use actual numbers from the graph in your answer.
- 4. Describe** Write a description of the environment that has 75 species of corals.

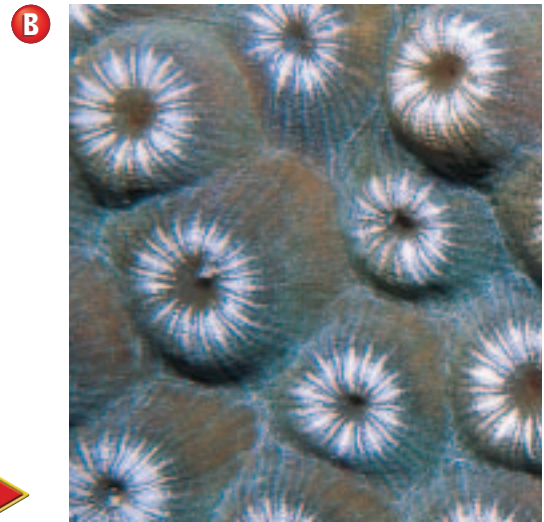
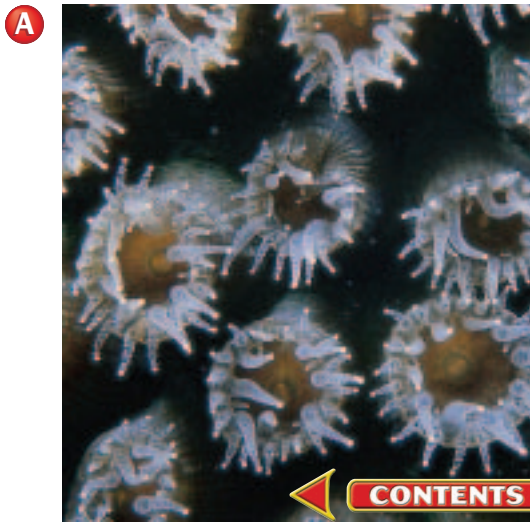


The living portion of a coral reef is a thin, fragile layer that grows on top of the shelters left behind by previous generations. Coral reefs form slowly. It took thousands of years to form the reefs found today in tropical and subtropical waters. Find out more about the fragility of coral reefs by reading the *Biology and Society* feature at the end of this chapter.

A coral polyp extends its tentacles to feed, as shown in *Figure 26.12*. Although corals are often found in relatively shallow, nutrient-poor waters, they thrive because of their symbiotic relationship with microscopic, photosynthetic protists called zooxanthellae (zoh oh zan THEE lee). The zooxanthellae produce oxygen and food that the corals use, while using carbon dioxide and waste materials produced by the corals. These protists are primarily responsible for the bright colors found in coral reefs. Because the zooxanthellae are free-swimming, they sometimes leave the corals. Corals without these protists often die. You can find out how corals respond to changing environmental conditions in *Problem-Solving Lab 26.2*.

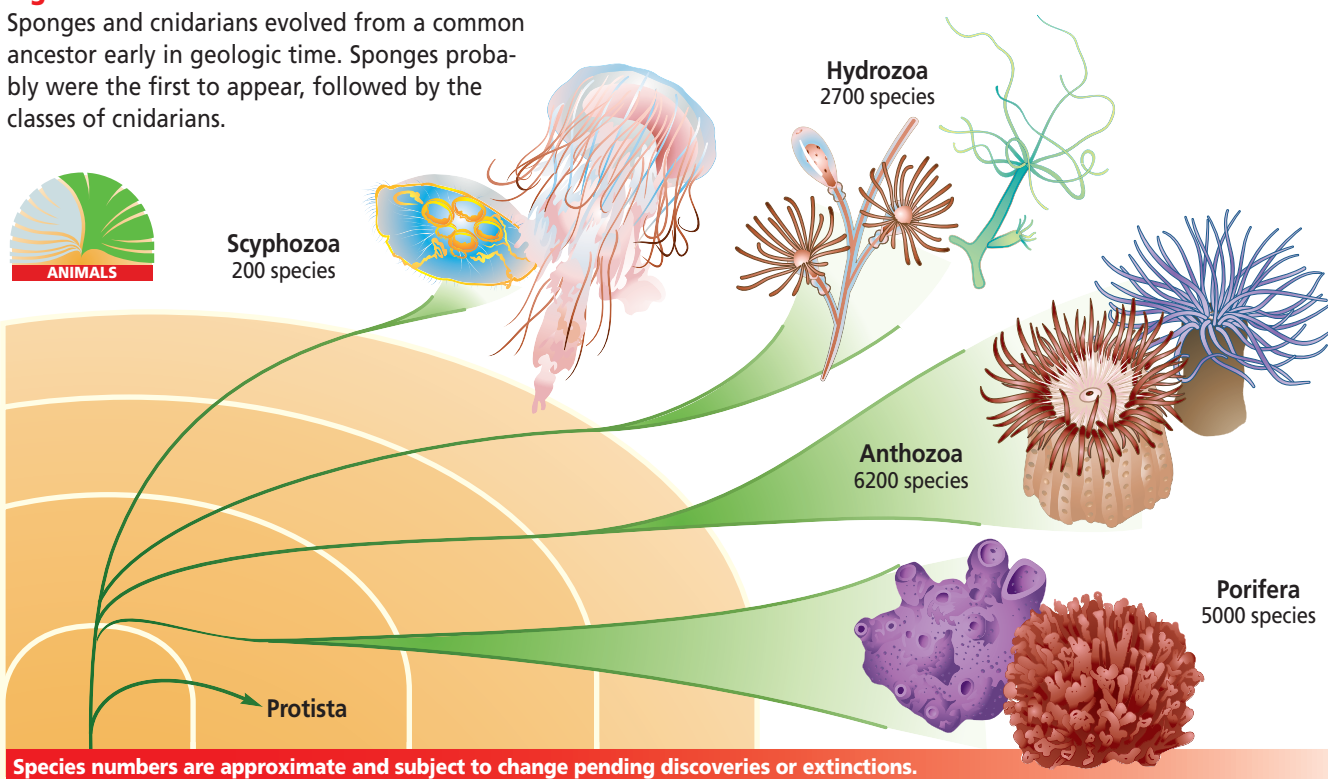
**Figure 26.12**

Corals feed by extending their tentacles outside their calcium carbonate cups (A). If they are threatened, they can retreat back into the cups (B) until danger has passed.



