27–4 Mollusks

They climb trees in tropical rain forests and float over coral reefs. They crawl into garbage cans, eat their way through farm crops, and speed through the deep ocean. Some are so small that you can hardly see them with the unaided eye, while others are 20 meters long! They are the mollusks—one of the oldest and most diverse phyla. Mollusks come in so many sizes, shapes, and forms that you might wonder why they are classified in the same phylum. To learn the answer, read on.

What Is a Mollusk?

Members of the phylum Mollusca, known as mollusks, are named from the Latin word *molluscus*, which means "soft." **Mollusks are soft-bodied animals that usually have an internal or external shell.** Mollusks include snails, slugs, clams, squids, and octopi. But a snail looks very different from a squid, which looks very different from a clam. So why are these animals all placed in the same phylum? One reason is that many mollusks share similar developmental stages. Many aquatic mollusks have a free-swimming larval stage called a **trochophore** (TRAHK-oh-fawr). The trochophore larva, which is shown in **Figure 27–20,** is also characteristic of annelids, indicating that these two groups may be closely related. Molecular studies suggest that a common ancestor of annelids and mollusks lived more than 550 million years ago.

Guide for Reading

Key Concepts
- What are the defining features of mollusks?
- What is the basic body plan of mollusks?
- What are the characteristics of the three main classes of mollusks?

Vocabulary
trochophore • foot
mantle • shell • visceral mass
radula • siphon
open circulatory system

Reading Strategy: Building Vocabulary
As you read, make notes about the meaning of each term in the list above. After you read the section, make a table listing the different types of mollusks on the left and the vocabulary words that apply on the right.

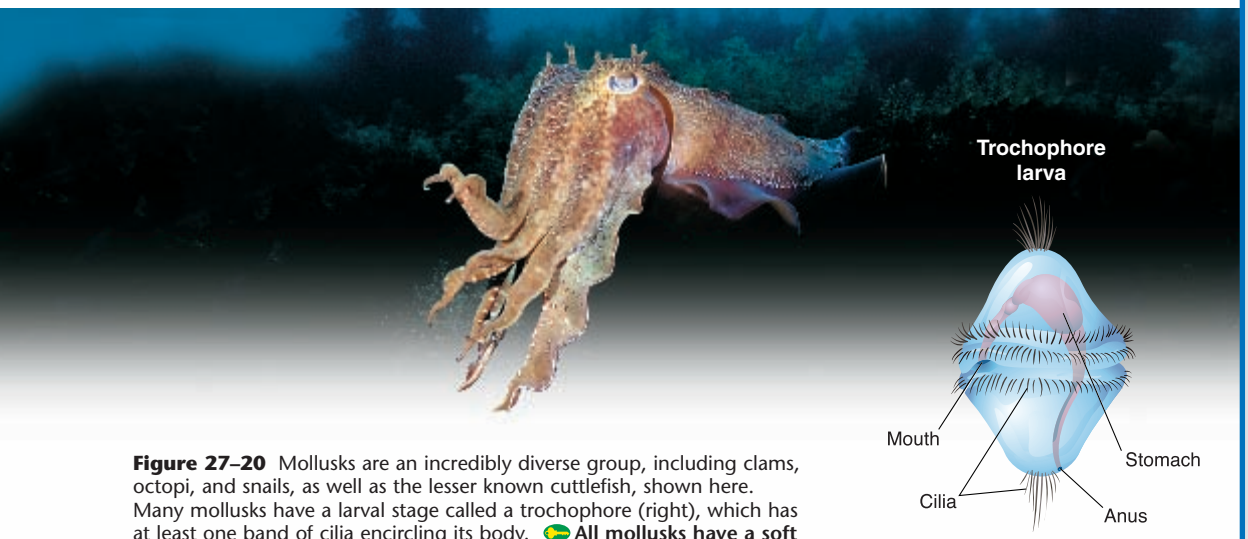


Figure 27–20 Mollusks are an incredibly diverse group, including clams, octopi, and snails, as well as the lesser known cuttlefish, shown here. Many mollusks have a larval stage called a trochophore (right), which has at least one band of cilia encircling its body. **All mollusks have a soft body, and most mollusks have an internal or external shell.**

