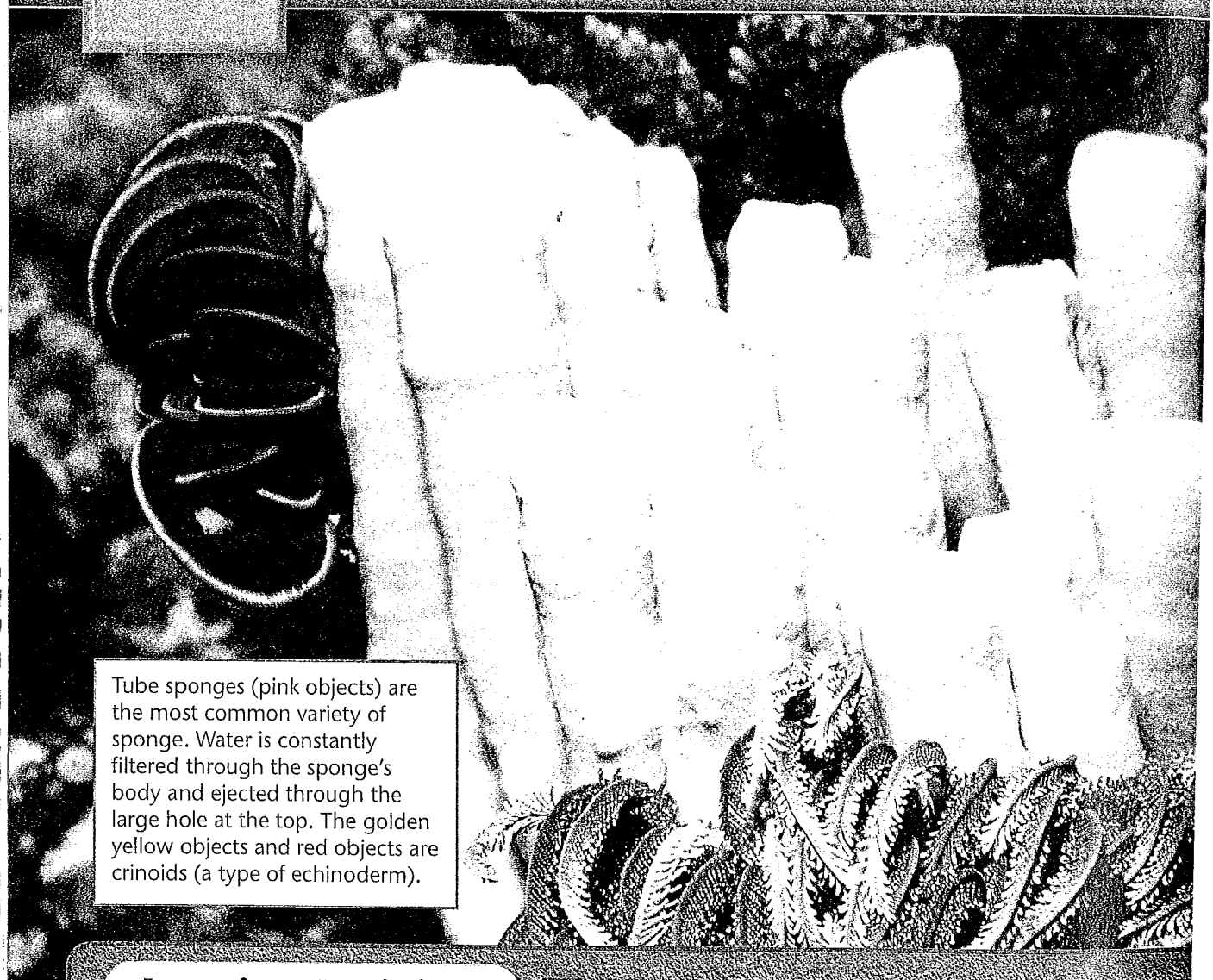
CHAPTER 26

Sponges and Cnidarians



Tube sponges (pink objects) are the most common variety of sponge. Water is constantly filtered through the sponge's body and ejected through the large hole at the top. The golden yellow objects and red objects are crinoids (a type of echinoderm).

Inquiry Activity

What makes an animal an animal?

Procedure

1. Observe the specimens or photographs of organisms provided by your teacher. Some of the organisms are animals, whereas others are not. Examine each organism carefully.
2. Make a list of each organism's characteristics.

Think About It

1. **Classifying** Classify the organisms into two groups: animals and nonanimals. Give your rea for putting each organism into a particular grou
2. **Forming Operational Definitions** List at le three characteristics shared by each of the orga isms you classified as animals. Describe how the characteristics separate them from the nonanim

26–1 Introduction to the Animal Kingdom

Of all the kingdoms of organisms, the animal kingdom is the most diverse in appearance. Some animals are so small that they live on or inside the bodies of other animals. Others are many meters long and live in the depths of the sea. They may walk, swim, crawl, burrow, or fly—or not move at all. As you will see, each major group, or phylum, has its own typical body plan.

Guide for Reading

Key Concepts

- What characteristics do all animals share?
- What essential functions do animals carry out?
- What are the important trends in animal evolution?

Vocabulary

invertebrate • vertebrate
feedback inhibition
blastula • protostome
deuterostome • anus
endoderm • mesoderm
ectoderm • radial symmetry
bilateral symmetry
cephalization

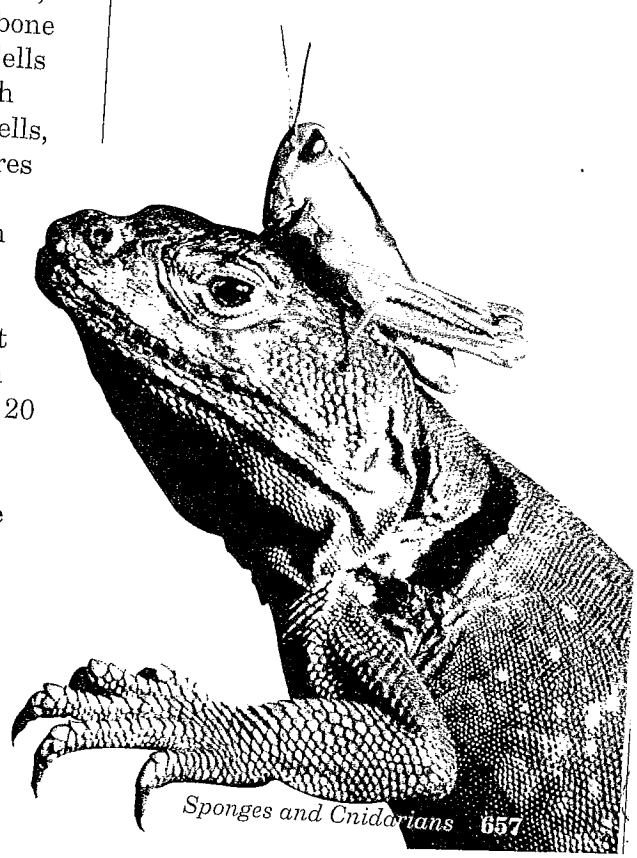
Reading Strategy: Monitoring Your Understanding Before you read, write down what you already know about animals. After you have read this section, write down what you learned about animals.

What Is an Animal?

All members of the animal kingdom share certain characteristics. Animals are all heterotrophs, meaning that they obtain nutrients and energy by feeding on organic compounds from other organisms. Animals are multicellular, or composed of many cells. The cells that make up animal bodies are eukaryotic, meaning that they contain a nucleus and membrane-bound organelles. Unlike the cells of algae, fungi, and plants, animal cells do not have cell walls. **Animals, members of the kingdom Animalia, are multicellular, eukaryotic heterotrophs whose cells lack cell walls.**

The bodies of most animals contain tissues. Recall that a tissue is a group of cells that perform a similar function. Animals have epithelial, muscular, connective, and nervous tissues. Epithelial tissues cover body surfaces. The epithelial cells that line lung surfaces, for example, have thin, flat structures through which gases move in and out easily. The cells of muscle tissue contain proteins that enable the cells to contract, moving parts of animals' bodies. Connective tissue, such as bone and blood, support an animal's body and connect its parts. Cells embedded in bone tissue produce minerals that give strength and hardness to bone. Nervous tissue is composed of nerve cells, which have threadlike projections that act like telephone wires to carry information throughout the body.

Over 95 percent of all animal species are often grouped in a single, informal category: invertebrates. This group is defined in an odd way—by describing a characteristic that its members do *not* have. **Invertebrates** are animals that do not have a backbone, or vertebral column. They range in size from microscopic dust mites to the giant squid, which is more than 20 meters in length. They include groups as diverse as sea stars, worms, jellyfishes, and insects. The other 5 percent of animals, including fishes, amphibians, reptiles, birds, and mammals, are called **vertebrates,** because they have a backbone.



▶ **Figure 26–1** The animal kingdom includes an incredible diversity of forms and lifestyles. **Despite their differences in appearance, both the collared lizard and the grasshopper are eukaryotic heterotrophs whose cells lack cell walls.**

What Animals Do to Survive

Animals carry out the following essential functions: feeding, respiration, circulation, excretion, response, movement, and reproduction. Over millions of years, animals have evolved in a variety of ways that enable them to do this. The study of the functions of organisms is called physiology. The structure, or anatomy, of an animal's body enables it to carry out physiological processes.

Many body functions help animals maintain homeostasis, or a relatively stable internal environment. Homeostasis is often maintained by internal feedback mechanisms called feedback loops. Most of these feedback loops involve **feedback inhibition,** in which the product or result of a process stops or limits the process. For example, when a dog becomes too hot, it pants. Panting releases heat, and the animal's body temperature decreases.

Feeding

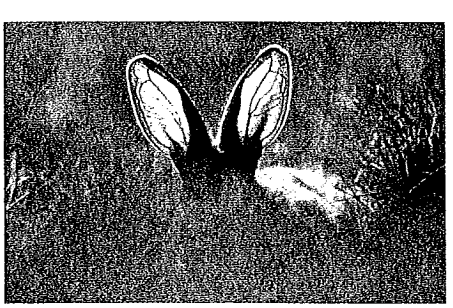
Feeding Most animals cannot absorb food; instead, they ingest (or eat) it. Animals have evolved a variety of ways to feed. Herbivores eat plants; carnivores eat other animals; and omnivores feed on both plants and animals. Detritivores feed on decaying plant and animal material. Filter feeders are aquatic animals that strain tiny floating organisms from water.

Animals can also form symbiotic relationships, in which two species live in close association with each other. A parasite, for example, is a type of symbiont that lives within or on another organism, the host. The parasite feeds on the host, harming it.

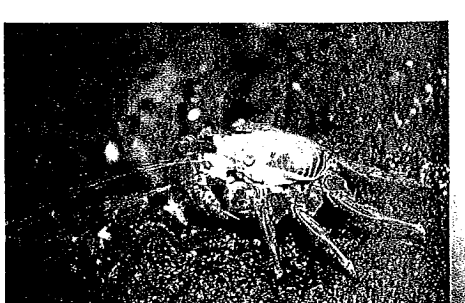
Respiration

Respiration Whether they live in water or on land, all animals respire, which means that they take in oxygen and give off carbon dioxide. Because of their very simple, thin-walled bodies, some animals can rely on the diffusion of these substances through their skin. Most other animals, however, have evolved complex tissues and organ systems for respiration.

Circulation Many small aquatic animals, such as some aquatic worms, rely solely on diffusion to transport oxygen, nutrient molecules, and waste products among all their cells. Diffusion is sufficient because these animals are only a few cell layers thick. Larger animals, however, have some kind of circulatory system to move materials around within their bodies.



Circulation



Excretion

Excretion A primary waste product of cells is ammonia, a poisonous substance that contains nitrogen. A buildup of ammonia and other waste products would kill an animal. Most animals have an excretory system that either eliminates ammonia quickly or converts it into a less toxic substance that is removed from the body. By eliminating metabolic wastes, excretory systems help maintain homeostasis.

Response Animals respond to events in their environment using specialized cells called nerve cells. In most animals, nerve cells hook up together to form a nervous system. Some cells, called receptors, respond to sound, light, and other external stimuli. Other nerve cells process information and determine how the animal responds. The arrangement of nerve cells in the body changes dramatically from phylum to phylum.

Movement Some adult animals stay attached to a single spot. Most animals, however, are motile, meaning they can move. But both stick-in-the-muds and jet-setters usually have either muscles or musclelike tissues that generate force by becoming shorter. Muscle contraction enables motile animals to move around, usually by working in combination with a support structure called a skeleton. Muscles also help even sedentary animals feed and pump water and fluids through their bodies.

Reproduction Most animals reproduce sexually by producing haploid gametes. Sexual reproduction helps create and maintain genetic diversity in populations. It therefore helps improve species' abilities to evolve when the environment changes. Many invertebrates can also reproduce asexually. Asexual reproduction produces offspring that are genetically identical to the parent. It allows animals to increase their numbers rapidly.