**Figure 26.13**

Sponges and cnidarians evolved from a common ancestor early in geologic time. Sponges probably were the first to appear, followed by the classes of cnidarians.



## Origins of Sponges and Cnidarians

As shown in *Figure 26.13*, sponges represent an old animal phylum. The earliest fossil evidence for sponges dates this group to late in the Precambrian, about 650 million years ago. Scientists infer that sponges may have evolved directly from a group of flagellated protists that today resemble the collar cells of sponges.

The earliest known cnidarians also date to the Precambrian, about 630 million years ago. Because cnidarians are soft-bodied animals, they do not preserve well as fossils, and their origins are not well understood. The earliest coral species were not reef builders, so reefs cannot be used to date early cnidarians. The larval form of cnidarians resembles protists, and because of this, scientists consider cnidarians to have evolved from protists.

### Section Assessment

#### Understanding Main Ideas

1. Evaluate the adaptations of cnidarians for obtaining food.
2. Diagram and interpret the advantage of the reproductive cycle of a jellyfish.
3. What are the advantages of a two-layered body in cnidarians?
4. Distinguish between corals and other cnidarians.

#### Thinking Critically

5. Investigate and explain how destruction of a large coral reef would affect other ocean life.

#### Skill Review

6. **Get the Big Picture** In a table, list the three main groups of cnidarians, their characteristics, and a member of each group. For more help, refer to *Get the Big Picture* in the **Skill Handbook**.



# Section 26.3

## SECTION PREVIEW

### Objectives

**Distinguish** between the structural adaptations of parasitic flatworms and free-living planarians.

**Explain** how parasitic flatworms are adapted to their way of life.

### Review Vocabulary

**acoelomate:** an animal that has three cell layers—ectoderm, endoderm, and mesoderm—but no body cavity (p. 682)

### New Vocabulary

regeneration  
pharynx  
scolex  
proglottid

# Flatworms

## This Is the Life

**Using an Analogy** Imagine the ultimate couch potato life. All of your needs are provided while you stay on the couch. Food and beverages are supplied constantly and wastes are taken away. Over time, however, you could become totally dependent on someone to supply all of your needs. This describes the parasitic life of a tapeworm, like the one shown to the right.

**Compare and Contrast** As a class, compile two lists: Advantages of Parasitism and Disadvantages of Parasitism. Infer what structural adaptations are found in most parasites.

Color-enhanced SEM Magnification: 15X



Tapeworm scolex

## What is a flatworm?

To most people, the word worm describes a spaghetti-shaped animal. Many animals have this general appearance, but are classified into different phyla. The least complex worms belong to the phylum Platyhelminthes (pla tee HEL min theeZ), as shown in **Figure 26.14**. These flatworms are acoelomates with thin, solid bodies. They range in size from 1 mm up to several meters. There are approximately 14 500 species of flatworms found in marine and freshwater environments and in moist habitats on land.



**Figure 26.14**

A tapeworm (A) is a parasite that invades and lives in a host organism. A fluke (B) usually requires two hosts in its complex life cycle. A planarian (C) is not parasitic, nor does it cause disease.

LM Magnification: 10X

The most well-known members of this phylum are the parasitic tapeworms and flukes, which cause diseases in other animals, among them frogs and humans. The most commonly studied flatworms in biology classes are the free-living planarians. You can learn about the evolutionary relationships among these flatworm groups in the *Problem-Solving Lab* on this page.

### Nervous control in planarians

Most of a planarian's nervous system is located in its head—a characteristic common to other bilaterally symmetrical animals. The nervous system enables a planarian to respond to stimuli in its environment. Some flatworms have a nerve net, and others have the beginnings of a central nervous system. A planarian's nervous system includes two nerve cords that run the length of the body, as shown in *Figure 26.15*. It also includes eyespots that can detect the presence or absence of light and sensory cells that can detect chemicals and movement in water. At the anterior end of the nerve cord is a small swelling called a ganglion (plural, ganglia). The ganglion receives messages from the eyespots and sensory pits, then communicates with the rest of the body along the nerve cords. Messages from the nerve cords trigger responses in a planarian's muscle cells.

### Reproduction in planarians

Like many of the organisms studied in this chapter, most flatworms including planarians, are hermaphrodites. During sexual reproduction, individual planarians exchange sperm, which travel along special tubes to reach the eggs. Fertilization occurs internally. The zygotes are released in capsules into the water, where they hatch into tiny planarians.

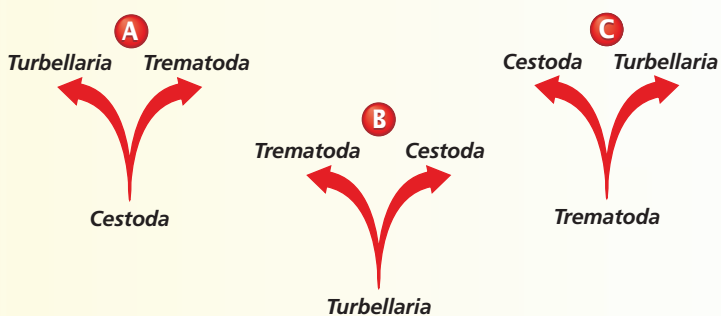
## Problem-Solving Lab 26.3

### Predict

**Which came first?** There are three classes of flatworms. One class, Turbellaria, consists of free-living flatworms. The other two classes, Trematoda (flukes) and Cestoda (tapeworms), consist of parasitic organisms that often have mammal hosts, including humans.

### Solve the Problem

Diagrams A, B, and C show a possible evolutionary relationship among the three classes. The class at the bottom of each diagram supposedly evolved first.