SECTION REVIEW

Print:
- ***Laboratory Manual A,*** Chapter 27 Lab
- ***Laboratory Manual B,*** Chapter 27 Lab
- ***Teaching Resources,*** Lesson Plan 27–4, Adapted Section Summary 27–4, Adapted Worksheets 27–4, Section Summary 27–4, Worksheets 27–4, Section Review 27–4
- ***Reading and Study Workbook A,*** Section 27–4
- ***Lab Worksheets,*** Chapter 27 Exploration
- ***Adapted Reading and Study Workbook B,*** Section 27–4

Technology:
- ***iText,*** Section 27–4
- ***Animated Biological Concepts DVD,*** 35 Earthworm Anatomy
- ***Transparencies Plus,*** Section 27–4

Section 27–4

1 FOCUS

Objectives
27.4.1 ***Describe*** the defining features of mollusks.
27.4.2 ***Describe*** form and function in mollusks.
27.4.3 ***Identify*** the characteristics of the three main classes of mollusks.
27.4.4 ***Describe*** the ecology of mollusks.

Guide for Reading

Vocabulary Preview
Explain that students may use a few of the Vocabulary words in everyday speech, including *foot* and *mantle.* Caution students, especially English language learners, that they shouldn't allow the common meanings of these words to influence their understanding of the terms in the context of mollusk anatomy.

Reading Strategy
The terms *trochophore, foot, mantle, shell, visceral mass,* and *open circulatory system* apply to all mollusk groups. The term *siphon* applies only to bivalves and cephalopods. The term *radula* applies to gastropods. (You may want to point out that cephalopods also have radulae.)

2 INSTRUCT

What Is a Mollusk?

Use Visuals
Figure 27–20 Ask students: **How are the two organisms shown in the figure related?** *(The organism on the left is a mature cuttlefish, a type of mollusk. The labeled organism to the right is a trochophore, which is a free-swimming larval stage of a mollusk.)* **What defining features of mollusks can you observe in the cuttlefish?** *(It can be observed from the photo that the cuttlefish is a soft-bodied animal and does not have an external shell. Whether it has an internal shell—which it does have—cannot be determined from the image.)* L2

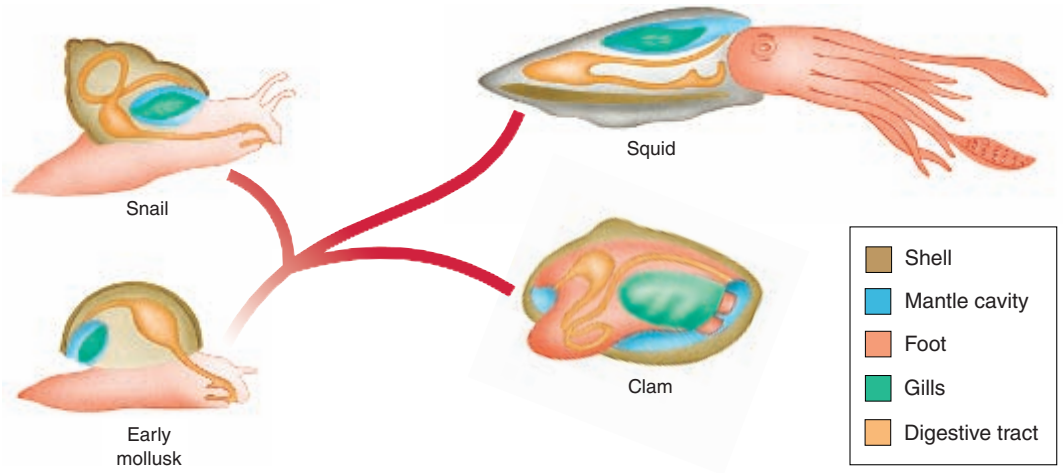
Form and Function in Mollusks

Use Visuals

Figure 27–21 Point out that the three living mollusks all descended from an early mollusk, shown in the lower left. Explain that the snail, clam, and squid each represent one of the three major classes of mollusks. Then, ask: **How is the shell in the squid different from the shells in the other two mollusks shown?** *(The shell in the squid is much less prominent than the shells of the snail and the clam, and it is internal.)* Explain that a squid is a cephalopod, and most modern cephalopods have only small internal shells. L2

