

SPONGES, CNIDARIANS, AND CTENOPHORES



Delicate polyps of Monet's tube coral, *Dendrophyllia gracilis*, extend from a hard skeleton.

SECTION 1 *Porifera*

SECTION 2 *Cnidaria and Ctenophora*

PORIFERA

Invertebrates are animals that do not have backbones.

Invertebrates include more than a million species. About 97 percent of all known animal species are invertebrates, among the simplest of which are sponges.

BODY PLAN OF SPONGES

Sponges are aquatic animals that make up the phylum Porifera (pohr-IF-uh-uh). These simple organisms clearly represent the transition from unicellular to multicellular life. Because sponges are heterotrophic, multicellular organisms that do not have cell walls, they are classified as animals. Sponges have no gastrula stage, exhibit less cell specialization than most other animals, and have no true tissues or organs.

But sponges do have a key property of all animal cells—cell recognition. A living sponge can be passed through a fine mesh, which separates the sponge into individual cells. These separated cells will then regroup to form a new sponge. There are about 5,000 named species of sponges. About 150 species live in fresh water, while the rest are marine.

Sponges are so unlike other animals that early biologists thought that sponges were plants. Most sponges do resemble plants in some ways. For example, adult sponges are **sessile** (SEHS-il), which means that they attach themselves firmly to a surface and do not move. Sponges grow in many shapes, sizes, and colors and often look like mossy mats, cactuses, or blobs of fungus. Sponges can be as small as 1 cm (0.4 in.) in length or as large as 2 m (6.6 ft) in diameter.

The basic body plan of a sponge consists of two layers of cells separated by a jellylike substance called **mesohyl** (MEHZ-oh-hil). In the simplest sponges, the body wall forms a hollow cylinder that is closed at the bottom and open at the top. The interior of the cylinder is lined with flagellated cells called **choanocytes** (koh-AN-oh-siets), or collar cells. By beating their flagella, choanocytes draw water into the sponge through numerous pores, called **ostia** (AHS-tee-uh) (singular, **ostium**), that penetrate the body wall. In fact, the name *Porifera* comes from a Latin word meaning “pore-bearer.” The water that is pumped into the interior of the sponge leaves through the **osculum** (AHS-kyoo-luhm), the opening at the top of the sponge that you can see in Figure 33-1 on the next page.

A sponge would collapse without some type of supporting structure. In some sponges, support is provided by a simple skeleton made of a network of tough, flexible protein fibers called **spongin** (SPUHN-jin). Other sponges have skeletons consisting of **spicules**.

OBJECTIVES

- **Describe** the basic body plan of a sponge.
- **Describe** the process of filter feeding in sponges.
- **Contrast** the processes of sexual and asexual reproduction in sponges.

VOCABULARY

sponge
sessile
choanocyte
ostium
osculum
spongin
spicule
filter feeding
amoebocyte
gemmule
regeneration
hermaphrodite



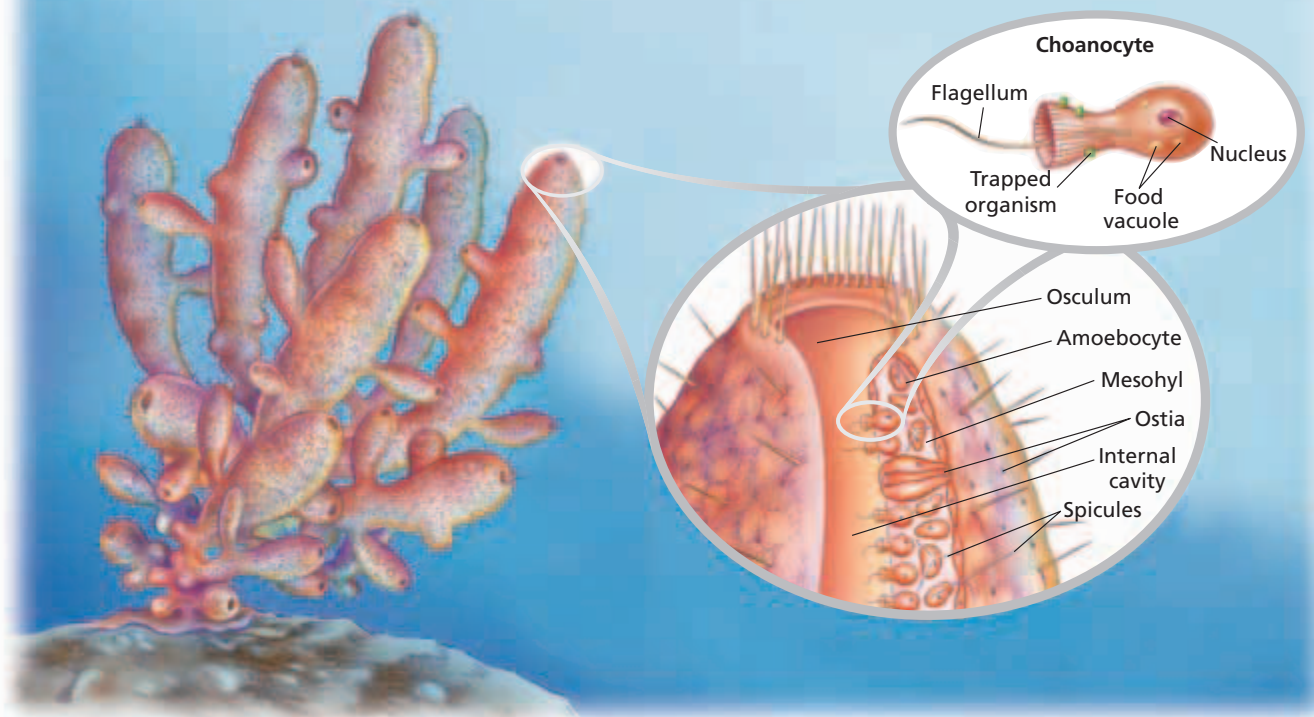


FIGURE 33-1

The body of a sponge is a hollow cylinder. Water is drawn into the cylinder through many small pores (ostia) in the sponge's body and exits through the osculum, the opening at the top of the sponge.

Spicules are tiny, hard particles of calcium carbonate or silicon dioxide that are often shaped like spikes. Calcium carbonate is one of the compounds that give bones and teeth their hardness, and silicon dioxide is the major component of glass and quartz. Still other sponges have a combination of spongin and spicules.