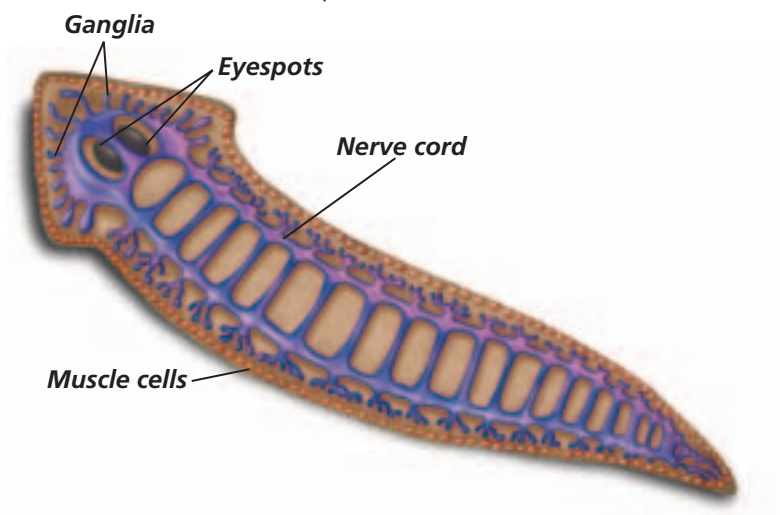


### Thinking Critically

One of the three evolutionary patterns is correct. Choose the one that you consider to be correct. Explain your reasoning. Analyze, review, and critique your explanation as to its strengths and weaknesses using scientific information.

**Figure 26.15**

The simple nervous system of a planarian enables it to respond to stimuli in its environment.





## A Planarian

**Figure 26.16**

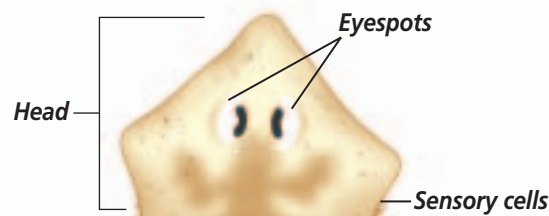
If you've ever waded in a shallow stream and turned over some rocks, you may have found tiny, black organisms stuck to the bottom of the rocks. These organisms were most likely planarians. Planarians have many characteristics common to all species of flatworms. The bodies of planarians are flat, with both a dorsal and a ventral surface. All flatworms have bilateral symmetry. **Critical Thinking** *Why is having a head an advantage to a swimming animal?*

LM Magnification: 10×



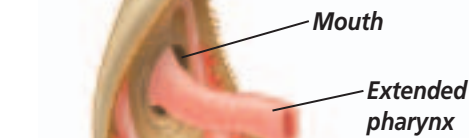
Planarian

**A Head** Flatworms have a clearly defined head. The head senses and responds to changes in the environment.



**B Eyespots** Eyespots are sensitive to light and enable the animal to respond to the amount of light present.

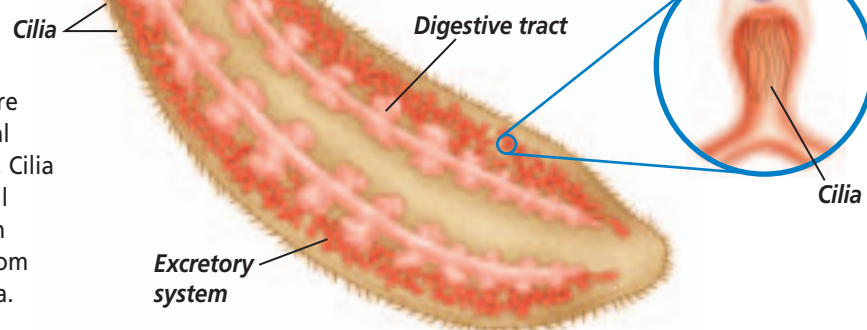
**F Pharynx** The pharynx is a muscular tube that can extend out through a planarian's mouth. It is used to take food into the planarian's digestive system.



**C Sensory cells** Located on each side of the head, sensory cells can detect food, chemicals, and movements in the environment.

**D Flame cells** Excess water is removed from the planarian's body by a system of flame cells. The water from flame cells collects in tubules and leaves the body through pores on the body surface.

**E Cilia** Hairlike cilia are located on the ventral surface of planarians. Cilia help the worm to pull itself along. Planarian locomotion results from the movement of cilia.



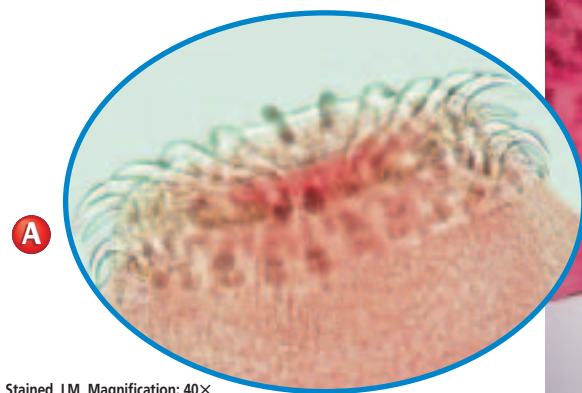
Planarians also can reproduce asexually. When a planarian is damaged, it has the ability to regenerate, or regrow, new body parts. **Regeneration** is the replacement or regrowth of missing body parts. Missing body parts are replaced through cell divisions. If a planarian is cut horizontally, the section containing the head will grow a new tail, and the tail section will grow a new head. Thus, a planarian that is damaged or cut into two pieces may grow into two new organisms—a form of asexual reproduction. The *BioLab* at the end of this chapter is about regeneration in planarians.

### Feeding and digestion in planarians

A planarian feeds on dead or slow-moving organisms. It extends a tube-like, muscular organ, called the **pharynx** (FAHR inx), out of its mouth, as shown in *Figure 26.16*. Enzymes released by the pharynx begin digesting food outside the animal's body. Food particles are sucked into the digestive tract, where they are broken up. Cells lining the digestive tract obtain food by endocytosis. Food is thus digested in individual cells.

#### Figure 26.17

The scolex (A) is covered with hooks and suckers that attach to the intestinal lining of the host. Mature proglottids full of fertilized eggs (B) are shed. Eggs hatch when they are eaten by a secondary host.



Stained LM Magnification: 40×

### Feeding and digestion in parasitic flatworms

A parasitic flatworm is adapted to obtaining nutrients from inside the bodies of one or two hosts. Recall that a parasite is an organism that lives on or in another organism and depends upon that host organism for its food. Parasitic flatworms have mouthparts with hooks that keep the flatworm firmly attached inside its host. Because they are surrounded by nutrients, they do not need to move to seek out or find food. Parasitic flatworms do not have complex nervous or muscular tissue.