Demonstration

Show students a rasp, a common tool used by woodworkers. Then, use the rasp to scrape a piece of scrap wood, making a mark and producing some sawdust. Ask: **How is a snail's radula like this rasp?** *(Like the surface of a rasp, a radula has hundreds of tiny teeth that can scrape and tear up a surface.)* **Why do you think that clams and similar mollusks do not have a radula?** *(Because they are filter feeders that obtain food by straining particles from water)* L1 L2



▲ **Figure 27–21** **The body plan of most mollusks includes a foot, mantle, shell, and visceral mass.** Early mollusks may have looked like the animal shown at the bottom. As they evolved, their body parts became adapted for different functions.

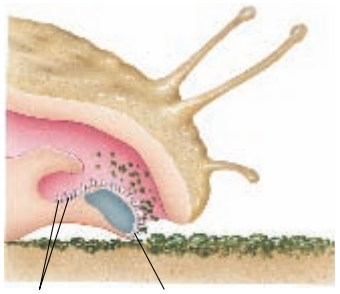
Form and Function in Mollusks

Like the annelids, mollusks have true coeloms surrounded by mesoderm tissue. They also have complex, interrelated organ systems that function together to maintain the body as a whole.

Body Plan The different body shapes of mollusks are variations on a single body plan, shown in **Figure 27–21.** **The body plan of most mollusks has four parts: foot, mantle, shell, and visceral mass.** The muscular **foot** takes many forms, including flat structures for crawling, spade-shaped structures for burrowing, and tentacles for capturing prey. The **mantle** is a thin layer of tissue that covers most of the mollusk's body, much like a cloak. The **shell** is made by glands in the mantle that secrete calcium carbonate. The shell has been reduced or lost in slugs and some other mollusk groups. Just beneath the mantle is the **visceral mass,** which consists of the internal organs.

Feeding Mollusks can be herbivores, carnivores, filter feeders, detritivores, or parasites. Snails and slugs feed using a flexible, tongue-shaped structure known as a **radula** (RAJ-oo-luh; plural: radulae), shown in **Figure 27–22,** to which hundreds of tiny teeth are attached. Herbivorous mollusks use their radula to scrape algae off rocks or to eat the soft tissues of plants. Carnivorous mollusks use their radula to drill through shells of other animals and to tear up and swallow the prey's soft tissue.

CHECKPOINT *How is a mollusk's shell made?*



◀ **Figure 27–22** Snails use a radula for feeding. The teeth of a radula give it the look and feel of sandpaper. Beneath the radula is a stiff supporting rod of cartilage. When the mollusk feeds, it places the tip of the radula on its food and pulls the sandpapery layer back and forth. **Formulating Hypotheses** *How might radulae with different structures allow snails to inhabit different environments?*