✓CHECKPOINT *How do sexual and asexual reproduction differ?*

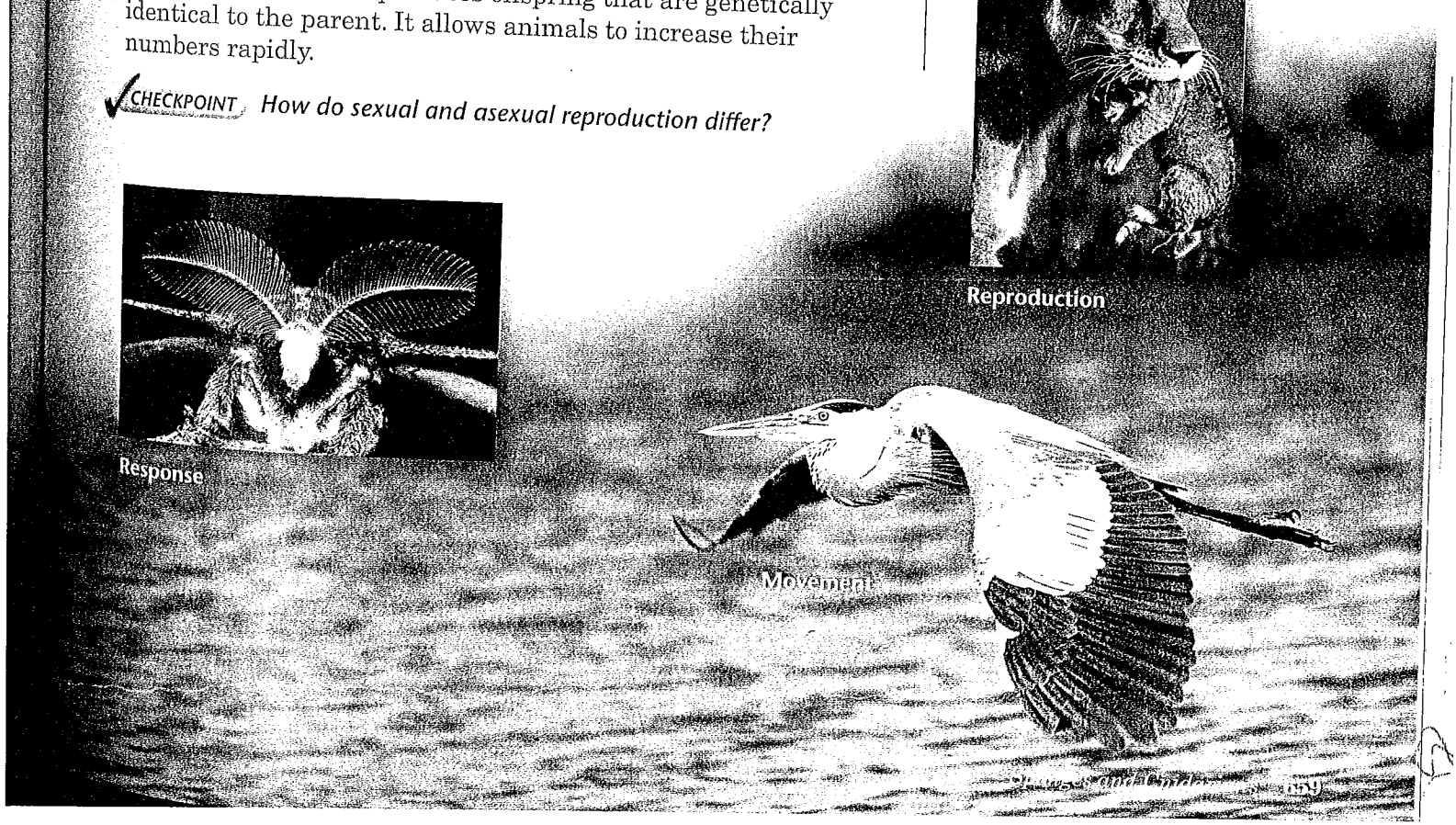
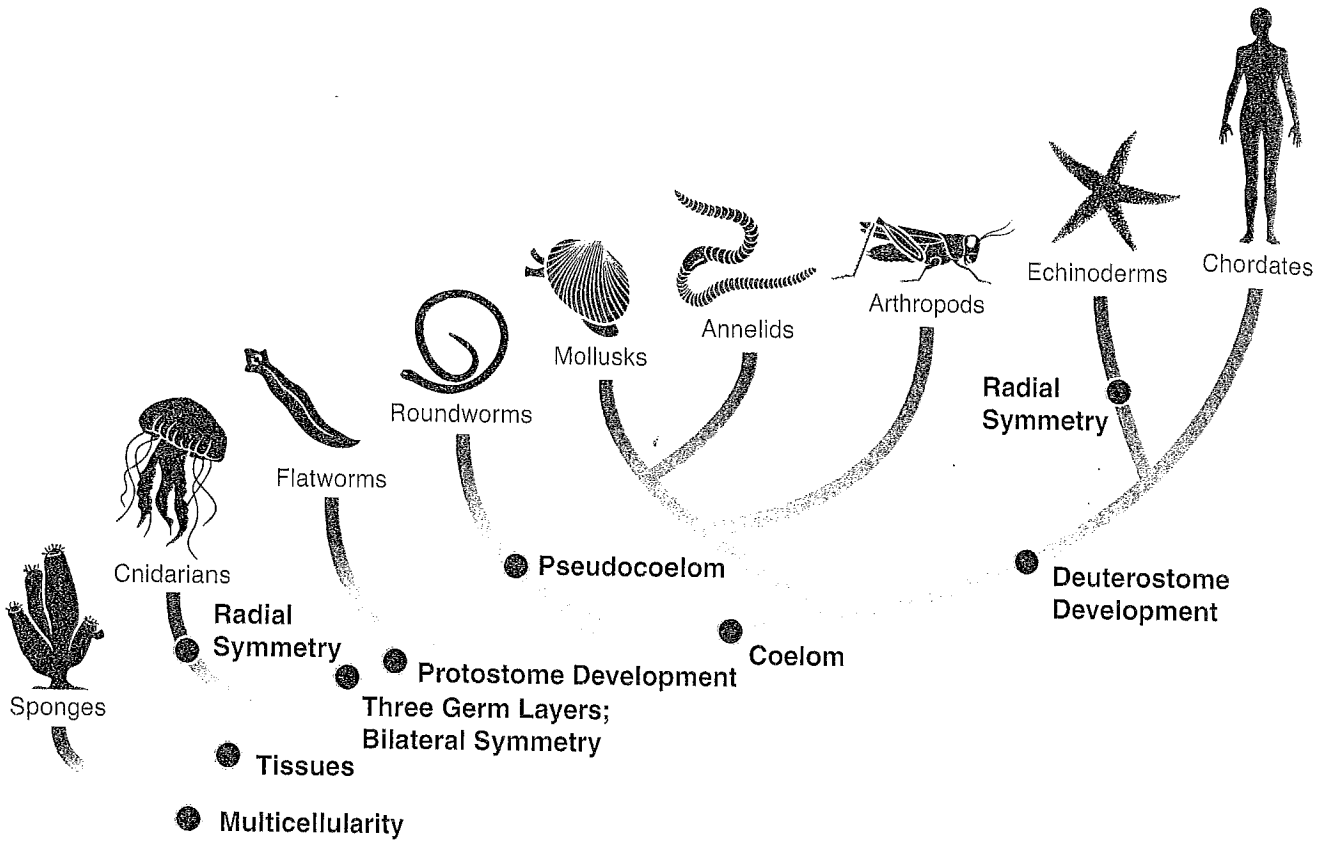


Figure 26–2 **Animals carry out seven essential functions: feeding, respiration, circulation, excretion, response, movement, and reproduction.** Some snakes feed by constricting, or squeezing, their prey. Humans respire by breathing oxygenated air into lungs. A rabbit's circulatory system pumps blood through closed vessels, which are visible in its ears. Crabs rid their bodies of metabolic wastes by excreting fluid. Like many insects, moths respond to stimuli that they detect from the environment using specialized sense organs such as antennae. Herons move using a system of muscles attached to a low-density skeleton. Animals reproduce either sexually or asexually; lions reproduce sexually and have only a few offspring per litter.



▲ **Figure 26–3** This diagram illustrates phylogenetic, or evolutionary, relationships among major groups of animals. Groups shown close together, such as echinoderms and chordates, are more closely related than groups that are shown farther apart, such as echinoderms and cnidarians. During the course of evolution that produced these different groups, important traits evolved. **Animals that are more complex typically have specialized cells, bilateral body symmetry, cephalization, and a body cavity.**

Trends in Animal Evolution

Your survey of the animal kingdom will begin with simple forms and move through more complicated ones. These different phyla are related to one another by a common evolutionary heritage. The diagram in **Figure 26–3** shows our most current understanding of phylogenetic relationships among groups of living animals. A comparison of the groups in the diagram shows important trends in animal evolution. **Complex animals tend to have high levels of cell specialization and internal body organization, bilateral body symmetry, a front end or head with sense organs, and a body cavity.** In addition, the embryos of complex animals develop in layers.

Cell Specialization and Levels of Organization As animals have evolved, by natural selection and other evolutionary processes, their cells have become specialized to carry out different functions, such as movement and response. Large animals need greater efficiency in body processes than do very small animals. Unicellular organisms, such as amoebas, move nutrients and waste products directly across their cell membranes. In multicellular organisms such as animals, however, each cell type has a structure and chemical composition that enable it to perform a specialized function. Groups of specialized cells form tissues. Tissues join together to form organs and organ systems—all of which work together to carry out a variety of complex functions.

Early Development Animals that reproduce sexually begin life as a zygote, or fertilized egg. **Figure 26–4** shows patterns of embryology, or development of the embryo after fertilization. The zygote undergoes a series of divisions to form a **blastula** (BLAS-tyoo-luh), which is a hollow ball of cells. The blastula folds in on itself, forming a single opening called a blastopore. The process of blastopore formation changes a simple ball of cells—similar to an inflated balloon—into an elongated structure with a tube inside, as if you were holding the balloon and pushing your thumbs toward the center.

The blastopore leads into a central tube that runs the length of the developing embryo. This tube becomes the digestive tract and is formed in one of two ways. A **protostome** (PROH-tuh-stohm) is an animal whose mouth is formed from the blastopore. Most invertebrate animals are protostomes. A **deuterostome** (DOO-tur-uh-stohm) is an animal whose anus is formed from the blastopore. The **anus** is the opening through which wastes leave the digestive tract. The mouth is formed second, after the anus. Echinoderms and all vertebrates are deuterostomes. This similarity in embryology may indicate that vertebrates have a closer evolutionary relationship to echinoderms than to other invertebrates.

During early development, the cells of most animal embryos differentiate into three layers called germ layers. The cells of the **endoderm,** or innermost germ layer, develop into the linings of the digestive tract and much of the respiratory system. The cells of the **mesoderm,** or middle layer, give rise to muscles and much of the circulatory, reproductive, and excretory organ systems. The **ectoderm,** or outermost layer, gives rise to sense organs, nerves, and the outer layer of the skin.