FEEDING AND DIGESTION IN SPONGES

Because they are sessile, sponges cannot pursue food. Instead, most sponges feed by sieving food out of the water. The flagella of the choanocytes beat, drawing water through the ostia. The choanocytes trap plankton and other tiny organisms in their small, hairlike projections. This feeding method is called **filter feeding**. Other food of filter-feeding sponges includes bits of organic matter. However, scientists have discovered a sponge species that uses movable filaments covered with hooked spicules to snare small shrimp. The shrimp are then absorbed into the sponge's body.

The food that a sponge collects is engulfed and digested by the choanocytes. Nutrients pass from the choanocytes to cells that crawl about within the body wall and deliver the nutrients to the rest of the body. Scientists call these crawling cells **amoebocytes** (uh-MEE-buh-siets) because the cells resemble amoebas. Locate the amoebocytes in Figure 33-1. Carbon dioxide and other wastes produced by the sponge's cells diffuse into the water that passes through the sponge. The water carries these wastes as it flows out through the osculum, thus removing the wastes from the sponge.

Word Roots and Origins

amoebocyte

from the Greek *amoibe*, meaning "change," and *kytos*, meaning "cavity"

REPRODUCTION IN SPONGES

Sponges can reproduce asexually by forming small buds that break off and live separately. The sponge shown in Figure 33-1 has many buds. During droughts or cold weather, some freshwater sponges produce internal buds called **gemmules** (JEM-yoolz). Each gemmule is a food-filled ball of amoebocytes surrounded by a protective coat made of organic material and spicules. Gemmules can survive harsh conditions that may kill adult sponges. When conditions improve, sponge cells emerge from the gemmules and grow into new sponges. Sponges also have remarkable powers of **regeneration**, the regrowth of missing cells, tissues, or organs. A very small piece of a sponge can regenerate a complete new sponge.

Sponges can also reproduce sexually. As you can see in Figure 33-2, sperm released into the water from one sponge enter the pores of a second sponge. Choanocytes in the second sponge engulf the sperm and transfer them to amoebocytes. Amoebocytes carry the sperm to an egg located in the mesohyl. After the egg is fertilized, it develops into a larva. A *larva* is an immature stage of an animal that is usually very different in form from the adult. Flagella on the larva's surface enable the larva to leave its parent sponge. Eventually, the larva settles and attaches to an object. Its cells then reorganize to form an adult sponge.

Some species of sponges have separate sexes, but in most species, each individual is a hermaphrodite (her-MAF-roh-diet). **Hermaphrodites** produce both eggs and sperm. Self-fertilization rarely happens in hermaphroditic species. Instead, the sperm of one individual usually fertilize the eggs of another individual. Because each hermaphrodite produces eggs, the chances of fertilization are greater than in species in which only females produce eggs. Hermaphroditism is common in invertebrates that are sessile, that move slowly, or that live in low-density populations.

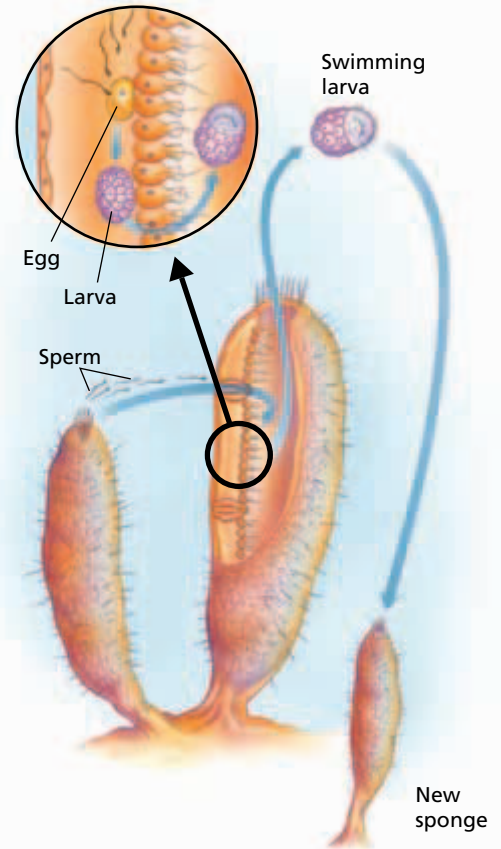


FIGURE 33-2

Sponges can reproduce asexually and sexually. In sexual reproduction, the union of an egg and sperm ultimately results in a swimming larva that escapes from the parent sponge and grows into a new individual.

SECTION 1 REVIEW

1. Compare the structure of spongin with the structure of spicules.
2. Describe two different ways in which sponges feed.
3. How do gemmules help some freshwater sponges survive unfavorable conditions?
4. What role do amoebocytes play in the sexual reproduction of sponges?

CRITICAL THINKING

5. **Analyzing Concepts** How is it possible for a population of sponges, which are sessile animals, to disperse?
6. **Applying Information** Consider the properties of a natural bath sponge that is made of spongin. How is a spongin skeleton adaptive?
7. **Relating Concepts** Why are sponges not considered to be predators?

SECTION 2

OBJECTIVES

- **Describe** the basic body plan of a cnidarian.
- **Summarize** how cnidarians feed.
- **Describe** the nervous system of cnidarians.
- **Identify** and give examples of the four classes of cnidarians.
- **Describe** the common characteristics of ctenophores.

VOCABULARY

medusa
polyp
epidermis
gastrodermis
mesoglea
gastrovascular cavity
tentacle
cnidocyte
nematocyst
nerve net
planula
coral reef
colloblast
apical organ
bioluminescence

CNIDARIA AND CTENOPHORA

Cnidaria (nie-DER-ee-uh) and Ctenophora (tee-NAHF-uh-uh) are two phyla of radially symmetrical invertebrates. The animals in these phyla are more complex than the sponges. Their cells are organized into tissues, and they have a few simple organs. All members of the phyla Cnidaria and Ctenophora are aquatic, and most live in the ocean.