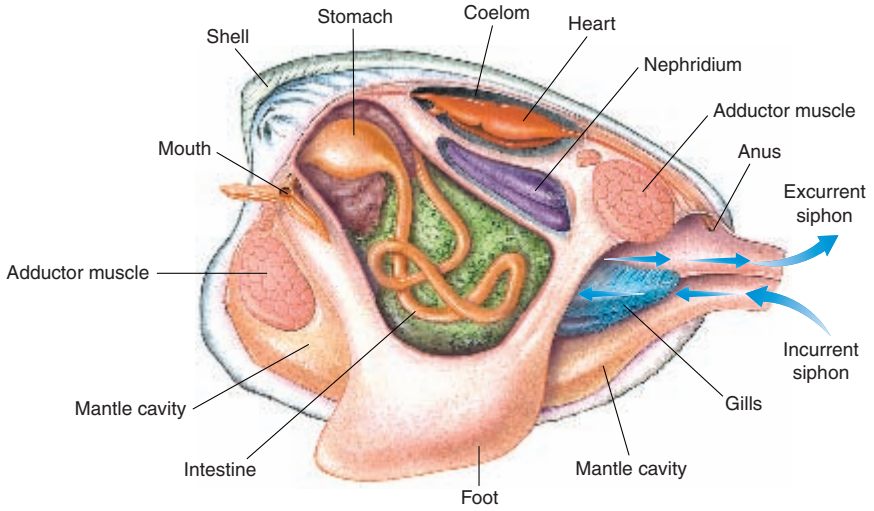
UNIVERSAL ACCESS

Inclusion/Special Needs

Before students read the subsection Form and Function in Mollusks, preview the subsection on Groups of Mollusks by reading the names of the groups aloud. Point out that organisms in each group of mollusks will have differences in the ways they carry out the seven essential functions. Then, as students read about mollusk form and function, they should note any details that specifically apply to one or another of the groups. L1

English Language Learners

Explain that the prefix *bi-* means "two." Point out that students might be asked in math class to "bisect" a line, which means they should cut it in two by finding the midpoint of the line. Also explain that the word part *valve* means "shell" as used in the context of mollusks. Therefore, a *bivalve* is an organism with "two shells." As you explain the term *bivalve*, show students an oyster or clam shell and emphasize that two shells make up the whole. L1 L2



Octopi and certain sea slugs use their sharp jaws to eat their prey. To subdue their prey, some octopi also produce poisons. Clams, oysters, and scallops lead a quieter existence by filter feeding using feathery gills. Food is carried by water, which enters through the incurrent siphon, shown on the right in **Figure 27–23.** A **siphon** is a tubelike structure through which water enters and leaves the body. The water flows over the gills and then leaves by the excurrent siphon. As water passes over the gills, plankton become trapped in sticky mucus. Cilia on the gills move the mixture of mucus and food into the mouth.

Respiration Aquatic mollusks such as snails, clams, and octopi typically breathe using gills inside their mantle cavity. As water passes through the mantle cavity, oxygen in the water moves into blood flowing through the gills. At the same time, carbon dioxide moves in the opposite direction—from the blood into the water. Land snails and slugs do not have gills. Instead, they respire using a mantle cavity that has a large surface area lined with blood vessels. Because this lining must be kept moist so that oxygen can diffuse across its surface, land snails and slugs typically live in moist places.

Circulation Oxygen and nutrients are carried to all parts of a mollusk's body by a circulatory system. The circulatory system of mollusks is either open or closed. "Open" does not mean that blood can spill to the outside of the animal! In an **open circulatory system,** blood is pumped through vessels by a simple heart. Blood eventually leaves the vessels and works its way through different sinuses. A sinus is a large saclike space. The blood passes from the sinuses to the gills, where oxygen and carbon dioxide are exchanged, and then back to the heart.

▲ **Figure 27–23** The anatomy of a clam is typical of bivalves, or two-shelled mollusks. The mantle and part of the foot have been cut away to show internal organs. The adductor muscles are used to open and shut the two exterior shells. The gills exchange oxygen and carbon dioxide between the body and the surrounding water. The arrows show the path of water over the gills. **Predicting** ***What might happen if a clam's incurrent siphon became blocked?***

Build Science Skills

Classifying Display a variety of mollusk shells. These might include clam, oyster, nautilus, and snail shells. Explain that biologists think the color of shells is primarily the result of the food the mollusk has eaten. Provide students with several shell guides or other resources that they can use to identify the shells. Then, challenge students to classify each shell by which organism it belongs to. When students have completed classification, discuss their findings as a class. Have volunteers then write a caption for each shell and create a classroom display. L2 L3