CHECKPOINT *Which germ layer gives rise to the muscles?*

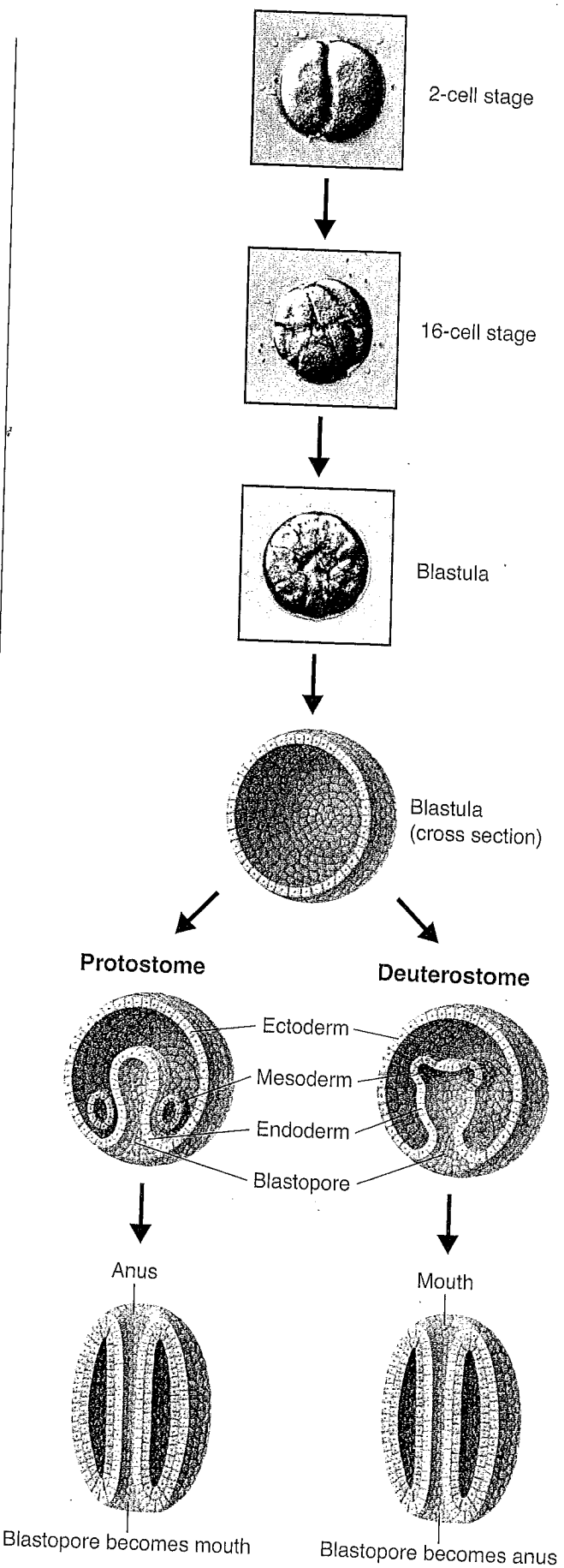
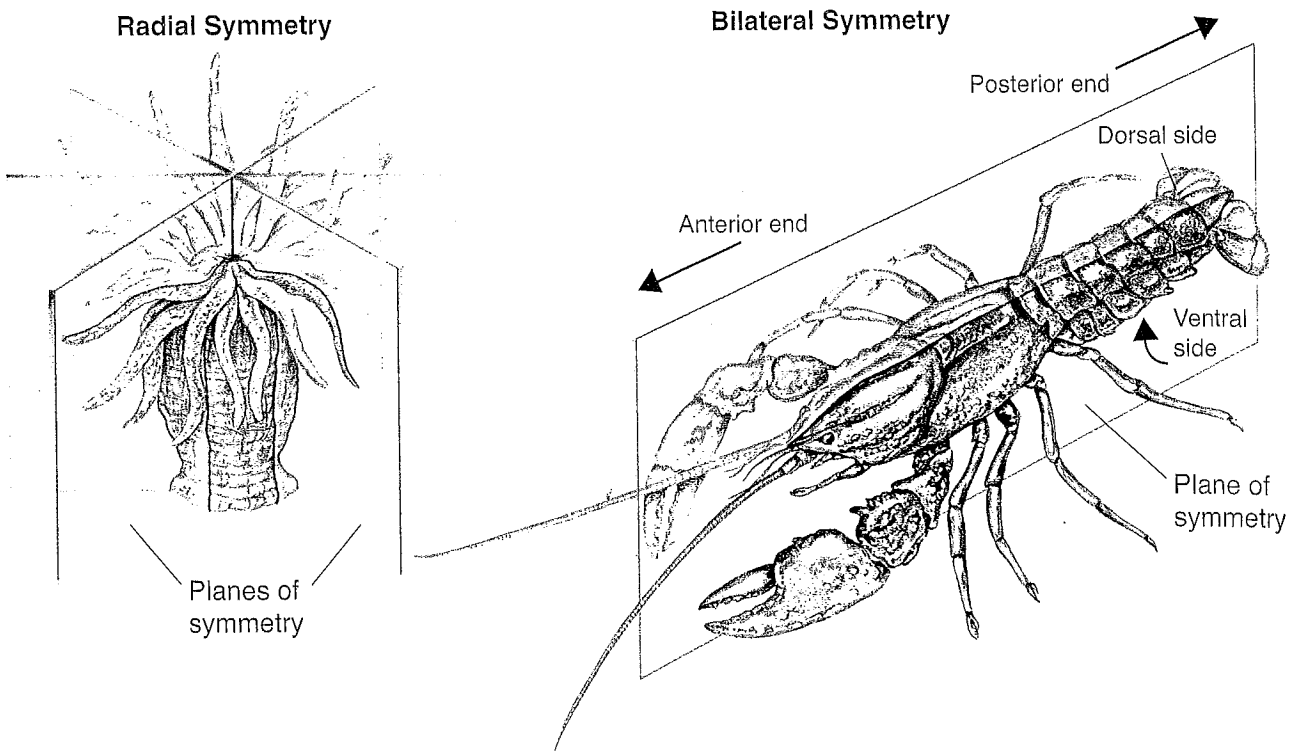


Figure 26–4 During the early development of animal embryos, cells divide to produce a hollow ball of cells called a blastula. An opening called a blastopore forms in this ball. In protostomes, the blastopore develops into the mouth. In deuterostomes, the blastopore forms an anus. **Interpreting Graphics** *Which cell layer lines the digestive tract in both protostomes and deuterostomes?*



▲ **Figure 26–5** Animals with radial symmetry have body parts that extend from a central point. Animals with bilateral symmetry have distinct anterior and posterior ends and right and left sides. **Interpreting Graphics** *How many planes of symmetry does the crayfish, above right, have?*

Quick Lab

How can body symmetry affect movement?

Material modeling clay

Procedure

1. Use modeling clay to make models of two animals. Make one model radially symmetrical and the other long, narrow, and bilaterally symmetrical.
2. Make grooves to divide each model into similar segments.
3. Add legs to some segments of your models.

Analyze and Conclude

1. **Inferring** Which type of body symmetry is more suited to walking forward?
2. **Using Models** How is bilateral symmetry an advantage to animals that walk or run?

Body Symmetry With the exception of sponges, every kind of animal exhibits some type of body symmetry in its anatomy, or body structure. Many simple animals, such as the sea anemone shown on the left in **Figure 26–5**, have body parts that repeat around the center of the body. These animals exhibit **radial symmetry,** similar to that of a bicycle wheel, in which any number of imaginary planes can be drawn through the center, each dividing the body into equal halves.

In animals with **bilateral symmetry,** such as the crayfish, only a single imaginary plane can divide the body into two equal halves. Animals with bilateral symmetry have left and right sides. They also usually have front and back ends and upper and lower sides. The anterior is the front end, and the posterior is the back end. The dorsal is the upper side, and the ventral is the lower side.

An anatomy with bilateral symmetry allows for segmentation, in which the body is constructed of many repeated and similar parts, or segments. Animals with bilateral symmetry, such as worms, insects, and vertebrates, typically have external body parts that repeat on either side of the body. The combination of bilateral symmetry and segmentation is found in two of the most successful animal groups—arthropods and vertebrates. Geneticists are learning how gene interactions during development control the growth and form of segments. Amazingly, the same controls are found in humans and insects!

✓CHECKPOINT *How do radial symmetry and bilateral symmetry differ?*

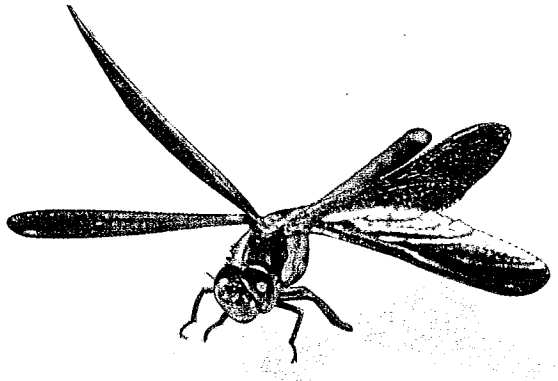


Figure 26–6 Animals with cephalization have the brain and other sense organs toward the front of the body. This end of the body comes into contact with the environment first, allowing animals to respond effectively to stimuli. **Inferring** *How might cephalization help animals to move quickly?*

Cephalization Animals with bilateral symmetry usually exhibit the anatomical characteristic called cephalization (sef-uh-lih-ZAY-shun). **Cephalization** is the concentration of sense organs and nerve cells at the front end of the body. Animals with cephalization, such as the dragonfly in **Figure 26–6**, respond to the environment more quickly and in more complex ways than simpler animals can. Animals with bilateral symmetry usually move with the anterior end forward, so this end comes in contact with new parts of the environment first. As sense organs such as eyes have evolved, they have tended to gather at the anterior end, as have nerve cells that process information and "decide" what the animal should do. In general, the more complex animals become, the more pronounced their cephalization. The anterior end is often different enough from the rest of the body that it is called a head.

Body Cavity Formation Most animals have a body cavity, which is a fluid-filled space that lies between the digestive tract and the body wall. A body cavity is important because it provides a space in which internal organs can be suspended so that they are not pressed on by muscles or twisted out of shape by body movements. Body cavities also allow for specialized regions to develop, and they provide room for internal organs to grow and expand. In some animals, body cavities contain fluids that are involved in circulation, feeding, and excretion.

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26–1 Section Assessment

1. **Key Concept** What are the characteristics of members of the animal kingdom?
2. **Key Concept** Describe the seven essential functions performed by all animals.
3. **Key Concept** In what ways are complex animals different from simple animals?
4. How is the embryology of echinoderms similar to that of vertebrates? What might this similarity indicate about their evolutionary relationship?
5. How are body symmetry and cephalization related?
6. **Critical Thinking Applying Concepts** How is hunger an internal feedback mechanism for maintaining homeostasis?

Thinking Visually

Constructing a Chart
Make a two-column chart of the different functions that enable animals to survive and respond to the environment. In the first column, list each function. In the second column, include a drawing, photograph, or magazine clipping that illustrates an example of that function.

26–2 Sponges

Guide for Reading

Key Concepts

- Why are sponges classified as animals?
- How do sponges carry out essential functions?

Vocabulary

choanocyte
osculum
spicule
archaeocyte
internal fertilization
larva
gemmule

Reading Strategy: Using Visuals Before you read, preview **Figure 26–8** and **Figure 26–9.** For each figure, write a brief statement that summarizes the content of the illustration. Once you have read the section, explain how each illustration reinforces or enhances the content of the section.

Sponges are the simplest and probably the most unusual animals. Living on Earth for at least 540 million years, sponges are also the most ancient animals. Today, most sponges live in the ocean, from the Arctic and Antarctic regions to the tropics, and from shallow water to depths of several hundred meters. To humans, however, they are probably best known in their dried form—the natural sponges used for bathing.

What Is a Sponge?

Sponges are placed in the phylum Porifera (poh-RIF-ur-uh), which means "pore-bearers." This name is appropriate because sponges have tiny openings, or pores, all over their bodies, as shown in **Figure 26–7.** Sponges are sessile, meaning that they live their entire adult life attached to a single spot.

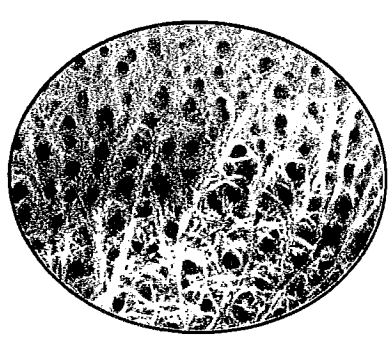
Given these unusual features, why are sponges considered animals? **Sponges are classified as animals because they are multicellular, heterotrophic, have no cell walls, and contain a few specialized cells.** Because sponges are so different from other animals, some scientists think that they evolved independently from all other animals. Other evidence suggests that sponges share a common ancestor with other animals but that they separated from this ancestor long before the other groups did.

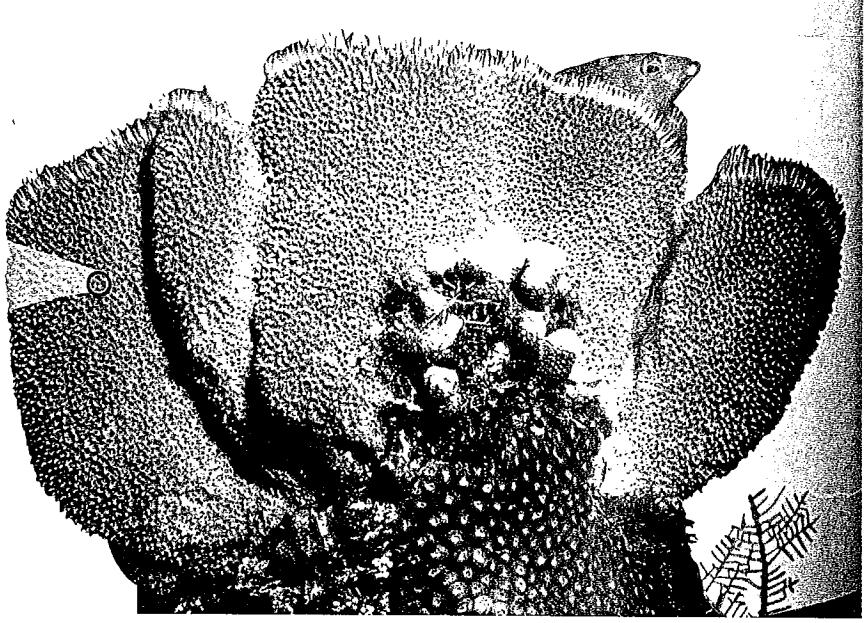
✓ *CHECKPOINT Why is the phylum name Porifera appropriate for sponges?*

Form and Function in Sponges

Sponges have nothing resembling a mouth or gut, and they have no tissues or organ systems. Simple physiological processes are carried out by a few specialized cells.