### Tapeworm bodies have sections

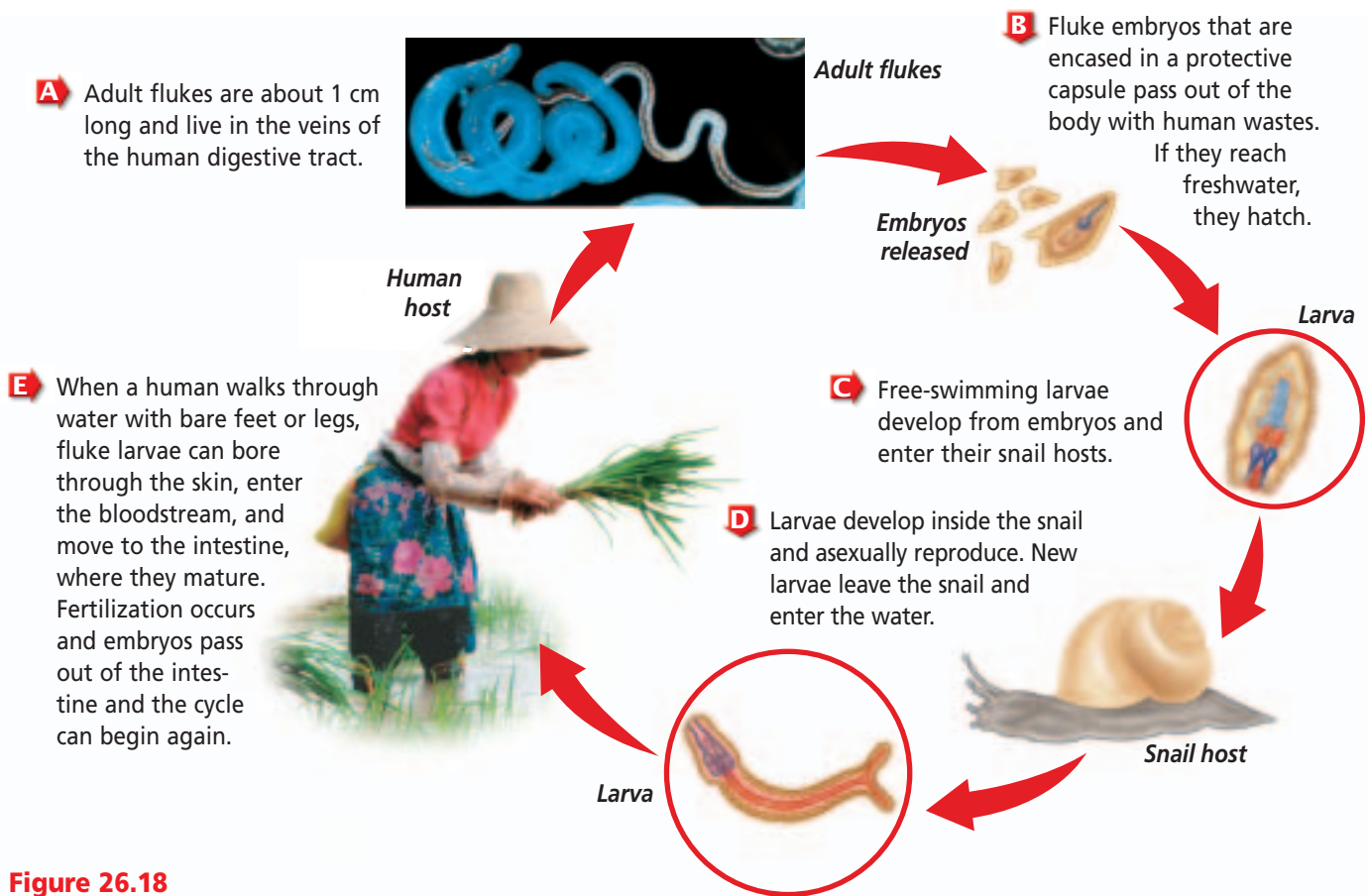
The body of a tapeworm is made up of a knob-shaped head called a **scolex** (SKOH leks), and detachable, individual sections called proglottids, as shown in *Figure 26.17*. A **proglottid** (proh GLAH tihd) contains muscles, nerves, flame cells, and male and female reproductive organs. Each proglottid can contain up to 100 000 eggs. Some adult tapeworms that live in animal intestines can be more than 10 m in length and consist of 2000 proglottids.

#### Word Origin

**scolex** from the Greek word *skolek*, meaning "worm"; A scolex is the knob-shaped head of a tapeworm.

LM Magnification: 5×





**Figure 26.18**

The fluke, *Schistosoma*, requires two hosts to complete its life cycle.

### The life cycle of a fluke

A fluke is a parasitic flatworm that spends part of its life in the internal organs of a vertebrate, such as a human or a sheep. It obtains its nutrition by feeding on cells, blood, and other fluids of the host organism. Flukes have complex life cycles that can include one, two, or more invertebrate and/or vertebrate hosts.

Blood flukes of the genus *Schistosoma*, as shown in **Figure 26.18**, cause a disease in humans known as schistosomiasis. Schistosomiasis is common in countries where rice is grown. Farmers must work in standing water in rice fields during planting and harvesting. Blood flukes are common where the secondary host, snails, also are found.

## Section Assessment

### Understanding Main Ideas

1. Diagram and label the structures of a planarian.
2. Explain why a tapeworm doesn't have a digestive system.
3. Discuss the adaptive advantage of a nervous system for a free-living flatworm.
4. Make a table to compare and contrast the body of a tapeworm and that of a planarian.

### Thinking Critically

5. Examine the life cycle of a parasitic fluke, and suggest ways to prevent infection on a rice farm.

### SKILL REVIEW

6. **Observe and Infer** How might an organism that has no mouth or digestive system interact with other organisms in its environment? For more help, refer to *Observe and Infer* in the **Skill Handbook**.



# Section 26.4

## SECTION PREVIEW

### Objectives

**Compare and contrast** the structural adaptations of roundworms and flatworms.

**Identify** the characteristics of four roundworm parasites.

**Review Vocabulary**  
**pseudocoelom:** fluid-filled body cavity partly lined with mesoderm (p. 683)

**New Vocabulary**  
trichinosis

## Word Origin

**Nematoda** from the Greek words *nema*, meaning “a thread,” and *ooides*, meaning “similar to”; Many roundworms are small and thread-like in appearance.