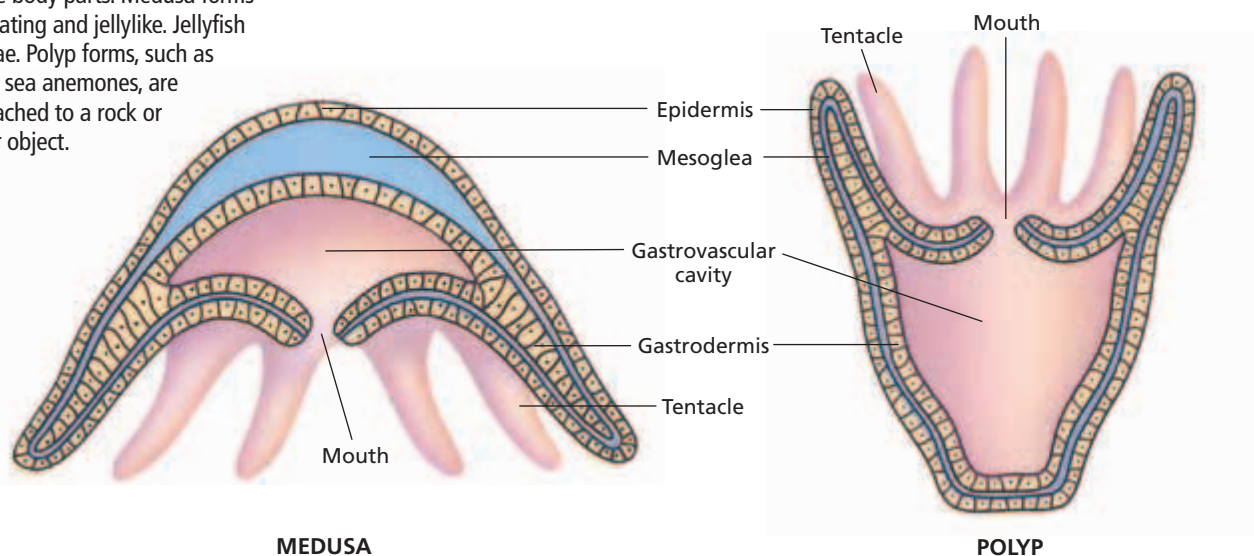
BODY PLAN OF CNIDARIANS

Tiny freshwater hydra, stinging jellyfish, and flowerlike coral all belong to the phylum Cnidaria. Animals in this phylum are called **cnidarians**. As you can see in Figure 33-3, the body of a cnidarian may be either bell-shaped or vase-shaped. The bell-shaped **medusa** (me-DOO-suh) is specialized for swimming. In contrast, the vase-shaped form, called a **polyp** (PAHL-ip), is specialized for a sessile existence.

Figure 33-3 also shows that all cnidarians have bodies constructed of two cell layers—an outer **epidermis** and an inner **gastrodermis**. Between these layers is a jellylike material known as **mesoglea** (mez-uh-GLEE-uh). In the center of the body is a hollow gut called the **gastrovascular cavity**, which has a single opening, or mouth. Surrounding the mouth are numerous flexible extensions called **tentacles**.

FIGURE 33-3

The contrasting forms of medusae and polyps result from different arrangements of the same body parts. Medusa forms are free-floating and jellylike. Jellyfish are medusae. Polyp forms, such as hydras and sea anemones, are usually attached to a rock or some other object.



FEEDING AND DEFENSE IN CNIDARIANS

One of the distinguishing features of cnidarians is the presence of cnidocytes (NIE-duh-siets), which give the phylum its name. **Cnidocytes** are specialized cells used for defense and capturing prey. Figure 33-4 shows a type of cnidocyte organelle called a **nematocyst** (nuh-MAT-uh-sist), which has a long filament coiled up inside it. In some cnidarians, the cnidocytes are concentrated in the epidermis, especially on the tentacles. When an object brushes against the “trigger” on a cnidocyte, the nematocyst inside it suddenly pushes the filament out of the cell with great force. Some nematocysts have filaments with sharp tips and spines that puncture the object and inject poison. Others have filaments that adhere to the object by wrapping around it.

The relationship between structure and function is clearly seen in the way cnidarians feed. The tentacles capture small animals with their nematocysts and paralyze them with the poison they inject. The tentacles then push the prey into the gastrovascular cavity through the mouth. After enzymes inside the gastrovascular cavity break up the prey, cells lining the cavity absorb the nutrients. Undigested food and waste are expelled through the mouth.

NERVOUS SYSTEM IN CNIDARIANS

Nervous responses in cnidarians are controlled by a diffuse web of interconnected nerve cells called a **nerve net**. In many cnidarians, like the polyp shown in Figure 33-5, the nerve net is distributed uniformly throughout the entire body. There is no brain or similar structure that controls the rest of the nerve net. But in the medusa form of some cnidarians, such as jellyfish, some of the nerve cells are clustered in rings around the edge of the bell-shaped body.

The nerve net enables cnidarians to respond to specific stimuli in their environment. For example, when cells in the epidermis are touched, they relay a signal to nerve cells. The nerve cells, in turn, transmit a signal via the nerve net to contractile cells, which can cause the animal to withdraw from the stimulus. In cnidarians with the simplest nerve nets, a stimulus anywhere on the body causes signals to be sent through the nerve net in all directions. These signals bring about a contraction of the entire body.

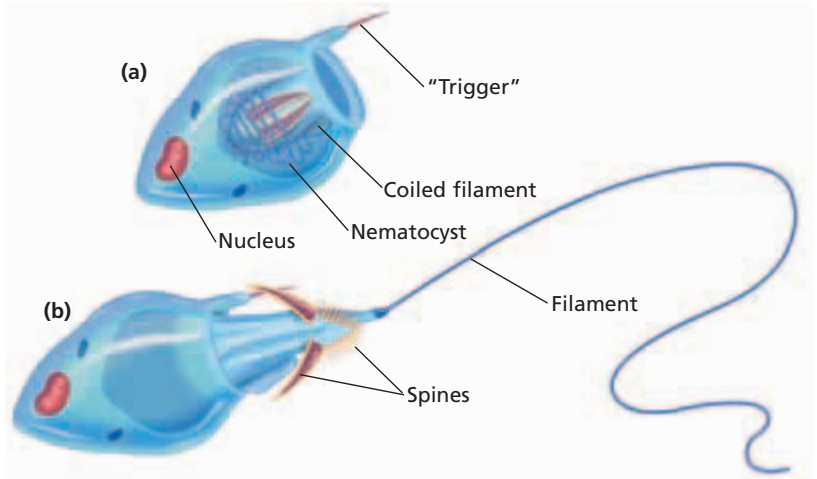
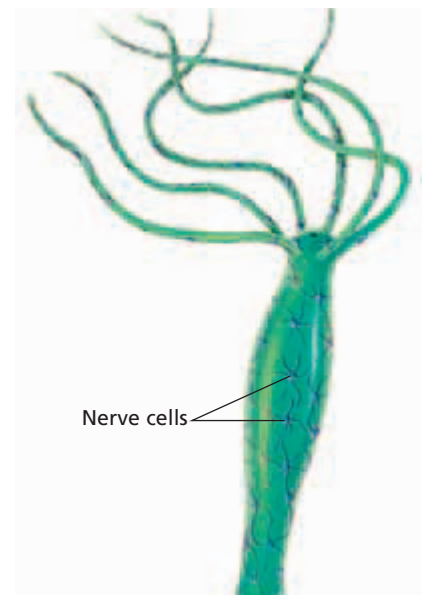


FIGURE 33-4

(a) The nematocyst inside this cnidocyte contains a coiled filament. (b) When something touches the “trigger,” the nematocyst suddenly ejects the filament.