▼ **Figure 26–7** Sponges **are animals because they are heterotrophic and have specialized cells.** Sponges are probably the least typical of what we think of as animals. They grow in irregular shapes and live attached to the floor of oceans and freshwater bodies. Water enters the body of a sponge through small holes called pores (inset photo).





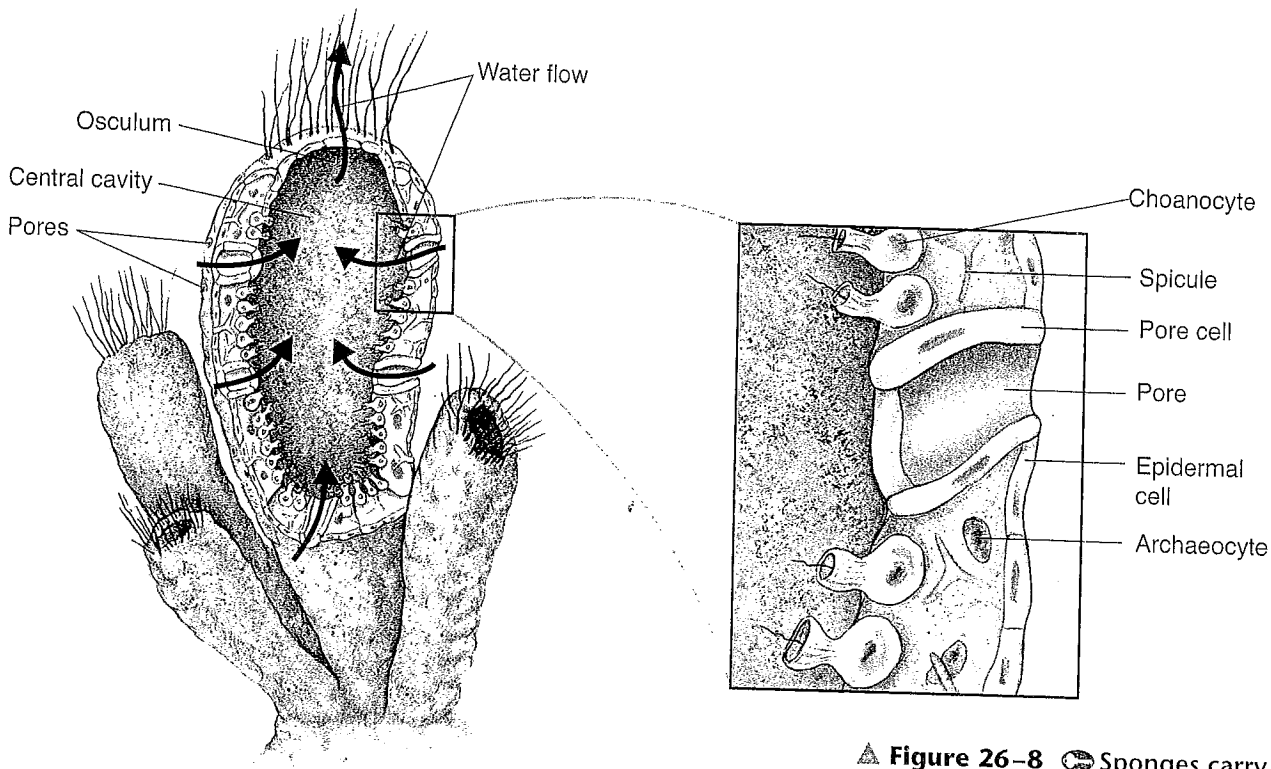


Figure 26–8 Sponges carry out basic functions, such as feeding and circulation, by moving water through their bodies. Choanocytes use flagella to move water through pores in the wall of the sponge and out through the osculum. As water moves through the sponge, food particles are filtered from the water, and wastes are removed from the sponge.

Body Plan Sponges are asymmetrical; they have no front or back ends, and no left or right sides. A sponge can be thought of as a large, cylindrical water pump. The body of a sponge, shown in **Figure 26–8**, forms a wall around a large central cavity through which water is circulated continually. **Choanocytes** (koh-AN-uh-sytz) are specialized cells that use flagella to move a steady current of water through the sponge. This water enters through pores located in the body wall. Water then leaves through the **osculum** (AHS-kyoo-lum), a large hole at the top of the sponge. **The movement of water through the sponge provides a simple mechanism for feeding, respiration, circulation, and excretion.**

Sponges have a simple skeleton. In harder sponges, the skeleton is made of spiny spicules. A **spicule** is a spike-shaped structure made of chalklike calcium carbonate or glasslike silica. Spicules are made by **archaeocytes** (ARK-ee-uh-sytz), which are specialized cells that move around within the walls of the sponge. Softer sponges have an internal skeleton made of spongin, a network of flexible protein fibers. These are the sponges that are harvested and used as natural bath sponges.

Feeding Sponges are filter feeders that sift microscopic food particles from the water. Digestion is intracellular, meaning that it takes place inside cells. As water moves through the sponge, food particles are trapped and engulfed by choanocytes that line the body cavity. These particles are then digested or passed on to archaeocytes. The archaeocytes complete the digestive process and transport digested food throughout the sponge.

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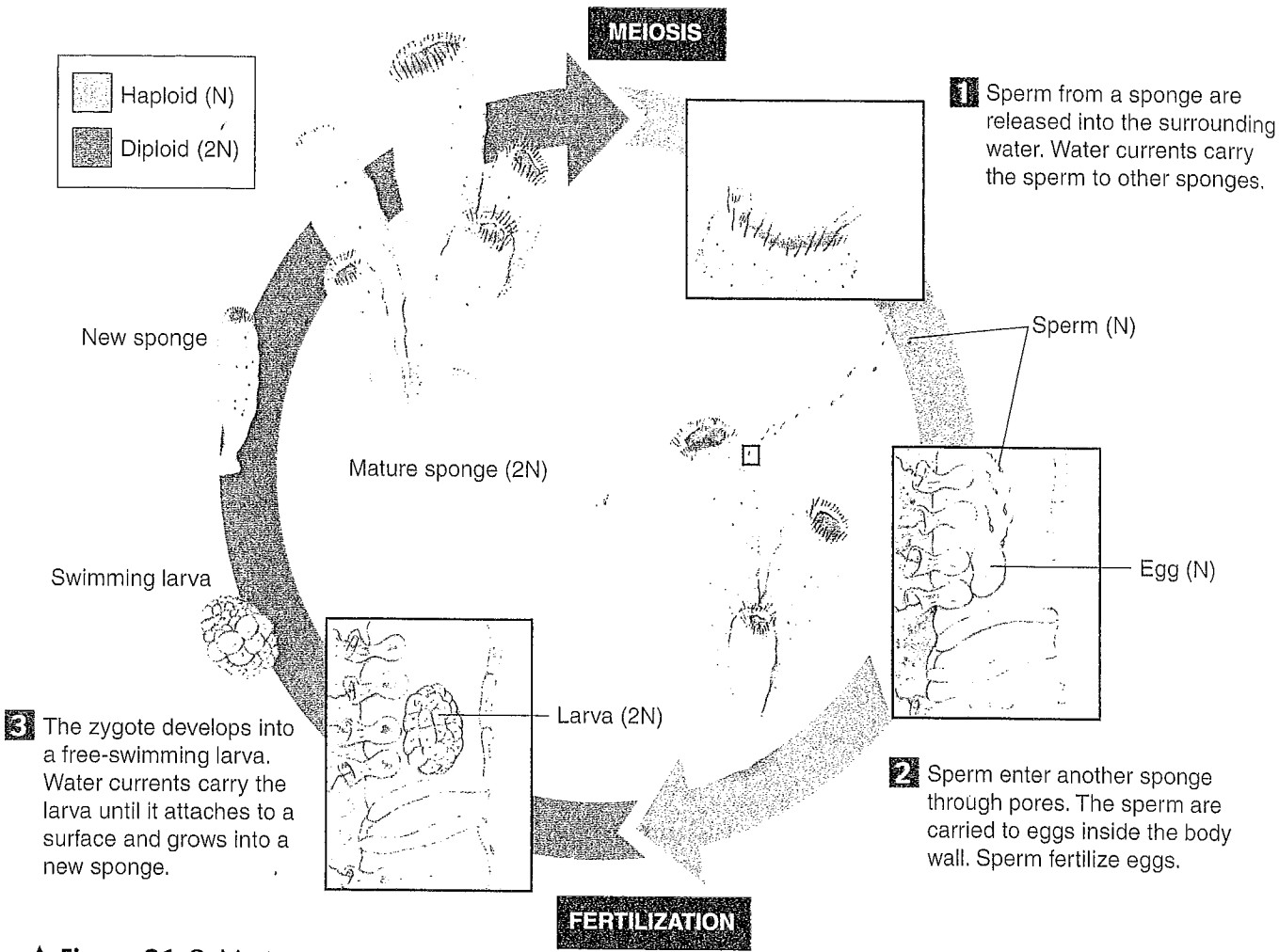


▲ **Figure 26–9** Most sponges reproduce sexually, and many have internal fertilization. **Interpreting Graphics** *Is an adult sponge haploid or diploid?*

Respiration, Circulation, and Excretion Sponges rely on the movement of water through their bodies to carry out body functions. As water moves through the body cavity, oxygen dissolved in the water diffuses into the surrounding cells. At the same time, carbon dioxide and other wastes, such as ammonia, diffuse into the water and are carried away.

Response Sponges do not have nervous systems that would allow them to respond to changes in their environment. However, many sponges protect themselves by producing toxins that make them unpalatable or poisonous to potential predators.

Reproduction Sponges can reproduce either sexually or asexually. The steps in sexual reproduction are diagrammed in **Figure 26–9.** In most sponge species, a single sponge forms both eggs and sperm by meiosis. The eggs are fertilized inside the sponge's body, in a process called **internal fertilization.** Sperm are released from one sponge and are carried by water currents until they enter the pores of another sponge. Archaeocytes carry the sperm to an egg. After fertilization, the zygote develops into a larva. A **larva** is an immature stage of an organism that looks different from the adult form. The larvae of sponges are motile and are usually carried by currents before they settle to the sea floor.

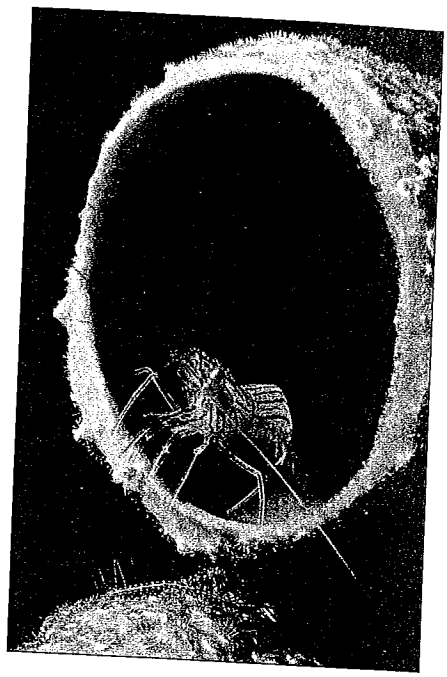
Sponges can reproduce asexually by budding or by producing gemmules. In budding, part of a sponge breaks off of the parent sponge, settles to the sea floor, and grows into a new sponge. When faced with difficult environmental conditions, some sponges produce **gemmules** (JEM-yoolz), which are groups of archaeocytes surrounded by a tough layer of spicules. Gemmules can survive freezing temperatures and drought. When conditions become favorable, a gemmule grows into a new sponge.

Sexual reproduction—in sponges and other organisms—involves the joining of haploid gametes that have been produced by meiosis. Since the zygote contains genes from both parents, the new sponge is not genetically identical to either parent. Asexual reproduction, in contrast, does not involve meiosis or the joining of haploid gametes. Instead, the cells of the bud or gemmule, which are diploid, divide repeatedly by mitosis, producing growth. Asexual reproduction produces offspring that are genetically identical to the parent.

Ecology of Sponges

Sponges are important in aquatic ecology. Sponges have irregular shapes and many are large. Therefore, they provide habitats for marine animals such as snails, sea stars, and the shrimp in **Figure 26–10.** These are examples of commensalism. Sponges also form partnerships with photosynthetic bacteria, algae, and plantlike protists. These photosynthetic organisms provide food and oxygen to the sponge, while the sponge provides a protected area where these organisms can thrive. This relationship is an example of mutualism, since both partners benefit. Sponges containing photosynthetic organisms play an important role in the ecology and primary productivity of coral reefs.

Sponges usually live attached to the sea floor, where they often receive only low levels of filtered sunlight. Recently, scientists have found clues to the mystery of how organisms within the sponge get enough light to carry out photosynthesis. The spicules of some sponges look like cross-shaped antennae. Like a lens or magnifying glass, they focus and direct incoming sunlight to cells lying below the surface of the sponge—where symbiotic organisms carry out photosynthesis. This adaptation may allow sponges to survive in a wider range of habitats.