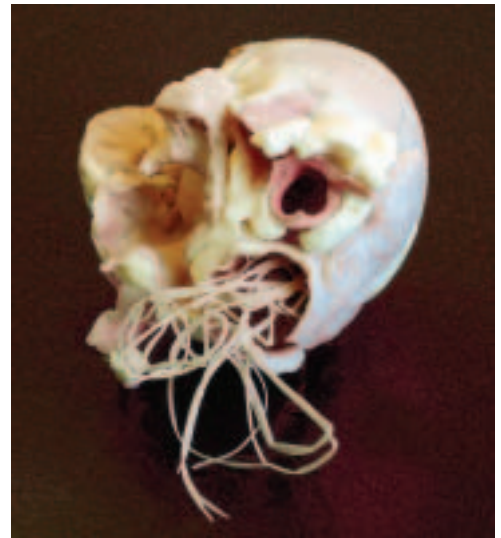
# Roundworms

## Public Health and Roundworms

### Using Prior Knowledge

Have you ever been to the veterinarian to have your dog tested for heartworms? Perhaps you recall warnings about properly cooking pork products. It has been estimated that about one-third of the world’s human population is affected by problems caused by roundworms.

**Research** *Contact your local health department or county extension service to learn what roundworm pests are common in your area. Research one of these roundworm pests. Collect information about its life cycle, ways to prevent its infection, recommended treatments for infection, and data regarding the number of reported infections during the previous year. On index cards, make a classroom reference file about roundworm pests.*



Dog heart infected with heartworms

## What is a roundworm?

Roundworms belong to the phylum Nematoda. They are widely distributed, living in soil, animals, and both freshwater and marine environments. More than 12 000 species of roundworms are known to scientists. Most roundworm species are free-living, but many are parasitic. Nearly all plant and animal species are affected by parasitic roundworms.

Roundworms are tapered at both ends. They have a thick outer covering, which they shed four times as they grow, that protects them in harsh environments. Roundworms look like tiny, wriggling bits of thread. They lack circular muscles but have lengthwise muscles. As one muscle contracts, another muscle relaxes. This alternating contraction and relaxation of muscles causes roundworms to move in a thrashing fashion.

Roundworms have a pseudocoelom and are the simplest animals with a tubelike digestive system. Unlike flatworms, roundworms have two body openings—a mouth and an anus. The free-living species have well-developed sense organs, such as eyespots, although these are reduced in parasitic forms.

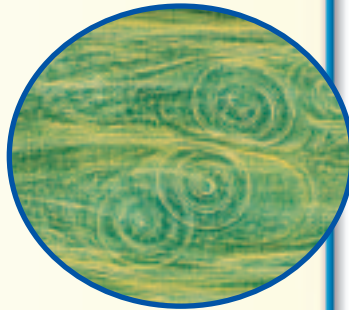
 **Reading Check** **Identify** the characteristics of the phylum Nematoda.

## MiniLab 26.2

### Observe

**Observing the Larval Stage of *Trichinella*** You can observe the larval stage of a *Trichinella spiralis* embedded within swine muscle tissue. It will look like a curled up hot dog surrounded by muscle tissue.

Magnification: unavailable



*Trichinella*

### Procedure

- 1 Examine a prepared slide of *Trichinella* larvae under the low-power magnification of your microscope.
- 2 Locate several larvae by looking for "spiral worms enclosed in a sac." All other tissue is muscle.
- 3 Estimate the size of the larva in  $\mu\text{m}$  (micrometers).
- 4 Diagram one larva. Indicate its size on the diagram.

### Analysis

1. **Describe** What is the appearance of a *Trichinella* larva?
2. **Predict** Why might it be difficult to find larva embedded in muscle when meat inspectors use visual checking methods in packing houses to screen for *Trichinella* contamination?
3. **Infer** What might inspectors do to help detect *Trichinella* larvae?

## Diversity of Roundworms

Approximately half of the described roundworm species are parasites, and about 50 species infect humans.

### Roundworm parasites of humans

Infection by *Ascaris* (ASS kuh ris), shown in **Figure 26.19**, is the most common roundworm infection in humans. It occurs worldwide but is more common in subtropical or tropical areas. Children become infected more often than adults do. Eggs of *Ascaris* are found in soil and enter a human's body through the mouth. The eggs hatch in the intestines, move into the bloodstream, and eventually to the lungs, where they are coughed up, swallowed, and begin the cycle again.

Pinworms are the most common human roundworm parasites in the United States. The highest incidence of infection is in children. Pinworms are highly contagious because eggs can survive for up to two weeks on surfaces. Its life cycle begins when live eggs are ingested. They mature in the host's intestinal tract. Female pinworms exit the host's anus—usually as the host sleeps—and lay eggs on nearby skin. These eggs fall onto bedding or other surfaces.

*Trichinella* causes a disease called **trichinosis** (trih keh NOH sis). This roundworm can be ingested in raw or undercooked pork, pork products, or wild game. Trichinosis can be controlled by properly cooking meat. Find out what these roundworms look like in *MiniLab 26.2*.



A

**Figure 26.19**

Parasitic roundworms include, *Ascaris* (A), hookworms (B), and pinworms (C). Describe **How do the means of infection differ among these organisms?**

B



Color-enhanced SEM Magnification: 100 $\times$

C



LM Magnification: 12 $\times$

**Figure 26.20**

Roundworm plant parasites usually enter the roots, forming cysts that inhibit the growth of the plant's vascular system.



Hookworm infections are common in humans in warm climates where they walk on contaminated soil in bare feet. Hookworms cause people to feel weak and tired due to blood loss.

### Roundworm parasites of other organisms

About 1200 species of nematodes cause diseases in plants. Nematodes can infect and kill pine trees, cereal crops, and food plants such as potatoes. They are particularly attracted to plant roots, as shown in *Figure 26.20*, and cause a slow decline of the plant. They also can infect fungi and can form symbiotic associations with bacteria. Nematodes also can be used to control pests, as described in *Problem-Solving Lab 26.4*.