FIGURE 33-5

The interconnected nerve cells in the nerve net of this cnidarian (a hydra), coordinate the animal’s responses to its environment.





Quick Lab

Identifying Poriferans, Ctenophorans, and Cnidarians

Materials pencil, paper, a picture of either a poriferan, a ctenophoran, or a cnidarian

Procedure

1. Prepare a dichotomous key to differentiate among poriferans, ctenophorans, and cnidarians by writing paired statements for the three phyla and for classes Hydrozoa, Scyphozoa, and Anthozoa.
2. Statement (1a) describes cnidarians and leads to paired statements (3). Statement (1b) leads to paired statements (2).
3. Statement (2a) describes Porifera and (2b) describes Ctenophora.
4. Statement (3a) describes Hydrozoa and (3b) leads to paired statements (4).
5. Statement (4a) describes Scyphozoa and (4b) describes Anthozoa.
6. Get a picture from your teacher. Identify the animal using your dichotomous key. Exchange keys with another group, and use the new key to identify your animal.

Analysis What do sponges and hydrozoans have in common? How do comb jellies differ from cnidarians? What is the dominant body form in each cnidarian class?

The nerve net also coordinates the complex activities of the body that are necessary for feeding and traveling through the environment. The movements by which the tentacles bring prey to the mouth and push it into the gastrovascular cavity are controlled by the nerve net, as are the rhythmic contractions of the body that propel swimming medusae through the water.

CLASSIFICATION OF CNIDARIANS

Scientists recognize four classes of cnidarians—Hydrozoa, Cubozoa, Scyphozoa, and Anthozoa. The members of these classes are known as hydrozoans, cubozoans, scyphozoans, and anthozoans, respectively. Some species of hydrozoans live only as polyps, some live only as medusae, some alternate between these two forms, and some live as mixed colonies of polyps and medusae. Cubozoans and scyphozoans spend most of their lives as medusae, while anthozoans live only as polyps.

Class Hydrozoa

The class Hydrozoa includes about 3,700 species, most of which live as colonial organisms in the oceans. Examples of colonial hydrozoans are species of the genus *Obelia*. As Figure 33-6a illustrates, one such species has many polyps attached to branched stalks. Some of the polyps function in gathering food, while others are responsible for reproduction.

The hydrozoan shown in Figure 33-6b, the Portuguese man-of-war (genus *Physalia*), exists as a colony of medusae and polyps. Its gas-filled float, which can measure as much as 30 cm (1 ft) across, keeps the colony at the surface of the ocean. The polyps in the colony are specialized for feeding, digestion, or sexual reproduction. Tentacles up to 20 m (65 ft) long dangle from the feeding polyps and carry large numbers of cnidocytes. The Portuguese man-of-war preys mostly on small fish, but its cnidocytes contain a neurotoxin (nerve poison) that can be painful and even fatal to humans.

FIGURE 33-6

These organisms are two examples of colonial hydrozoans. (a) This colony of the genus *Obelia* is made up of polyps, although organisms of the genus *Obelia* can produce medusae that reproduce sexually. (b) The tentacles of this Portuguese man-of-war, genus *Physalia*, have both polyps and medusae that have specialized functions.



(a)



(b)

One hydrozoan that has been extensively studied is the hydra. Hydras are not typical hydrozoans because they exist only as polyps, they are not colonial, and they live in fresh water. Hydras range from 1 to 4 cm (0.4 to 1.6 in.) in length. Most hydras are white or brown, but some, like the one shown in Figure 33-7, appear green because of the algae that live symbiotically inside cells of their gastrodermis. Hydras can be found in quiet ponds, lakes, and streams. They attach themselves to rocks or water plants by means of a sticky secretion produced by cells at the hydra's base.

A hydra can leave one place of attachment and move to another. This can happen when the base secretes bubbles of gas, which cause the hydra to float upside down on the surface of the water. Hydras can also move by tumbling. This movement occurs when the tentacles and the mouth end bend over and touch the surface to which the hydra was attached while the base pulls free.

During warm weather, hydras generally reproduce asexually. Small buds, such as the one you can see in Figure 33-8, develop on the outside of the hydra's body. These buds grow their own tentacles and then separate from the body and begin living independently.

Sexual reproduction usually occurs in the fall, when low temperatures trigger the development of eggs and sperm. The eggs are produced by meiosis along the body wall in swellings called *ovaries*. Motile sperm are formed by meiosis in similar swellings called *testes*. In some species, eggs and sperm are produced in the same hermaphroditic individual, as indicated in Figure 33-8. In other species, the individuals are either male or female. In either case, sperm are released into the water, and those that reach ovaries can fertilize egg cells. Each fertilized egg then divides and grows into an embryo. A hard covering protects the embryo through the winter, and in the spring the embryo hatches and develops into a new hydra.



FIGURE 33-7

The green color of this hydra, *Chlorohydra viridissima*, comes from the algae that live inside the hydra's cells. (LM 30×)