▲ **Figure 26–10** Sponges often provide habitats for other organisms. Observe how the sponge provides shelter for this snapping shrimp. **Inferring** *How might the sponge protect the shrimp from predators?*

26–2 Section Assessment

1. **Key Concept** What features do sponges share with all other animals?
2. **Key Concept** How do sponges use water to carry out essential functions?
3. Describe the different types of sponge skeletons.
4. **Critical Thinking Drawing Conclusions** Why would sponges be unable to live on land?

Focus on the BIG Idea

Interdependence in Nature
In Chapter 4, you learned about mutualism, commensalism, and other symbiotic relationships. Compare and contrast mutualism and commensalism, and explain how each is important in the life of a sponge.

TECHNOLOGY & SOCIETY

Using Nature to Produce Sunscreen

One way of generating new medicines is to look for them in nature. Organisms of all kinds have been battling one another and their physical environment since life began. So, researchers can search for molecules that have been assembled and tested by the oldest process for generating new compounds on Earth—natural selection.

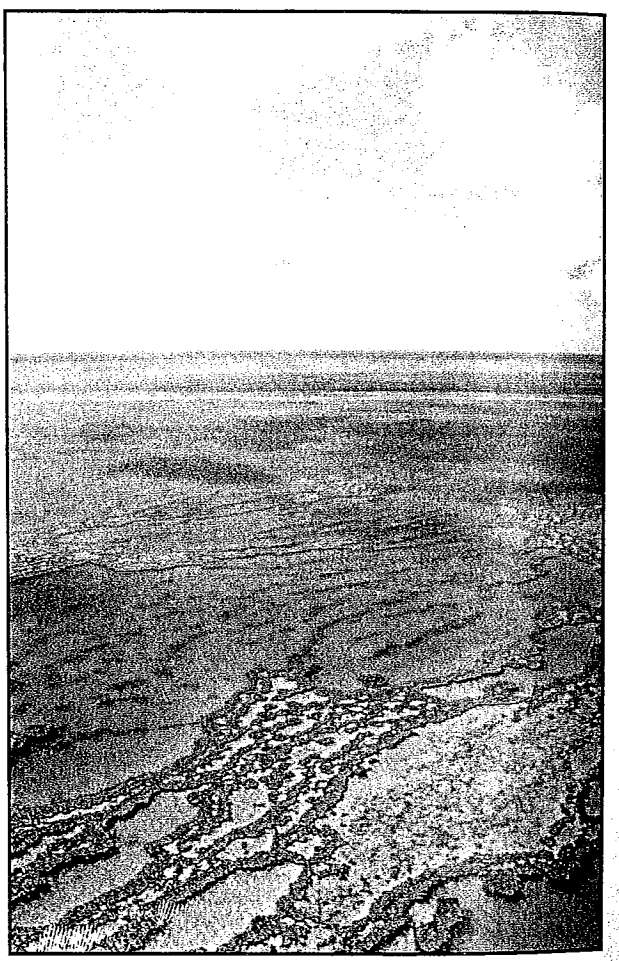
Natural UV Protection in Corals

One of these "new" molecules may be the world's first naturally produced sunscreen. Known as Sunscreen 855, this compound was discovered by researchers studying corals that live in shallow waters along Australia's Great Barrier Reef. During the low tide, these corals are exposed to the air and full sunlight. Investigators reasoned that these corals might have evolved some sort of protection against the damaging ultraviolet (UV) radiation of intense sunlight. Sure enough, their search turned up a UV-blocking compound in the tissues of these corals.

From Natural to Synthetic

After isolating and analyzing the compound in Sunscreen 855, the researchers learned that it was structurally different from the compounds used in synthetic sunscreens. They devised a way to produce it in the laboratory so that corals would not need to be harvested to make the sunscreen. Preliminary tests have shown that the sunscreen is highly efficient in absorbing radiation in the damaging UV-B region of the spectrum.

Sunscreen 855 is not sold in any drugstore—nor will it be for several years. Researchers are working with investors, lawyers, and businesspeople to test the new product for safety and effectiveness. If it passes final tests, Sunscreen 855 could be the best—and most natural—protection yet against the harmful effects of the sun.



Research and Decide

Use library or Internet resources to learn more about Sunscreen 855. Then, suppose that Sunscreen 855 were made into a product that people could buy. Make a list of things that the product should do. Make another list of things it should not do (such as harmful side effects it might cause). Describe how you would test these different claims.

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26–3 Cnidarians

Imagine that you are swimming in warm, tropical waters. Far away, delicate jellyfishes float in the ocean currents. Within arm's reach, sea fans sway in the shallow currents. Brightly colored sea anemones cling to rocks, looking more like underwater flowers than animals. All these creatures are animals in the phylum Cnidaria (ny-DAYR-ee-uh), a group that includes hydras, jellyfishes, sea anemones, and corals. These fascinating animals are found in waters all over the world. Some cnidarians live as individuals. Others live in colonies composed of dozens or even thousands of connected individuals.

Guide for Reading

Key Concepts
- What is a cnidarian?
- What two body plans exist in the cnidarian life cycle?
- What are the three groups of cnidarians?

Vocabulary
cnidocyte
nematocyst
polyp
medusa
gastrovascular cavity
nerve net
hydrostatic skeleton
external fertilization

Reading Strategy: Finding Main Ideas Before you read, skim the section to identify the key concepts. Read the section carefully, and then write down the information that supports each key concept.

What Is a Cnidarian?

A few important features unite the cnidarians as a group. **Cnidarians are soft-bodied, carnivorous animals that have stinging tentacles arranged in circles around their mouths. They are the simplest animals to have body symmetry and specialized tissues.** Cnidarians get their name from the **cnidocytes** (NY-duh-syts), or stinging cells, that are located along their tentacles. **Figure 26–11** shows the structure of cnidocytes. Cnidarians use these cells for defense and to capture prey. Within each cnidocyte is a nematocyst (NEM-uh-toh-sist). A **nematocyst** is a poison-filled, stinging structure that contains a tightly coiled dart. When an unsuspecting shrimp or small fish brushes up against the tentacles, thousands of nematocysts explode into the animal, releasing enough poison to paralyze or kill the prey.

CHECKPOINT *What is the function of cnidocytes?*

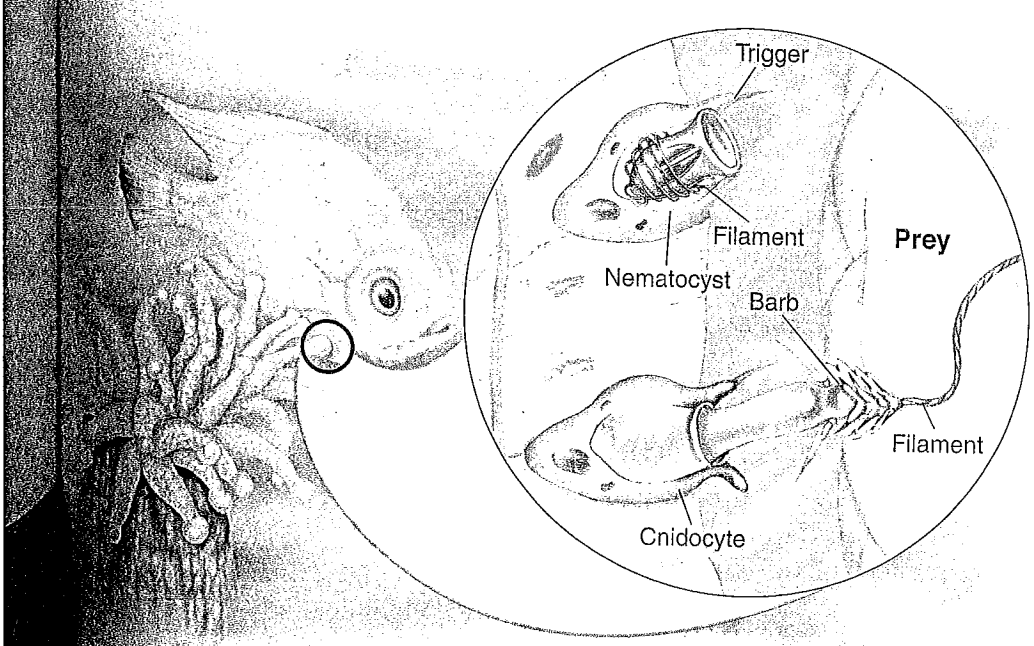
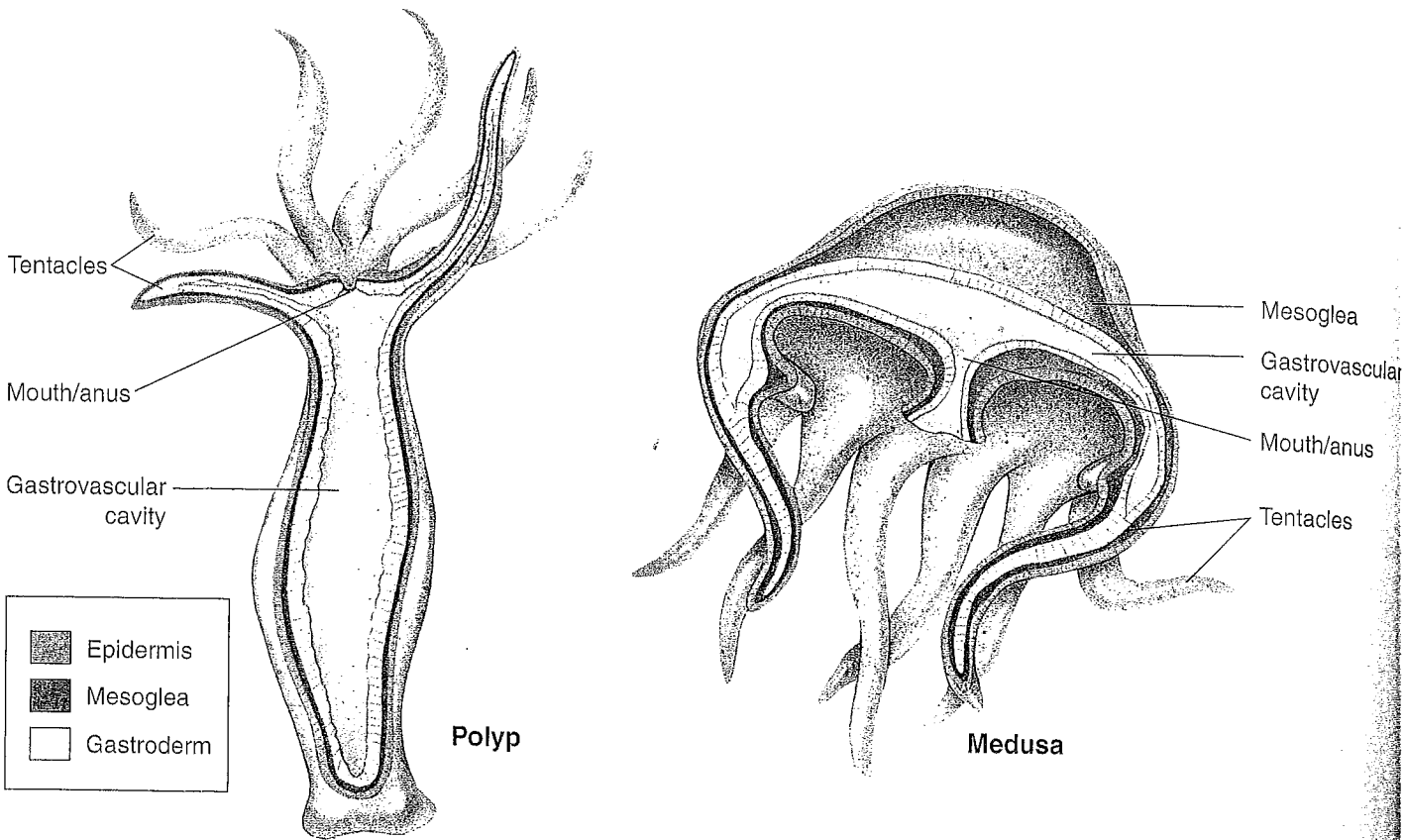


Figure 26–11 **Cnidarians are carnivorous animals that have stinging tentacles arranged around their mouths. Stinging cells called cnidocytes are used to capture and paralyze prey.** Within each cnidocyte is a stinging structure called a nematocyst. Here, a sea anemone captures a fish that has brushed the trigger of the nematocyst. When an animal touches the trigger of a nematocyst, the filament inside uncoils and shoots a barb into the animal.



▲ **Figure 26–12** Many cnidarians have both a polyp stage and a medusa stage. Both stages have an outer epidermal tissue; a gastroderm tissue, which lines the gastrovascular cavity; and a mesoglea layer, which lies between the two tissues. (Note that a medusa's tentacles are much narrower than in the illustration.)