## Problem-Solving Lab 26.4

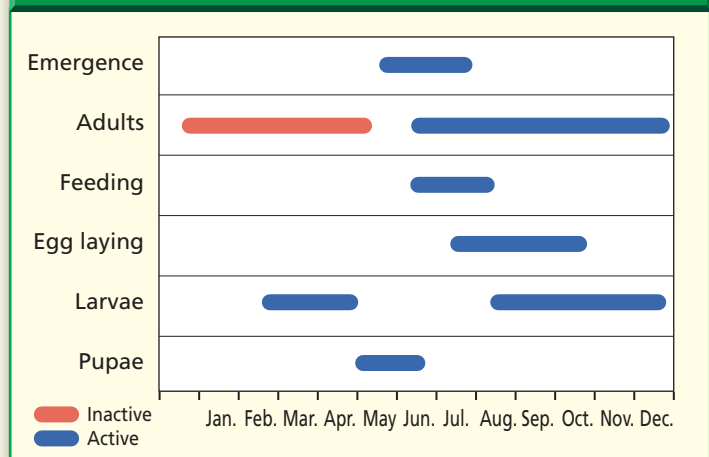
### Interpret Data

**Can nematodes control weevil damage to plants?** In the Pacific Northwest, the larvae of certain weevils feed on roots of woody shrubs, killing them in large numbers. Instead of using chemical pesticides, certain free-living nematodes can be used to kill weevil larvae. The nematodes must be introduced to the soil when it is warm and after the weevil larvae have recently hatched.

### Solve the Problem

Study the life cycle of the black vine weevil, and infer what is the best time to apply soil nematodes to kill larvae.

#### Life Cycle of Black Vine Weevil



### Thinking Critically

**Interpret Data** What months would be best for application of soil nematodes to kill black vine weevil larvae? Explain.

## Section Assessment

### Understanding Main Ideas

1. Compare and contrast the body structures of roundworms and flatworms.
2. Infer why children should be taught to wash their hands before eating.
3. Outline the method of infection of *Ascaris*.
4. Compare how humans are infected by a hookworm and by *Trichinella*.

### Thinking Critically

5. An infection of pinworms is spreading among children at a preschool. Make a list of precautions that could be taken to stop its spread.

### Skill Review

6. **Make and Use Tables** Make a table of the characteristics of four roundworm parasites, list their names, how the parasite is contracted, its action in the body, and means of prevention. For more help, refer to *Make and Use Tables* in the **Skill Handbook**.



# INVESTIGATE BioLab

## Before You Begin

Certain animals have the ability to replace lost body parts through regeneration. In regeneration, organisms regrow missing parts. This process occurs in a number of different phyla throughout the animal kingdom. In this activity, you will observe regeneration in planarians. Planarians are able to form two new animals when one has been cut in half.

# Observing Planarian Regeneration

## PREPARATION

### Problem

How can you determine if the flatworm *Dugesia* is capable of regeneration?

### Objectives

*In this BioLab, you will:*

- **Observe** the flatworm, *Dugesia*.
- **Conduct** an experiment to determine if planarians are capable of regeneration.

### Materials

planarians	chilled glass slide
petri dish	dissecting microscope
distilled or bottled water	marking pencil or labels
camel hair brush	single-edged razor blade

### Safety Precautions



**CAUTION:** Use extreme caution when cutting with a razor blade. Wash your hands both before and after working with planarians. Use care when handling a microscope and glassware.

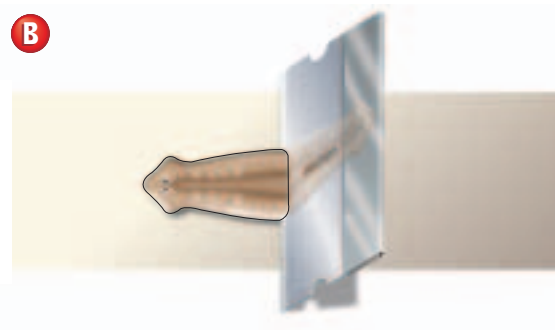
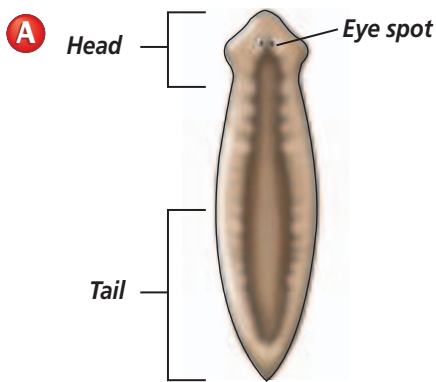
### Skill Handbook

If you need help with this lab, refer to the **Skill Handbook**.

## PROCEDURE

1. Obtain a planarian and place it in a petri dish containing a small amount of distilled or bottled water. You can pick up a planarian easily with a small camel hair brush.
2. Use a dissecting microscope to observe the planarian. Locate the animal's head and tail region and its "eyes." Use Diagram **A** as a guide.
3. Move the animal onto a chilled glass slide. This will cause its muscles to relax.
4. Place the slide under the microscope. While looking through the microscope, use a single-edged razor blade to cut the animal in half across the midsection. Use Diagram **B** as a guide.





5. Remove the head end and return it to the petri dish filled with water. Put the lid on the dish and label the dish with the date, your name, and the word *Head*.
6. Add distilled or bottled water to a different petri dish and place the tail section in it. Put the lid on the dish, and label it as in step 5, except mark this dish *Tail*.
7. Repeat steps 3–6 with a second planarian.
8. Place the four petri dishes in an area designated by your teacher. Change the water in each petri dish every 3–4 days.
9. Prepare a data table that will allow you to record your observations of your planarians every other day for two weeks.
10. Observe your planarians under a dissecting microscope and record observations. Include diagrams and the number of days since starting the experiment in your data table.
11. **CLEANUP AND DISPOSAL** Clean all equipment as instructed by your teacher, and return everything to its proper place. Properly dispose of slides and planarians. Wash your hands thoroughly.

## ANALYZE AND CONCLUDE

1. **State** To what phylum do flatworms belong? Are planarians free living or parasitic? What is your evidence?
2. **Observe** What new part did each original head piece regenerate? What new part did each original tail piece regenerate?
3. **Observe** Which section, head or tail, regenerated new parts faster?
4. **Infer** Is regeneration by mitosis or meiosis? Explain.
5. **Think Critically** What might be the advantage for an animal that can regenerate new body parts?
6. **Think Critically** Would the term “clone” be suitable in reference to the newly formed planarians? Explain your answer.

### Apply Your Skill

**Experiment** Design an experiment that would test this hypothesis: If regenerating planarians are placed in a warmer environment, then the time needed for new parts to form would decrease.