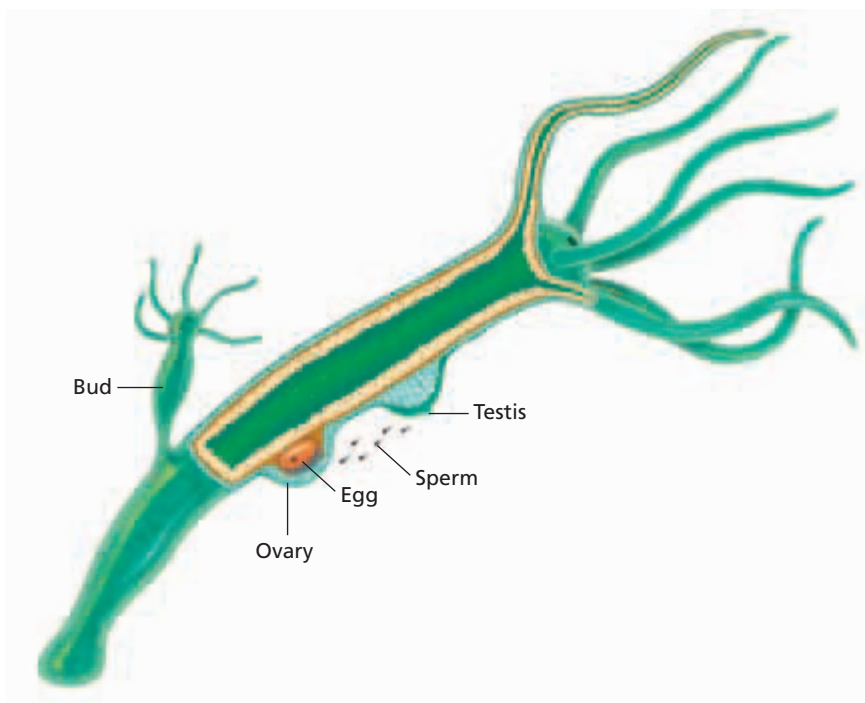


FIGURE 33-8

Hydras can reproduce either asexually, by forming buds, or sexually, by producing sperm that fertilize eggs.

Class Cubozoa

The cubozoans, or box jellies, were once classified in the class Schyphozoa. As their name implies, cubozoans have cube-shaped medusae. Their polyp stage is inconspicuous and has never been observed in some species. Most box jellies are only a few centimeters in height, although some reach 25 cm (10 in.) tall. A tentacle or group of tentacles is found at each corner of the “box.” The cnidocytes of some species, such as the sea wasp, can inflict severe pain and even death among humans. The sea wasp lives in the ocean along the tropical northern coast of Australia.

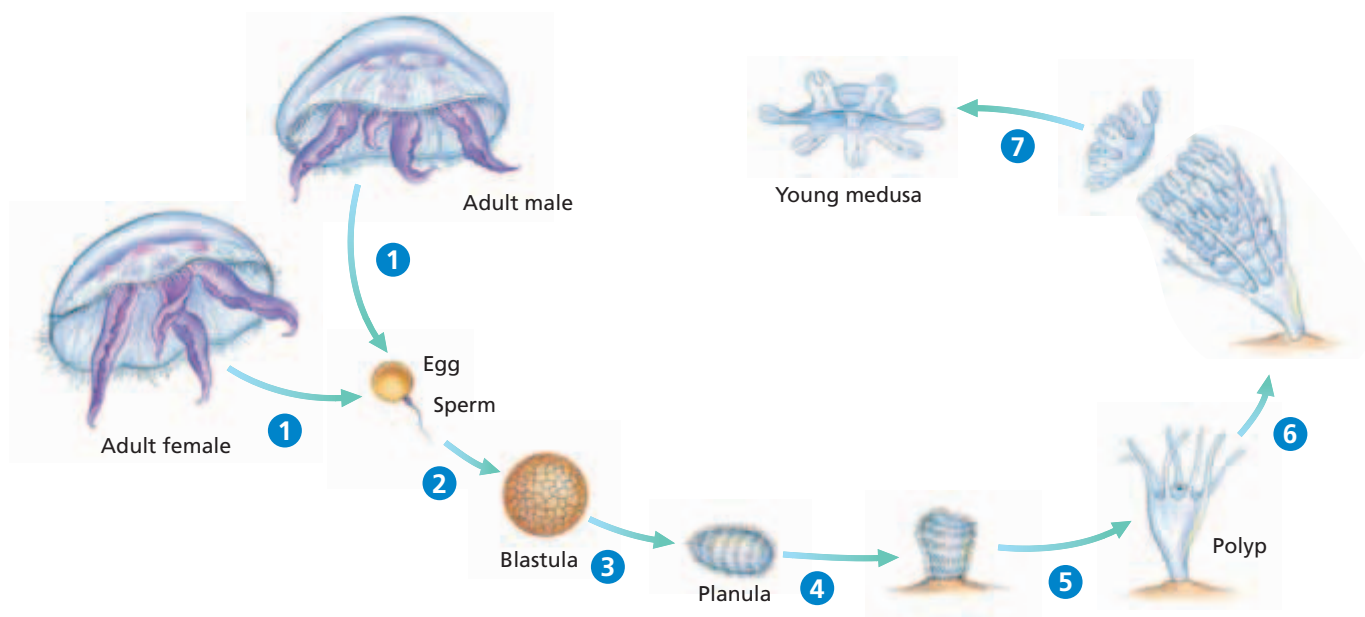
Class Scyphozoa

The name *Scyphozoa* (sie-foh-ZOH-uh) means “cup animals,” which describes the medusa, the dominant form of the life cycle of this class. There are more than 200 species of scyphozoans, known commonly as jellyfish. The cups of the medusae range from 2 cm (0.8 in.) to 4 m (13 ft) across, and some species have tentacles that are several meters long. Pulsating motions of the cup propel the jellyfish through the water. Like the Portuguese man-of-war, some jellyfish carry poisonous nematocysts that can cause severe pain and even death in humans.

The common jellyfish, genus *Aurelia*, is a scyphozoan whose life cycle includes both medusa and polyp forms. As you can see in Figure 33-9, step ①, adult medusae release sperm and eggs into the water, where fertilization occurs. The resulting zygote divides many times to form a blastula, as shown in step ②. In step ③, the blastula then develops into a ciliated larva called a **planula** (PLAN-yuh-luh). In step ④, the planula attaches to the ocean bottom. The planula becomes a polyp by developing a mouth and tentacles at the unattached end as shown in step ⑤. As the polyp grows, shown in step ⑥, it forms a stack of medusae. Finally, as shown in step ⑦, the medusae detach and develop into free-swimming jellyfish.

FIGURE 33-9

The common jellyfish, genus *Aurelia*, reproduces when sperm from an adult male medusa fertilize eggs from an adult female medusa. Each fertilized egg produces a blastula, which develops into larva known as a planula. The planula forms a polyp, which produces more medusae.



Class Anthozoa

The name *Anthozoa* means “flower animals,” which is a fitting description for the approximately 6,100 marine species in this class. Two examples of anthozoans are sea anemones and corals, which are shown in Figure 33-10.

Sea anemones are polyps commonly found in coastal areas, where they attach themselves to rocks and other submerged objects. Anemones feed on fishes and other animals that swim within reach of their tentacles. However, some anemones in the Pacific Ocean have a symbiotic relationship with the clownfish, as Figure 33-11 demonstrates. The two animals share food and protect each other from predators. The movements of the clownfish also help prevent sediments from burying the anemone. The clownfish produces a slimy mucus that prevents the anemone from firing its nematocysts when the clownfish touches the anemone’s tentacles.