Word Origins

Medusa is the name of a monster in Greek mythology. In the myth, Medusa was once a beautiful woman, but she bragged about her beauty, causing a jealous goddess to change her into a hideous monster. Medusa had long, twisting snakes for hair. **In what way are cnidarian medusas similar to the monster named Medusa?**

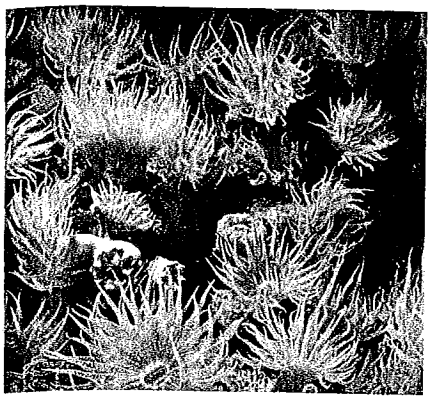
Form and Function in Cnidarians

Cnidarians are only a few cells thick and have simple body systems. Most of their responses to the environment are carried out by specialized cells and tissues. These tissues function in physiological processes such as feeding and movement.

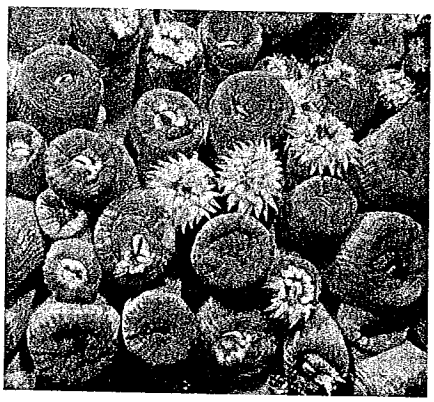
Body Plan Cnidarians are radially symmetrical. They have a central mouth surrounded by numerous tentacles that extend outward from the body. **Cnidarians typically have a life cycle that includes two different-looking stages: a polyp and a medusa.** Both forms are shown in **Figure 26–12.** A **polyp** (PAHL-ip) is a cylindrical body with armlike tentacles. In a polyp, the mouth points upward. Polyps are usually sessile. A **medusa** (muh-DOO-suh) has a motile, bell-shaped body with the mouth on the bottom.

Cnidarian polyps and medusas each have a body wall that surrounds an internal space called a gastrovascular cavity. The gastroderm is the inner lining of the gastrovascular cavity, where digestion takes place. The epidermis is the outer layer of cells. The mesoglea (mez-uh-GLEE-uh) is a layer that lies between these two tissues. It varies from a thin, noncellular membrane to a thick, jellylike material that contains cells.

✓CHECKPOINT *What are the three layers in cnidarians?*

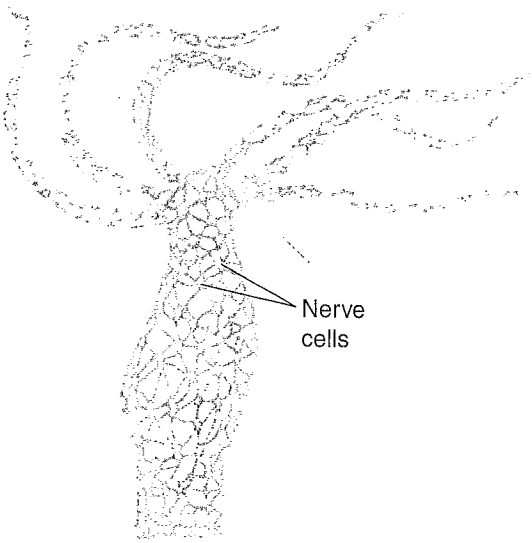


Before



After

Figure 26–13 Cnidarians have nerve nets that consist of many individual nerve cells, as shown in the hydra below. Many cnidarians respond to touch by pulling their tentacles inside their bodies. This response, shown at left in cup corals, is cued by nerve cells located in the tentacles. **Formulating Hypotheses** *How might a nerve net differ between motile and sessile cnidarians?*

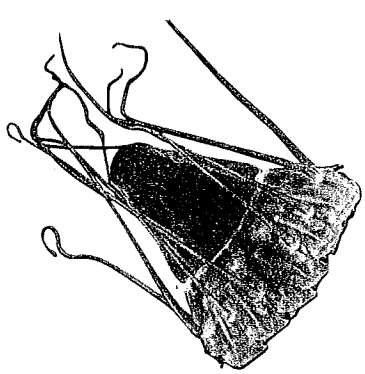


Feeding After paralyzing its prey, a cnidarian pulls the prey through its mouth and into its **gastrovascular cavity,** a digestive chamber with one opening. Food enters and wastes leave the body through that opening. Digestion—the breakdown of food—begins in the gastrovascular cavity. The digestion that occurs in the gastrovascular cavity is extracellular, meaning that it takes place outside of cells. Partially digested food is absorbed by the gastroderm. Digestion is completed intracellularly, within cells in the gastroderm. Any materials that cannot be digested are passed out of the body through the mouth.

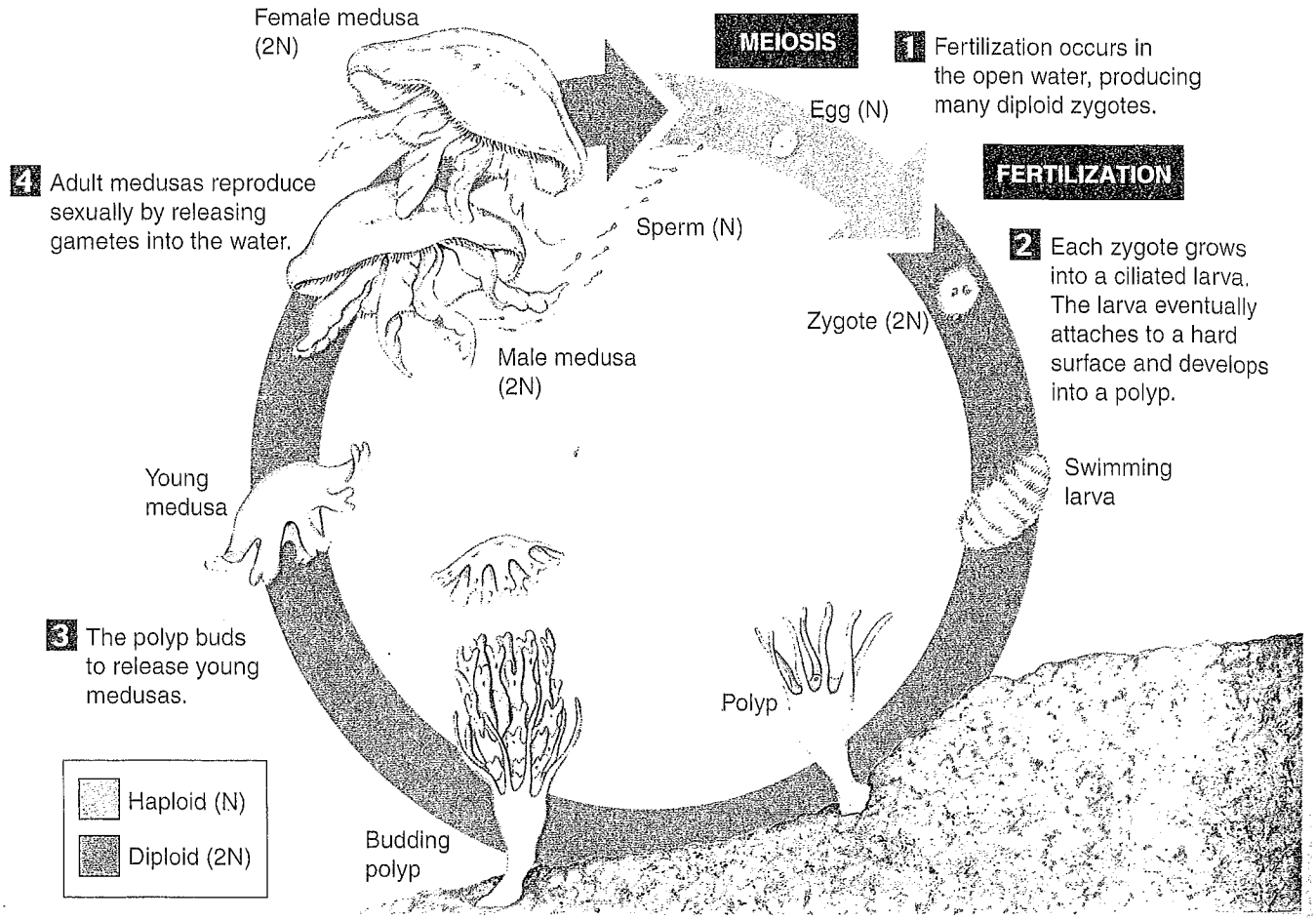
Respiration, Circulation, and Excretion Following digestion, nutrients are usually transported throughout the body by diffusion. Cnidarians respire and eliminate the wastes of cellular metabolism by diffusion through their body walls.

Response Cnidarians gather information from their environment using specialized sensory cells. Both polyps and medusas have a nerve net, shown in **Figure 26–13.** A **nerve net** is a loosely organized network of nerve cells that together allow cnidarians to detect stimuli such as the touch of a foreign object. The nerve net is usually distributed uniformly throughout the body, although in some species it is concentrated around the mouth or in rings around the body. Cnidarians also have statocysts, which are groups of sensory cells that help determine the direction of gravity. Ocelli (oh-SEL-eye; singular: ocellus) are eyespots made of cells that detect light.

Movement Different cnidarians move in different ways. Some cnidarians, such as sea anemones, have a hydrostatic skeleton. The **hydrostatic skeleton** consists of a layer of circular muscles and a layer of longitudinal muscles that, together with the water in the gastrovascular cavity, enable the cnidarian to move. For example, if the anemone's circular muscles contract when the anemone's mouth is closed, the water inside the cavity can't escape. The pressure of the water makes the body become taller. In contrast, medusas move by jet propulsion. Muscle contractions cause the bell-shaped body to close like a folding umbrella. This action pushes water out of the bell, moving the medusa forward, as shown in **Figure 26–14.**



▲ **Figure 26–14** Jellyfishes move by means of jet propulsion. The body contracts to force water out, moving the jellyfish in the opposite direction. **Applying Concepts** *Is the body plan of this jellyfish a medusa or a polyp?*



▲ **Figure 26–15** Jellyfishes reproduce sexually by producing eggs and sperm. Depending on the species, fertilization is either internal or external. In *Aurelia,* shown here, fertilization is external, occurring after eggs and sperm are released into the water. **Interpreting Graphics** *What cells are formed by the process of meiosis?*

Reproduction Most cnidarians reproduce both sexually and asexually. Polyps can reproduce asexually by budding. The new animal is genetically identical to the parent animal. One type of budding begins with a swelling on the side of an existing polyp. This swelling grows into a new polyp. In another type of budding, polyps produce tiny medusas that separate and become new individuals.

In most cnidarians, sexual reproduction takes place with external fertilization in water. **External fertilization** takes place outside the female's body. The sexes are often separate—each individual is either male or female. The female releases eggs into the water, and the male releases sperm. The life cycle of *Aurelia,* a common jellyfish, is shown in **Figure 26–15.** Observe that the zygote grows into a free-swimming larva. The larva eventually attaches to a hard surface and develops into a polyp. Then, the polyp buds and releases a medusa that begins the cycle again.

Groups of Cnidarians

All cnidarians live under water, and nearly all live in the ocean.

Cnidarians include jellyfishes, hydras and their relatives, and sea anemones and corals. Some of the most familiar cnidarians are the jellyfishes.