**Web Links** To find out more about regeneration, visit [bdol.glencoe.com/regeneration](http://bdol.glencoe.com/regeneration)



## Why are the corals dying?

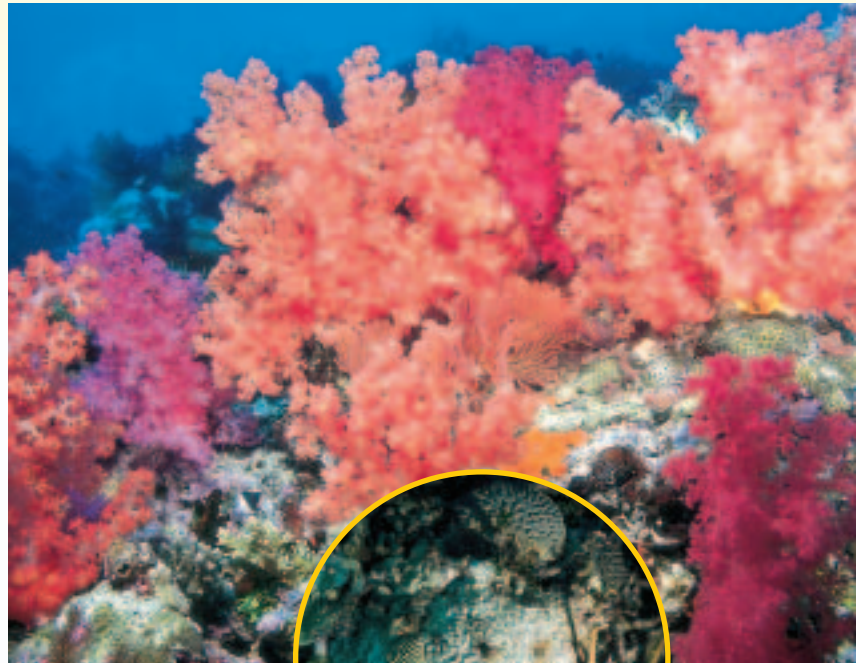
**C**oral reefs are some of Earth's most spectacularly beautiful and productive ecosystems. A reef is composed of hundreds of corals that together create a structure of brightly colored shapes and patterns. In the reef's cracks and crevices live a dazzling array of fishes and invertebrates. Coral reefs protect nearby shore areas from erosion by slowing incoming waves, thus, reducing the force that they can exert. But worldwide, coral reefs are increasingly being damaged and destroyed.

**Physical damage to coral reefs** Hurricanes can cause serious damage to coral reefs. Ships can run aground on reefs because they lie close to the water's surface. In some parts of the world, explosives are used to mine coral for building materials and fertilizers. Tropical aquarium fishes are sometimes collected by poisoning with cyanide, which stuns fishes and makes them easier to collect, but also kills corals. Collectors take pieces of coral for jewelry and souvenirs.

**Damage from organisms** In the 1970s, marine scientists began to realize that the world's coral reefs had diseases no one had seen before. Black band disease is caused by a cyanobacterium and two species of bacteria that combine to form a band of black filaments. This invading community slowly moves across the coral. White band disease causes the living tissue of a coral to peel away from its skeleton; the cause is uncertain.

Fishes, sea stars, and other organisms prey on corals and, as a result, damage coral reefs. Parrotfish eat corals causing excavations 1–2 cm deep. This condition is called white spot biting and was once thought to be rapid wasting disease.

Many of the world's coral reefs are losing their beautiful colors in a process called bleaching.



Healthy coral reef (above), and diseased reef (right)



The corals become gray or white in color. Some scientists hypothesize that coral bleaching is the result of a loss of zooxanthellae, the symbiotic protists that live in coral and give it much of its color as well as nutrients.

**Perspectives** Worldwide, coral reef health is declining. Most researchers hypothesize that coral diseases are on the increase because environmental changes, such as pollution in coastal runoff, higher water levels, or changes in ocean temperatures, make corals more vulnerable to opportunistic diseases.

### Forming Your Opinion

**Research** Investigate the effects that the death of a coral reef might have on nearby ocean and coastal ecosystems. Prepare a bibliography about this topic.



To find out more about coral reefs, visit [bdol.glencoe.com/biology\\_society](http://bdol.glencoe.com/biology_society)

# Chapter 26 Assessment

## STUDY GUIDE

### Section 26.1

## Sponges



### Key Concepts

- A sponge is an aquatic, sessile, asymmetrical, filter-feeding invertebrate.
- Sponges are made of four types of cells. Each cell type contributes to the survival of the organism.
- Most sponges are hermaphroditic with free-swimming larvae.

### Vocabulary

external fertilization (p. 696)  
filter feeding (p. 693)  
hermaphrodite (p. 696)  
internal fertilization (p. 696)

### Section 26.2

## Cnidarians



### Key Concepts

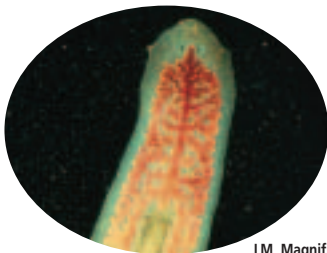
- All cnidarians are radially symmetrical, aquatic invertebrates that display two basic forms: medusa and polyp.
- Cnidarians sting their prey with cells called nematocysts located on their tentacles.
- The three primary classes of cnidarians include the hydrozoans, hydras; scyphozoans, jellyfishes; and anthozoans, corals and anemones.

### Vocabulary

gastrovascular cavity (p. 702)  
medusa (p. 700)  
nematocyst (p. 701)  
nerve net (p. 702)  
polyp (p. 700)

### Section 26.3

## Flatworms



LM Magnification: 10X

### Key Concepts

- Flatworms are acoelomates with thin, solid bodies. They are grouped into three classes: free-living planarians, parasitic flukes, and tapeworms.
- Planarians have simple nervous and muscular systems. Flukes and tapeworms have structures adapted to their parasitic existence.

### Vocabulary

pharynx (p. 709)  
proglottid (p. 709)  
regeneration (p. 709)  
scolex (p. 709)

### Section 26.4

## Roundworms



LM Magnification: 12X

### Key Concepts

- Roundworms are pseudocoelomate, cylindrical worms with lengthwise muscles, relatively complex digestive systems, and two body openings.
- Roundworms can be parasites of plants, fungi, and animals, including humans.

### Vocabulary

trichinosis (p. 712)



To help you review the diet, reproduction, structure, and adaptations of sponges, use the Organizational Study Fold on page 693.



# Chapter 26 Assessment

## Vocabulary Review

Review the Chapter 26 vocabulary words listed in the Study Guide on page 717. Determine if each statement is true or false. If false, replace the underlined word with the correct vocabulary word.