Corals are small polyps that usually live in colonies. Each polyp cements its calcium carbonate skeleton to the skeletons of adjoining polyps in the colony. When the polyps die, their hardened skeletons remain, serving as the foundation for new polyps. Over thousands of years, these polyps build up large, rocklike formations known as **coral reefs**. Only the top layer of the reef contains the living polyps. Coral reefs provide food and shelter for an enormous and colorful variety of fishes and invertebrates.

Nearly all coral reefs are restricted to a band of ocean within 30 degrees north or south of the equator. Most form at shallow depths in warm, clear waters. These conditions are necessary in order for photosynthesis to be carried out by the algae that live symbiotically inside coral cells. These corals depend on the algae to provide oxygen and to speed up the accumulation of calcium from the sea water. The algae in turn depend on the corals to supply vital nutrients.



(a)



(b)

FIGURE 33-10

Anthozoans, including this crimson anemone, *Cribinopsis fernaldi* (a), and this golden cup coral, genus *Tubastraea* (b), live as polyps along ocean coasts.



FIGURE 33-11

The clownfish, *Amphiprion ocellaris*, lives symbiotically among the tentacles of sea anemones. The anemone’s stinging tentacles protect the clownfish from predators. The clownfish, in turn, drives away other fish that try to feed on the anemone.

Word Roots and Origins

colloblast

from the Greek *kolla*, meaning "glue," and *blastos*, meaning "bud"

PHYLUM CTENOPHORA

The phylum Ctenophora includes about 100 species of marine animals known as *ctenophores*. A typical ctenophore is shown in Figure 33-12. *Ctenophora* means "comb holder" and refers to the eight comblike rows of cilia that run along the outside of the animal. Ctenophores resemble jellyfish and are often called *comb jellies*.

Ctenophores differ from jellyfish and other cnidarians in several ways. Rather than pulsating like jellyfish, they move through the water by beating their cilia. They are the largest organisms to move in this fashion. Also, ctenophores do not have cnidocytes. Instead, many have cells called **colloblasts**, which secrete a sticky substance that binds to their prey. Colloblasts are usually located on two tentacles. Ctenophores also have a sensory structure called an **apical organ** at one end of their body. This organ enables ctenophores to sense their orientation in the water. Nerves running from the apical organ coordinate the beating of the cilia. Most ctenophores are hermaphroditic.

One of the most striking features of ctenophores is their **bioluminescence** (BIE-oh-loo-muh-NES-ens), or production of light by means of a chemical reaction. Bioluminescent ctenophores often occur in large swarms near the surface of the ocean, which creates a spectacular display at night.

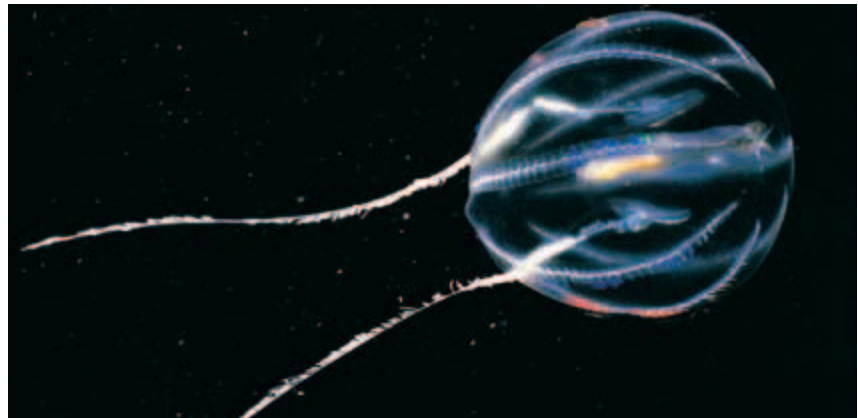


FIGURE 33-12

A ctenophore, *Pleurobrachia pileus*, moves through the water by beating its cilia, trailing its two long tentacles behind it.

SECTION 2 REVIEW

1. What are three characteristics that all cnidarians have in common?
2. Describe how cnidarians feed.
3. What is the name given to the nervous system of a cnidarian?
4. Describe one organism from each of the four cnidarian classes.
5. Describe three characteristics of ctenophores.

CRITICAL THINKING

6. **Analyzing Concepts** What might be the advantage of having a life cycle consisting of both medusae and polyps instead of only polyps?
7. **Inferring Relationships** Explain how having nerve cells clustered around the edge of its bell is advantageous to a medusa.
8. **Making Comparisons** Compare the movement of cnidarians with the movement of ctenophores.

CHAPTER HIGHLIGHTS

SECTION 1

Porifera

- The phylum Porifera is made up of sponges, sessile invertebrates that have no true tissues or organs. The simplest types of sponges are shaped like hollow cylinders.
- The body wall of a sponge is composed of two layers of cells that are separated by a jellylike substance called *mesohyl*. The body is supported by a skeleton made of spongin, spicules, or both.
- Choanocytes which line the inside of a sponge beat their flagella, thus drawing a current of water into the sponge through pores (ostia) in the body wall. Water leaves through the osculum, an opening at the top of the sponge.
- Sponges feed by filtering small organisms and organic matter out of the water that passes through their body. Nutrients are distributed through the body by amoebocytes, cells which crawl about within the body wall.
- Sponges can reproduce asexually, through budding or regeneration, and sexually, through the joining of egg and sperm. Most sponges are hermaphroditic, meaning that a single animal can produce both eggs and sperm.