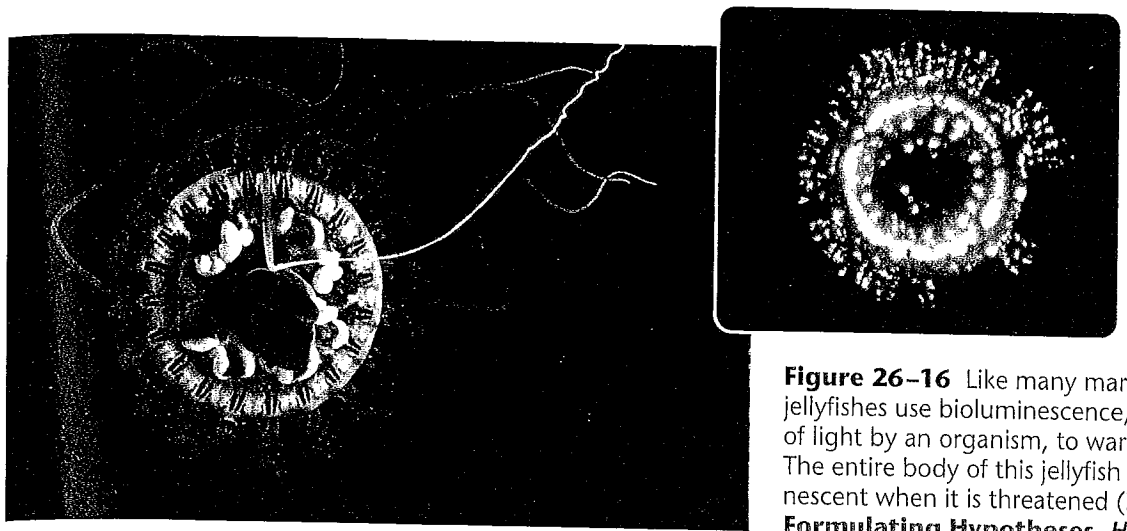


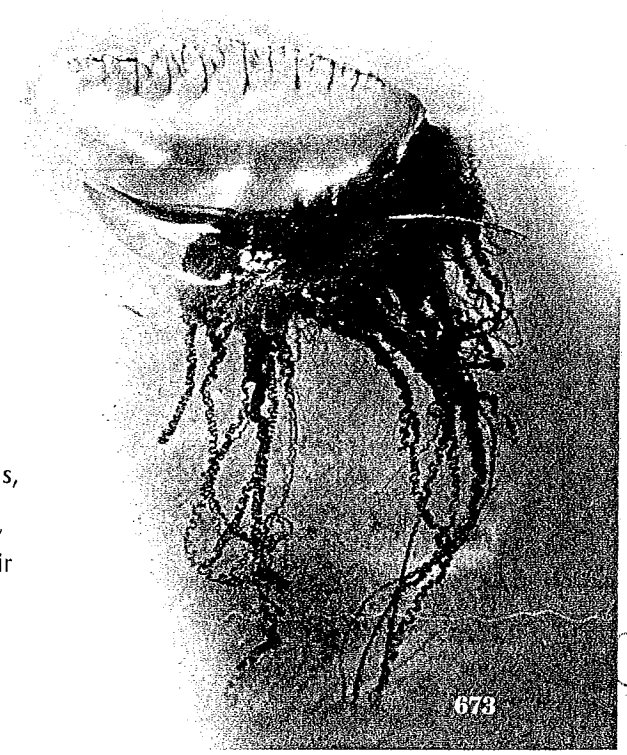
Figure 26–16 Like many marine organisms, jellyfishes use bioluminescence, or the production of light by an organism, to ward off predators. The entire body of this jellyfish becomes bioluminescent when it is threatened (inset).
Formulating Hypotheses *How might bioluminescence discourage potential predators?*

Jellyfishes The class Scyphozoa (sy-fuh-ZOH-uh) contains the jellyfishes, such as the jellyfish shown in **Figure 26–16.** Scyphozoans, which means "cup animals," live their lives primarily as medusas. The polyp form of jellyfishes is restricted to a small larval stage, and no elaborate colonies ever form. Jellyfishes can be quite large—the largest jellyfish ever found was almost 4 meters in diameter and had tentacles more than 30 meters long. Jellyfishes reproduce sexually.

Hydras and Their Relatives The class Hydrozoa (hy-druh-ZOH-uh) contains hydras and other related animals. The polyps of most hydrozoans grow in branching colonies that sometimes extend more than a meter. Within the colony, polyps are specialized to perform different functions. In the Portuguese man-of-war, shown in **Figure 26–17,** one polyp forms a balloonlike float that keeps the entire colony afloat. Other polyps in the colony produce long tentacles that hang several meters under water and sting prey (and humans!) using nematocysts. Some polyps digest food held by the tentacles, while others make eggs and sperm.

The most common freshwater hydrozoans are hydras. Hydras differ from other cnidarians in this class because they lack a medusa stage. Instead, they live only as solitary polyps. Hydras reproduce asexually, by budding, or sexually, by producing eggs and sperm in the body wall. Many hydras get their nutrition from capturing, stinging, and digesting small prey. Some hydras, however, get their nutrition from symbiotic photosynthetic protists that live in their tissues.

CHECKPOINT *How do hydras reproduce?*

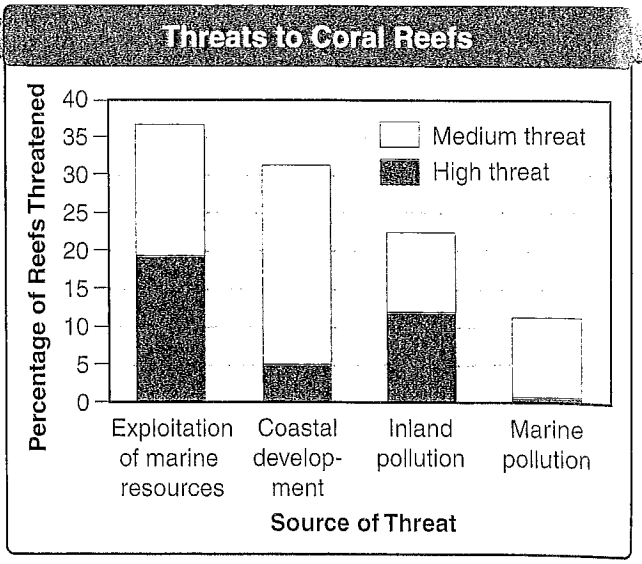


▶ **Figure 26–17** **Jellyfishes, hydrozoans, sea anemones, and corals are all cnidarians.** The Portuguese man-of-war, shown here, is a colonial hydrozoan that is composed of many specialized polyps. A single polyp that is enlarged and full of air helps keep the animal afloat, while other specialized polyps below water function in feeding and reproduction.

Analyzing Data

Coral Vanishing Act

The World Resources Institute, an organization that examines global environmental problems, has announced that 58 percent of the world's coral reefs are in danger of dying. Threats to coral reefs fall into four broad categories shown in the graph. The graph indicates the percentage of reefs that are threatened by each of these categories. It also rates the threat as medium or high, based on the distance between the coral reef and the source of the threat. Use the information in the graph to answer the following questions.



1. **Classifying** Place the four categories of risk in order from greatest high threat to least high threat.
2. **Using Tables and Graphs** Approximately how much greater is the high threat of overexploitation than the high threat of coastal development?
3. **Inferring** Based on the graph, write a generalization about the effect of human activities on the destruction of coral reefs.
4. **Making Judgments** Assume that you are a legislator drafting a law to protect coral reefs. Choose one of the threats shown in the graph, and outline a law that you would propose to counter the threat.

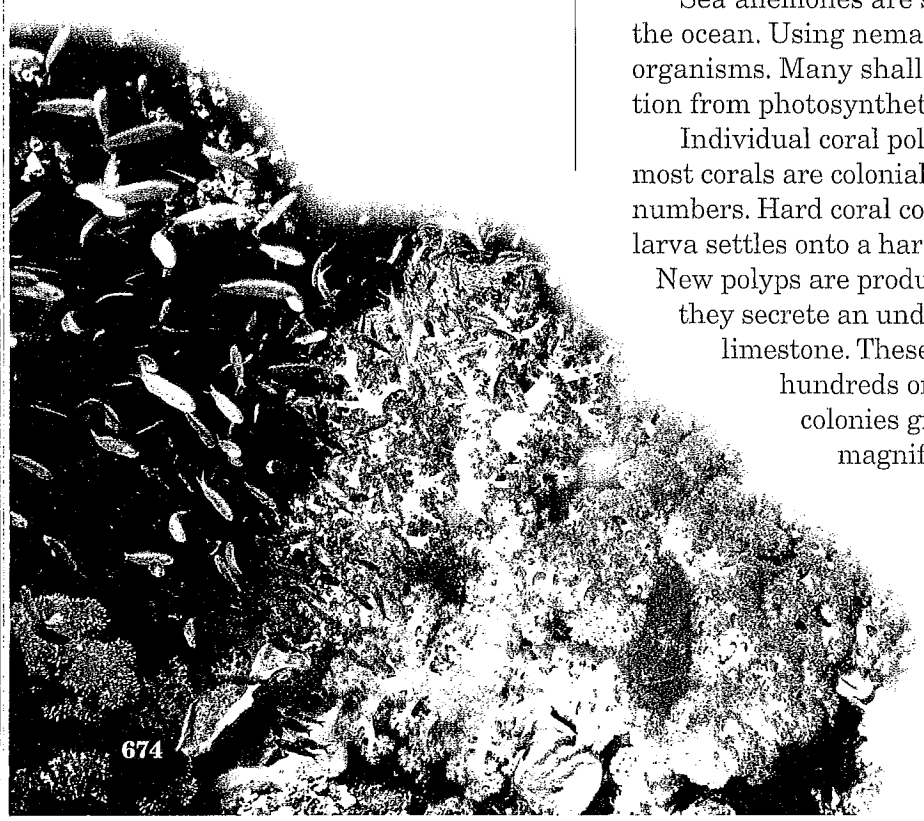
Sea Anemones and Corals The class Anthozoa (an-thuh-ZOH-uh) contains sea anemones and corals, animals that have only the polyp stage in their life cycle. Anthozoans all have a central body surrounded by tentacles—a form that gave them their name, *anthozoa,* which means "flower animal." Many species are colonial, or composed of many individual polyps. The appearance of an entire reef can include varied forms, as shown in **Figure 26–18.**

Sea anemones are solitary polyps that live at all depths of the ocean. Using nematocysts, they catch a variety of marine organisms. Many shallow-water species also depend on nutrition from photosynthetic symbionts.

Individual coral polyps look like miniature sea anemones. But most corals are colonial, and their polyps grow together in large numbers. Hard coral colonies are usually founded when a motile larva settles onto a hard surface and develops into a single polyp. New polyps are produced by budding, and as the colonies grow, they secrete an underlying skeleton of calcium carbonate, or limestone. These colonies grow slowly and may live for hundreds or even thousands of years. Many coral colonies growing near one another produce the magnificent structures known as coral reefs.

Anthozoans reproduce sexually by producing eggs and sperm that are released into the water. The zygote grows into a ciliated larva that becomes a new polyp. Some species can also reproduce asexually by budding or splitting into two halves.

▼ **Figure 26–18** Coral reefs are home to many types of organisms. Each flowerlike form shown in this photograph is an entire colony made of thousands of individual coral polyps.

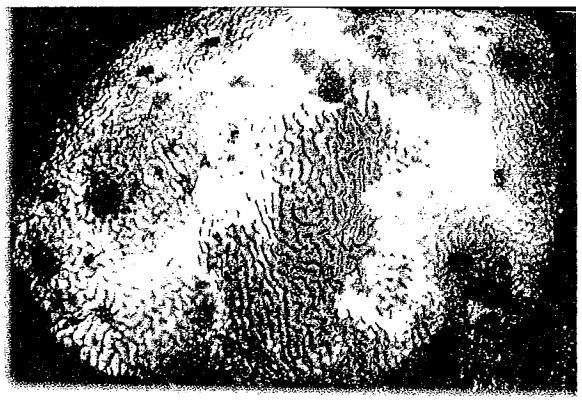


Ecology of Corals

The worldwide distribution of corals is determined by a few variables: temperature, water depth, and light intensity. The "stony" or "hard" corals that build coral reefs require high levels of light. Why should light be a requirement for an animal? Light is necessary because these corals rely on mutualistic relationships with algae that capture solar energy, recycle nutrients, and help corals lay down their calcium carbonate skeletons. Symbionts provide as much as 60 percent of the energy that corals need. This arrangement allows coral reefs to live in water that carries few nutrients.

Many coral reefs are now suffering from human activity. For example, recreational divers sometimes damage coral reefs. Silt and other sediments from logging, farming, mining, and construction can wash onto reefs and smother corals. Chemical fertilizers, insecticides, and industrial pollutants can poison the corals. Overfishing can upset the ecological balance of coral reefs. Even when human-caused problems do not kill corals, they can cause stress that makes the coral reefs susceptible to other threats.

Meanwhile, a problem called coral bleaching has become common. High temperatures can kill the algae that usually live in the tissues of corals, leaving behind only transparent cells atop ghostly white skeletons. The results of coral bleaching are shown in **Figure 26–19.** In the past, bleaching was a rare and short-term event from which many corals recovered. Over the last 20 years, however, bleaching has become more common and more severe, causing many corals to die. Researchers fear that rising ocean temperatures, produced by global warming, may be contributing to this problem. If this is the case, many reefs around the world could soon be in serious danger.



▲ **Figure 26–19** Under normal conditions, algae live within coral tissues, carrying out photosynthesis and giving the coral its green appearance. However, when stressed by pollutants or increasing temperatures, these algae can die, so only the clear cells of the coral remain. **Inferring** *What effect might the loss of symbiotic algae have on the coral?*

26–3 Section Assessment

1. **Key Concept** Describe three characteristics that all cnidarians share.
2. **Key Concept** How do the two body plans of cnidarians differ?
3. **Key Concept** Describe the three groups of cnidarians and give an example from each.
4. Describe how the digestion and absorption of food take place in cnidarians.
5. How has human activity affected coral reefs?
6. **Critical Thinking Inferring** A medusa typically has more specialized organs for movement and response than a polyp does. Why might this be the case? *Hint:* How does the lifestyle of a medusa differ from that of most polyps?

Writing in Science

Descriptive Writing

Write a paragraph describing the body of a hydra. Assume that your readers know nothing about hydras. *Hint:* First, list all the details you want to include in your paragraph. Then, decide how you want to organize those details—for example, from the outside of the hydra to the inside.

Chapter 26 Study Guide

26–1 Introduction to the Animal Kingdom

Key Concepts

- An animal is a multicellular, eukaryotic heterotroph whose cells lack cell walls.
- Animals are specialized to carry out the following essential functions: feeding, respiration, circulation, excretion, response, movement, and reproduction.
- In general, complex animals tend to have high levels of cell specialization and internal organization, bilateral body symmetry, cephalization, and a body cavity.