1. Any animal that can produce both eggs and sperm is called a hermaphrodite.
2. A medusa is a capsule that contains a coiled threadlike tube that is used to capture and poison prey.
3. The pharynx is a space surrounded by the inner cell layer of a cnidarian in which digestion occurs.
4. The cnidarian body form that is umbrella-shaped with tentacles that hang down is called a polyp.
5. A scolex is a detachable, individual section of a tapeworm that contains muscles, nerves, flame cells, and male and female reproductive organs.

## Understanding Key Concepts

6. Which of these cell types is found in sponges?  
A. collar                      C. mesoderm  
B. endoderm                 D. nematocyst
7. Of the following organisms, which one is a filter feeder?  
A. jellyfish                    C. pinworm  
B. sponge                     D. tapeworm
8. In cnidarians, medusae reproduce sexually to produce larvae, which develop into sessile \_\_\_\_\_.  
A. polyps                      C. nematocysts  
B. tentacles                 D. medusae
9. Acoelomate \_\_\_\_\_ have thin, solid bodies.  
A. roundworms              C. nematodes  
B. flatworms                 D. hookworms

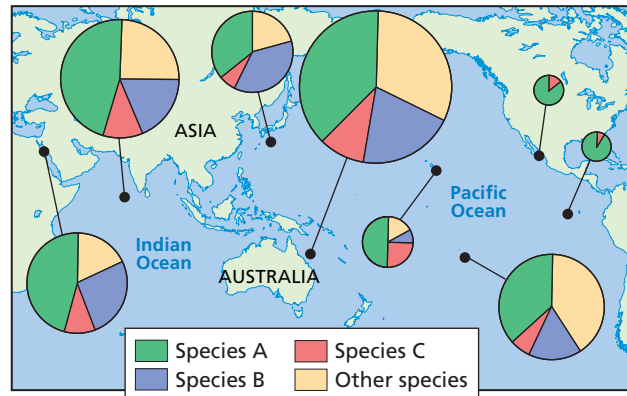
## Constructed Response

10. **Open Ended** At what point(s) could the life cycle of a blood fluke be interrupted to prevent infestation of humans? Explain.

11. **Open Ended** How do the adaptations of a free-living flatworm and a parasitic flatworm differ? How do the adaptations of each ensure their long-term survival?

## Thinking Critically

Use the diagram to answer question 12 and 13.



The map shows the worldwide distribution and biodiversity of coral reefs. The size of the circle is proportional to the total number of species that make up the reef.

12. **Interpret Data** Which three areas of Earth have the least biodiversity? How are species A, B, and C distributed in those areas?
13. **Infer** What might you infer about species C compared to the others? Why?
14. **REAL WORLD BIOCHALLENGE** Recent research shows that coral reefs suffer reduced diversity as a result of pollution, disease, warming water, hurricanes, and human destruction. Select an area of the world and investigate the health of the coral reefs found there. For information about your selected coral reefs, visit [bdol.glencoe.com](http://bdol.glencoe.com). What kinds of problems is the reef experiencing and why? Present the results of your research to your class in the form of a poster or a multimedia presentation.



# Chapter 26 Assessment

## Standardized Test Practice

All questions aligned and verified by



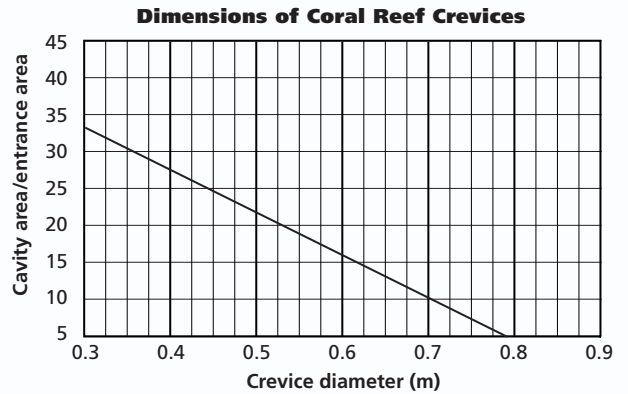
### Part 1 Multiple Choice

Use the table below to answer questions 15–17.

Effect of 1998 El Niño on Coral Reefs		
Region Destruction	Pre-1998 Coral Destruction	1998 Coral Destruction
Arabia	2%	33%
Indian Ocean (overall)	13%	46%
Australia, Papua New Guinea	1%	3%
Southeast Asia	16%	18%
Pacific Ocean (overall)	4%	5%
Caribbean	21%	1%
Global Total	11%	16%

15. The table shows coral destruction due to the 1998 El Niño warming was greatest in \_\_\_\_\_.
- A. Arabia                      C. the Indian Ocean  
B. the Caribbean          D. Southeast Asia
16. Where did the warming effect of the 1998 El Niño have the least effect on coral?
- A. Caribbean                C. Australia  
B. Indian Ocean            D. Southeast Asia
17. \_\_\_\_\_ has suffered the least total destruction of coral.
- A. Caribbean                C. Australia  
B. Pacific Ocean            D. Arabia

Use the graph to answer questions 18 and 19.



Until recently, coral reef crevices that are less than 1.5 meters in diameter had not been studied as habitats for other organisms. The graph shows the relationship between crevice opening diameter and the ratio of internal cavity area to entrance area on a coral reef.

18. A group of scientists wants to survey all the life supported by a coral reef. It is important they study \_\_\_\_\_.
- A. all crevices, large and small  
B. only large crevices  
C. only small crevices  
D. only the reef surface
19. The size of a reef cavity with an opening of 0.7 m is \_\_\_\_\_ the cavity with an opening of 0.4 m.
- A. larger than                      C. the same size as  
B. smaller than                  D. smaller on the outside than

### Part 2 Constructed Response/Grid In

Record your answers on your answer document.

20. **Open Ended** Mole crickets are pests of lawns and golf courses. Nematodes that often inhabit a cricket's digestive tract carry a bacterium that kills the cricket. As a greenskeeper for a golf course infested with mole crickets, what will you do to eliminate this pest?
21. **Open Ended** Synthetic optical fibers are important components of communication systems, but they degrade under water. A certain marine sponge produces light-conducting glass spicules that do not degrade when wet, therefore making them of high interest to optical fiber researchers. Assume you are a scientist interested in other properties of these sponge spicules. Describe an experiment you will do to compare the strength of sponge spicules to that of synthetic optical fibers.