Vocabulary

sponge (p. 673)
sessile (p. 673)
choanocyte (p. 673)

ostium (p. 673)
osculum (p. 673)
spongin (p. 673)

spicule (p. 673)
filter feeding (p. 674)
amoebocyte (p. 674)

gemmule (p. 675)
regeneration (p. 675)
hermaphrodite (p. 675)

SECTION 2

Cnidaria and Ctenophora

- Animals in the phylum Cnidaria can be either sessile polyps or swimming medusae. Some cnidarians alternate between polyp and medusa stages during their life cycles.
- The body of a cnidarian consists of two cell layers—an outer epidermis and an inner gastrodermis—separated by a jellylike mesoglea.
- Cnidarians have cells called *cnidocytes*, which contain organelles known as *nematocysts*. When a cnidocyte is stimulated, its nematocyst ejects a filament that can paralyze or ensnare prey.
- The cnidarian nervous system is a diffuse web of interconnected nerve cells called a *nerve net*.
- The four classes of cnidarians are Hydrozoa (which includes animals such as the hydra), Cubozoa (box jellies), Scyphozoa (jellyfish), and Anthozoa (which includes sea anemones and corals).
- Hydrozoans may live as polyps, medusae, or mixed colonies of polyps and medusae. Cubozoans and scyphozoans spend most of their lives as medusae. Anthozoans live only as polyps.
- Animals in the phylum Ctenophora move through the water by beating the cilia that occur in eight rows on the outside of a ctenophore's body.
- Ctenophores capture prey with a sticky substance secreted by cells called *colloblasts*, which are usually located on a pair of tentacles.
- An apical organ at one end of the body enables ctenophores to sense their orientation in the water. Most ctenophores are hermaphroditic, and many are bioluminescent.

Vocabulary

medusa (p. 676)
polyp (p. 676)
epidermis (p. 676)
gastrodermis (p. 676)

mesoglea (p. 676)
gastrovascular cavity (p. 676)
tentacle (p. 676)
cnidocyte (p. 677)

nematocyst (p. 677)
nerve net (p. 677)
planula (p. 680)
coral reef (p. 681)

colloblast (p. 682)
apical organ (p. 682)
bioluminescence (p. 682)


CHAPTER REVIEW

USING VOCABULARY

- For each pair of terms, explain how the meanings of the terms differ.
 - spongin* and *spicule*
 - medusa* and *polyp*
 - epidermis* and *gastrodermis*
 - cnidocyte* and *nematocyst*
 - gemmule* and *planula*
- Explain the relationship between choanocytes and filter feeding.
- Use each of the following terms in a separate sentence: *colloblast*, *apical organ*, and *bioluminescence*.
- Word Roots and Origins** The name *Porifera* is derived from the Latin *porus*, meaning “channel,” and *ferre*, meaning “to bear.” Explain why *Porifera* is a good name for the sponge phylum.

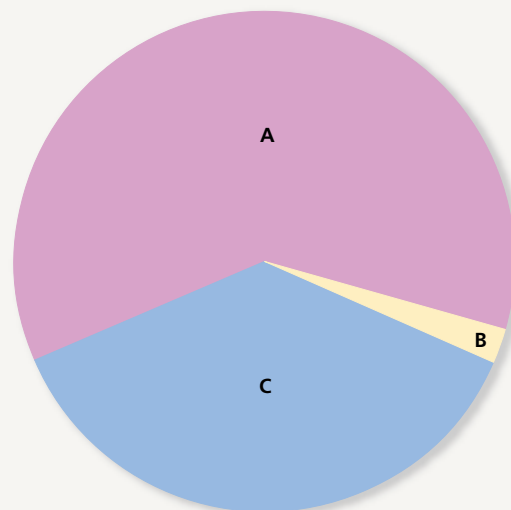
UNDERSTANDING KEY CONCEPTS

- Identify** three ways that sponges represent the transition from unicellular to multicellular life.
- Describe** why sponges are classified as animals.
- Outline** the path of water through a sponge, and explain what causes water to flow through a sponge.
- Explain** how a sponge’s usual method of feeding is suited to its sessile lifestyle.
- State** the role of gemmules in the life cycles of sponges.
- Summarize** the process of sexual reproduction in sponges.
- Compare** the two types of body structures that cnidarians have.
- Describe** how a cnidarian captures and ingests its prey.
- Identify** the specialization that is found among the individuals that make up a Portuguese man-of-war.
- Name** the benefits a sea anemone obtains from its symbiotic relationship with a clownfish. What benefit does the clownfish obtain from this relationship?
- Explain** why coral reefs are limited to warm, shallow environments.
- Compare** ctenophores and cnidarians. Include at least two differences.

-  **CONCEPT MAPPING** Use the following terms to create a concept map that sequences sexual reproduction in a typical scyphozoan: *adult male*, *medusa*, *blastula*, *adult female*, *sperm*, *polyp*, *planula*, and *egg*.

CRITICAL THINKING

- Applying Information** A single species of sponges may assume various appearances, depending on substrate, availability of space, and the velocity and temperature of water currents. How might these factors make the classification of sponges confusing? What features besides outward appearance can biologists use to classify sponges and eliminate some of this confusion?
- Analyzing Information** Sponge larvae have flagella on the outside of their bodies, while adult sponges have flagella lining their internal cavity. How is this structural difference related to functional differences between the larval and adult stages of sponges?
- Analyzing Patterns** Hydras generally reproduce asexually during warm weather and sexually in cooler weather. Based on what you have learned about the hydra embryo, what is the advantage of reproducing sexually when the weather turns cool?
- Predicting Results** What would happen to a coral reef if pollution or sediment caused the water around the reef to become less clear? Explain your answer.
- Interpreting Graphics** The pie chart below shows the relative numbers of hydrozoans, scyphozoans, and anthozoans. Which segment of the chart represents scyphozoans? How do you know?



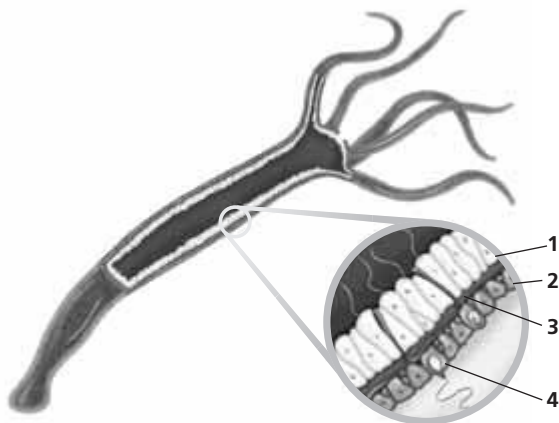


Standardized Test Preparation

DIRECTIONS: Choose the letter of the answer choice that best answers the question.

- Why are spongin and spicules important to a sponge?
 - They digest food.
 - They remove wastes.
 - They provide support.
 - They produce offspring.
- Which of the following structures are involved in both feeding and sexual reproduction in sponges?
 - spicules and gemmules
 - amoebocytes and spongin
 - gemmules and choanocytes
 - choanocytes and amoebocytes
- Which of the following is *not* a characteristic of cnidarians?
 - tentacles
 - choanocytes
 - nematocysts
 - gastrovascular cavity
- What do colloblasts do?
 - They produce light.
 - They secrete a sticky substance.
 - They draw water through sponges.
 - They form medusae that live in colonies.