Vocabulary

invertebrate, p. 657
vertebrate, p. 657
feedback inhibition, p. 658
blastula, p. 661
protostome, p. 661
deuterostome, p. 661
anus, p. 661
endoderm, p. 661
mesoderm, p. 661
ectoderm, p. 661
radial symmetry, p. 662
bilateral symmetry, p. 662
cephalization, p. 663

26–2 Sponges

Key Concepts

- Sponges are classified as animals because they are multicellular, heterotrophic, have no cell walls, and contain a few specialized cells.
- The movement of water through a sponge provides a simple mechanism for feeding, respiration, circulation, and excretion.

Vocabulary

choanocyte, p. 665
osculum, p. 665
spicule, p. 665
archaeocyte, p. 665
internal fertilization, p. 666
larva, p. 666
gemmule, p. 667

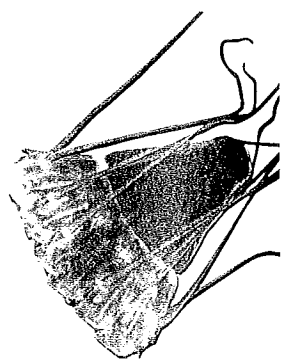
26–3 Cnidarians

Key Concepts

- Cnidarians are soft-bodied, carnivorous animals that have stinging tentacles arranged in circles around their mouth. They are the simplest animals to have body symmetry and specialized tissues.
- Cnidarians typically have a life cycle that includes two different-looking stages, a polyp and a medusa.
- Cnidarians include jellyfishes, hydras and their relatives, and sea anemones and corals.

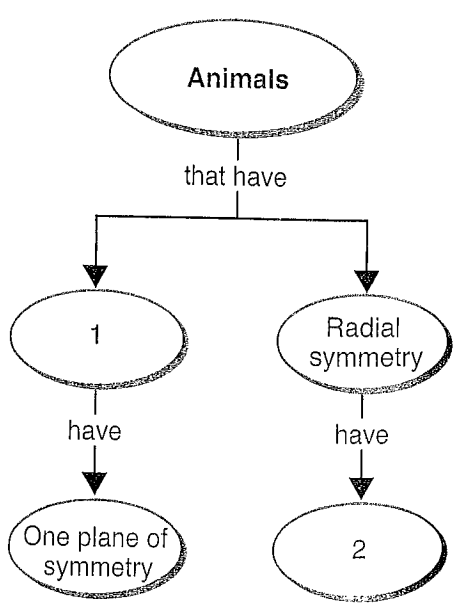
Vocabulary

cnidocyte, p. 669
nematocyst, p. 669
polyp, p. 670
medusa, p. 670
gastrovascular cavity, p. 671
nerve net, p. 671
hydrostatic skeleton, p. 671
external fertilization, p. 672



Thinking Visually

Complete the following concept map using information from the chapter:



Chapter 26 Assessment

Reviewing Content

Choose the letter that best answers the question or completes the statement.

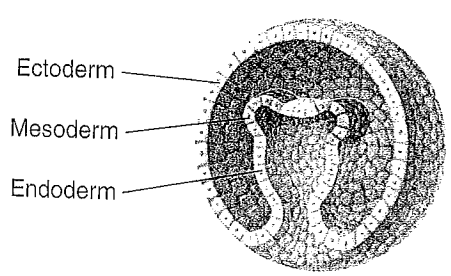
1. A multicellular eukaryotic heterotroph whose cells lack cell walls is a(an)
   a. protist. c. animal.
   b. virus. d. plant.

2. The process by which animals take in oxygen and give off carbon dioxide is known as
   a. circulation. c. respiration.
   b. reproduction. d. response.

3. Animals that have a backbone, also called a vertebral column, are known as
   a. vertebrates. c. protostomes.
   b. prokaryotes. d. invertebrates.

4. Many animals have body symmetry with distinct front and back ends. This type of symmetry is
   a. radial. c. circular.
   b. bilateral. d. dorsal.

5. The developing embryo shown below is a __?__, a group that includes __?__.

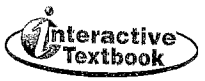


   a. protostome; simple invertebrates
   b. protostome; vertebrates
   c. deuterostome; echinoderms and chordates
   d. deuterostome; invertebrates

6. An animal whose mouth is formed from the blastopore is a
   a. deuterostome.
   b. detritivore.
   c. protostome.
   d. carnivore.

7. Animals in the phylum Porifera include
   a. chordates.
   b. sea stars.
   c. sponges.
   d. sea anemones.

8. A concentration of sense organs and nerve cells in the anterior end of the body is known as
   a. fertilization. c. symmetry.
   b. cephalization. d. anteriorization.

Interactive textbook with assessment at PHSchool.com 

9. The sessile body form of a cnidarian is a
   a. polyp.
   b. medusa.
   c. planula.
   d. nematocyst.

10. A soft-bodied animal with stinging tentacles arranged around its mouth is a
    a. spicule. c. vertebrate.
    b. cnidarian. d. choanocyte.

Understanding Concepts

11. Describe the characteristics that all members of the animal kingdom share.

12. How is the structure of the epithelial cells that line an animal's lungs related to their function?

13. Describe an example of how an internal feedback mechanism helps an animal maintain homeostasis.

14. Draw a fish, a jellyfish, and a sponge. Label each drawing, using as many of the following terms as appropriate: radial symmetry, bilateral symmetry, anterior, posterior, dorsal, lateral, ventral, sessile, motile.

15. Explain the advantages that cephalization confers on an animal.

16. Distinguish between a protostome and a deuterostome.

17. During the early development of many animals, cells differentiate into three germ layers. Name these layers and give an example of a body structure that develops from each layer.

18. What are archaeocytes?

19. Briefly describe the physiological processes of nutrition, respiration, and excretion in a sponge.

20. Describe the mutually beneficial relationships that exist between many sponges and certain photosynthetic organisms.

21. What is the function of statocysts?

22. Describe the process of feeding in cnidarians.

23. Describe two ways in which budding occurs in polyps.

24. Describe the life cycle of *Aurelia*, a common jellyfish. Be sure to include how the polyp form alternates with the medusa form.

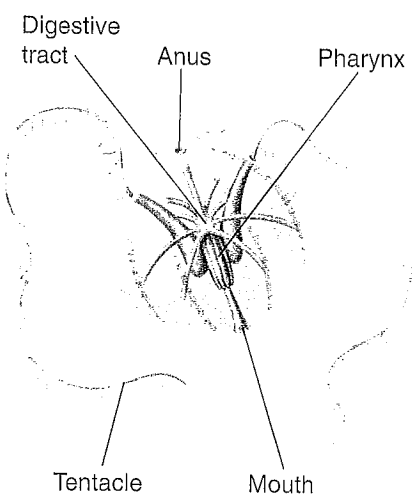
Critical Thinking

25. **Comparing and Contrasting** Explain how sponges are similar to most other animals. How are they different?

26. **Asking Questions** The gemmules of some sponges can survive periods of severe drought or freezing. Suppose you have the opportunity to study gemmules. Write three different questions you could investigate.

27. **Inferring** Most cnidarians do not swim toward their prey. Instead, they capture prey carried by water currents. How is this behavior related to their body plan?

28. **Classifying** The comb jelly below has a body made of two layers separated by mesoglea. Its digestive system includes an anal opening through which wastes can pass. Radiating around its body are eight "combs" of cilia, which produce movement. A pair of tentacles enable it to capture food. Should this animal be classified as a cnidarian? Explain.



29. **Making Judgments** Choose one human activity that can harm coral reefs. Describe measures that people might take to reduce the damage. Then, evaluate the impact the measures might have on human society.

30. **Applying Concepts** Would you say that the life cycle of most cnidarians is more or less complex than the life cycle of sponges? Give details to justify your answer.

31. **Inferring** How might the nerve net of a cnidarian be related to the functioning of the cnidarian's cnidocytes?

32. **Comparing and Contrasting** An inventory clerk is a store employee who checks to make sure the store has an adequate supply of merchandise. If the supply of an item is running low, the inventory clerk orders more of the item. Explain how the job of an inventory clerk is similar to internal feedback mechanisms in an organism.

33. **Applying Concepts** How is the anatomy of a sponge's choanocytes an adaptation that enables the choanocytes to perform the physiological function of moving water through the sponge?

34. **Comparing and Contrasting** Compare a hydra to a Portuguese man-of-war. Explain how they are both similar and different.

Focus on the BIG Idea

Information and Heredity In Chapters 10 and 11, you learned about the processes of mitosis and meiosis. Compare these two processes, and explain how each is involved in the reproduction of sponges.

Writing in Science

Write a paragraph explaining the symbiotic relationship that exists between certain sponges and photosynthetic organisms. Be sure to include information about how these photosynthetic organisms obtain light. (*Hint:* After you have written a draft of your paragraph, share your draft with a friend. Ask your friend to point out any statements that are unclear. Use this information to revise your paragraph.)

Performance-Based Assessment

Making Models Construct a two- or three-dimensional model of a sponge or cnidarian. Label the organism's important structures. Explain how the organism obtains food and responds to the environment.

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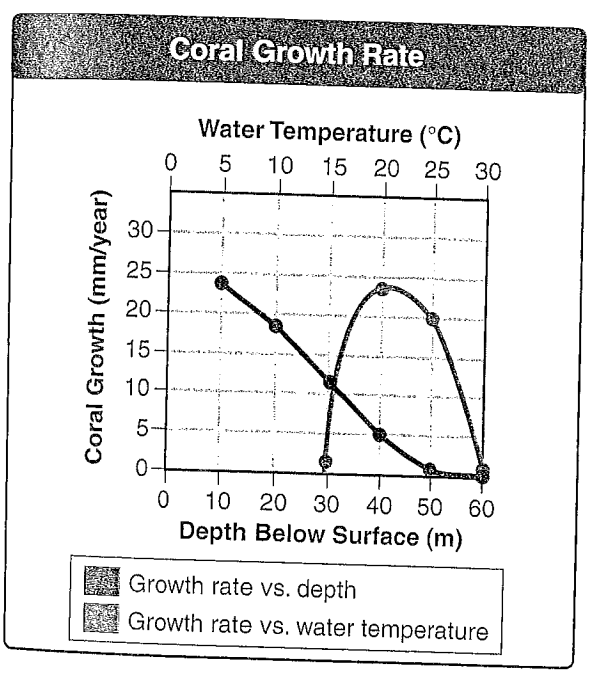
Test-Taking Tip When evaluating multiple-choice answers, read all the answer choices, even if the first choice seems to be the correct one. By doing so, you can make sure that the answer you choose is the best one.

Directions: Choose the letter that best answers the question or completes the statement.

The graph below shows the growth rate of a hypothetical coral species under different conditions. Use this information to answer questions 1 and 2.



1. This coral grows best at depths of __?__ and a temperature of __?__.
   (A) 10 m; 20°C
   (B) less than 10 m; 15°C
   (C) less than 10 m; 28°C
   (D) more than 10 m; 21°C
   (E) all depths, if water temperature is correct

2. Which of the following statements best explains the trend shown in the graph?
   (A) The growth rate of the coral increases as the depth below the water surface increases.
   (B) At temperatures of 15°C or above, the growth rate depends only on temperature.
   (C) Corals cannot grow below 30 m.
   (D) This coral grows best from 18° to 23°C.
   (E) Water temperatures depend on the depth of the coral below the surface.

3. Which of the following is a type of tissue that arises in most animals during development?
   I. Endoderm
   II. Mesoderm
   III. Ectoderm
   (A) I only
   (B) II only
   (C) I and II only
   (D) II and III only
   (E) I, II, and III

4. An adult sponge has all of the characteristics below EXCEPT
   I. Body symmetry
   II. Ability to move from place to place
   III. Cells without cell walls
   (A) I only
   (B) II only
   (C) I and II only
   (D) II and III only
   (E) I, II, and III

5. Which of the following is NOT a characteristic of animals?
   (A) the ability to make their own food
   (B) the ability to move
   (C) eukaryotic cells
   (D) cells that lack cell walls
   (E) multicellularity

6. Most animals reproduce sexually by producing
   (A) buds.
   (B) spores.
   (C) clones.
   (D) haploid gametes.
   (E) diploid gametes.

7. Which of the following is a body type of a cnidarian?
   I. gemmule
   II. polyp
   III. medusa
   (A) I only
   (B) II only
   (C) III only
   (D) II and III only
   (E) I, II, and III

Questions 8–11 Each of the lettered choices below refers to the following numbered statements. Select the best lettered choice. A choice may be used once, more than once, or not at all.

(A) Osculum
(B) Protostome
(C) Archaeocyte
(D) Deuterostome
(E) Blastula

8. A hollow ball of cells, formed after the zygote undergoes division
9. An animal whose mouth is formed from the blastopore
10. A large hole through which water leaves a sponge
11. A specialized cell that moves around within the wall of a sponge