INTERPRETING GRAPHICS: The diagram below illustrates a hydra. Study the diagram to answer the questions that follow.

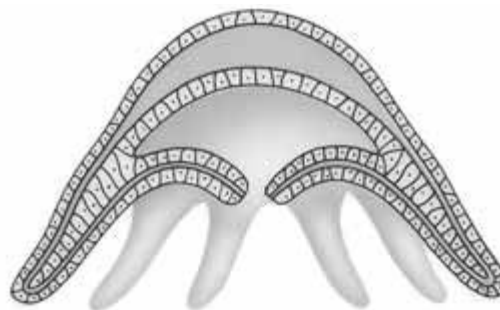


- Identify the substance found at point 3.
 - osculum
 - mesoglea
 - gastrodermis
 - gastrovascular cavity
- Which structure is involved in defense?
 - 1
 - 2
 - 3
 - 4

DIRECTIONS: Complete the following analogy.

- Sponge : osculum :: hydra :
 - mouth
 - tentacle
 - nerve net
 - nematocyst

INTERPRETING GRAPHICS: The diagram below illustrates a medusa. Study the diagram to answer the question that follows.



- In which class is this body form dominant?
 - Cnidaria
 - Hydrozoa
 - Anthozoa
 - Scyphozoa

SHORT RESPONSE

Cnidarians have two tissue layers, which is an important evolutionary advancement.

Describe the tissue layers and general body structure of a typical cnidarian.

EXTENDED RESPONSE

Sponges reproduce asexually in a number of ways.

Part A Describe three forms of asexual reproduction in sponges.

Part B Explain how reproducing asexually is advantageous to sponges.

Test TIP

You can sometimes figure out an answer to a question before you look at the answer choices. After you answer the question in your mind, compare your answer with the answer choices. Choose the answer that most closely matches your own answer.

Observing Hydra Behavior

OBJECTIVES

- Observe live specimens of hydra.
- Determine how hydras respond to different stimuli.
- Determine how hydras capture and feed on prey.

PROCESS SKILLS

- observing
- relating structure to function

MATERIALS

- silicone culture gum
- microscope slide
- hydra culture
- 2 medicine droppers
- compound microscope
- methylene blue solution
- vinegar
- stereomicroscope
- filter paper cut into pennant shapes
- forceps
- concentrated beef broth
- culture of *Daphnia pulex* or *Daphnia magna*


Background

1. How do animals respond to stimuli in their environment?
2. What is a hydra?




3. What characteristics do hydras share with other cnidarians?
4. How does a sessile animal, such as a hydra, obtain food?
5. What is a nematocyst?

PART A Close-up Examination of a Hydra

1.  **CAUTION** Slides break easily. Use care when handling them. Using a long piece of silicone culture gum, make a circular "well" on a microscope slide, as shown in the illustration below.



2.  **CAUTION** You will be working with a live animal. Be sure to treat it gently and to follow directions carefully. With a medicine dropper, gently transfer a hydra from the culture dish to the well on the slide, making sure the hydra is in water. The hydra should be transferred quickly; otherwise, it may attach itself to the medicine dropper. Allow the hydra to settle. As you go through the following steps, add water to the slide periodically to replace water that has evaporated, and keep the hydra wet.
3. Examine the hydra under the low-power setting of a compound microscope. Add a drop of methylene blue solution to the well containing the hydra to make the tentacles more visible. Identify and draw the hydra's body stalk, mouth, and tentacles in your lab report.
4. In your lab report, make a data table like the one shown on the next page. As you complete the following steps, record your observations in your data table.
5. As you continue to observe the hydra at low power, add a drop of vinegar to the well. Record what happens to the bumps on the tentacles. These bumps are cnidocytes.

- Transfer the hydra to the culture dish labeled "Used hydras." Rinse the well on your microscope slide with water to remove all traces of methylene blue and vinegar.



PART B Feeding Behavior

- Hydras eat small invertebrates, such as daphnia. With a medicine dropper, gently transfer another hydra to the well on your slide. Then transfer live daphnia to the well in the same manner.
- Observe the hydra carefully with the high-power setting of the stereomicroscope. Watch for threadlike nematocysts shooting out from the hydra. Some nematocysts release a poison that paralyzes prey. If the hydra does not respond after a few minutes, obtain another hydra from the culture dish and repeat this procedure.
- Observe the way the hydra captures and ingests daphnia, and record your observations in your data table. Record how long it takes for a hydra to ingest a daphnia.
- Transfer the hydra to the culture dish labeled "Used hydras." Rinse the well on your microscope slide with water to remove the daphnia.

PART C Response to Stimuli

- Transfer another hydra to the well on your slide, and examine it with the high-power setting of the stereomicroscope. Using forceps, move the long tip of a pennant-shaped piece of filter paper near the hydra's tentacles. Be careful not to touch the hydra with the filter paper. Observe the hydra's response to the filter paper, and record your observations in your data table.
- Now observe how the hydra responds to a chemical stimulus. Dip the same piece of filter paper in beef broth, and repeat the procedure in step 11. Again, be

careful not to touch the hydra. Record the hydra's response to the beef broth in your data table.

- Finally, investigate how the hydra responds to touch. Using the long tip of a clean pennant-shaped piece of filter paper, touch the hydra's tentacles, mouth, and body stalk. **CAUTION Touch the hydra gently.** Record your observations in your data table.
-   Transfer the hydra to the culture dish labeled "Used hydras." Clean up your materials and wash your hands before leaving the lab.

Analysis and Conclusions

- Is vinegar a normal part of a hydra's diet? Why do you think vinegar is used in this step?
- Based on your observations, how do you think a hydra behaves when it is threatened in its natural habitat?
- Describe a hydra's feeding behavior.
- What happens to food that has not been digested by a hydra?
- What was the purpose of using the clean filter paper in step 11?
- Did the hydra show a feeding response or a defensive response to the beef broth? Explain.
- How is a hydra adapted to a sessile lifestyle?
- How is the feeding method of a hydra different from that of a sponge?
- Do you think the hydra's response is triggered by water vibrations, by chemicals that daphnia releases, or by daphnia touching the hydra?

Further Inquiry

Design an experiment to determine how hydras respond to other stimuli, such as light.

OBSERVATIONS OF HYDRA BEHAVIOR

Behavior	Observations
Response to vinegar	
Feeding behavior	
Response to filter paper	
Response to beef broth on filter paper	
Response to touch with filter paper	