Address Misconceptions

Many students associate mollusks with the term *shellfish.* Explain that *shellfish* is a common term for any marine animal with an external shell, which includes a variety of invertebrates. Point out that fish are vertebrates. Ask students: **Is a mollusk a vertebrate or an invertebrate?** *(A mollusk is an invertebrate.)* Emphasize that mollusks cannot be classified as any kind of fish, despite the common label of *shellfish.* L1 L2

BIO INSIGHTS FACTS AND FIGURES

Shells of all shapes and sizes

Mollusk shells occur in such a variety of shapes and sizes that they serve as the main means of identification for many mollusk species. The obvious advantage of a hard exterior shell is the protection it provides for the animal's soft body. Like the exoskeletons of arthropods, exterior shells have one major disadvantage: Because shells do not consist of living, dividing cells, mollusks outgrow them as they develop. Many mollusks, however, have evolved shell designs that allow them to build onto the shell to accommodate their increased body size. The shell is not continuously added to but is expanded periodically as needed. Another disadvantage of shells is that they reduce mobility. Most mollusks, such as snails, lumber along under the load of their heavy shells. Other mollusks, such as clams, are fairly stationary throughout their adult lives.

Answers to . . .

CHECKPOINT *Glands in the mantle secrete the calcium carbonate of which the shell is made.*

Figure 27–22 *Depending on its structure, a radula can be used for different purposes, including scraping the algae off rocks, eating the soft tissues of plants, drilling through shells of other animals, and tearing up a prey's soft tissue. These feeding adaptations enable snails to inhabit diverse habitats, including ponds and land.*

Figure 27–23 *Since water carries food and oxygen to the clam, the clam could not obtain food or oxygen if its incurrent siphon was blocked.*

Build Science Skills

Designing Experiments Divide the class into small groups, and challenge each group to design an experiment that would test how intelligent octopi are. Students should first write a hypothesis that they can test. Then, they should describe an experiment that has a control and a manipulated variable. Students should also indicate what sorts of data they expect the experiment would yield that could prove or disprove their hypothesis. L2 L3

Make Connections

Physics After students have read about the jet propulsion of an octopus, explain that this is an example of Sir Isaac Newton's third law of motion. The third law says that for every action, there is an equal and opposite reaction. Ask: **In this case, what is the action, and what is the reaction?** *(The action is the movement of water expelled through the siphon. The reaction is the movement of the octopus forward.)* As students watch, blow up a balloon, and then release it. Students should observe the balloon rapidly moving in the opposite direction from the air moving out of its nozzle. Ask: **How is what you have just observed similar to and different from the jet propulsion used by an octopus?** *(It is similar in that there is an action and a reaction. It is different in that there is a movement of air from the balloon, while there is a movement of water from the octopus.)* L2

Figure 27–24 Mollusks have evolved a variety of ways of responding to potential danger. Snails (above) protect themselves by withdrawing into their shells in a matter of seconds. In some snails, a hard plate blocks the entrance to the shell, protecting the snail inside. Octopi (right) and squids squirt ink from inside their digestive tracts. The ink startles predators and may also cause temporary numbness. **Predicting** ***How might the hard plate protect snails during a period of drought?***

Open circulatory systems work well for slow-moving mollusks such as snails and clams. Faster-moving mollusks such as octopi and squid have a closed circulatory system. A closed circulatory system can transport blood through an animal's body much more quickly than an open circulatory system.

Excretion Cells of the body release nitrogen-containing waste into the blood in the form of ammonia. Tube-shaped nephridia remove ammonia from the blood and release it outside the body.

Response The complexity of the nervous system and the ability to respond to environmental conditions vary greatly among mollusks. Clams and other two-shelled mollusks have a simple nervous system consisting of small ganglia near the mouth, a few nerve cords, and simple sense organs, such as chemical receptors and eyespots.

In contrast, octopi and their relatives are active and intelligent predators that have the most highly developed nervous system of all invertebrates. Because of their well-developed brains, these animals can remember things for long periods and may be more intelligent than some vertebrates. Octopi are capable of complex behavior, such as opening a jar to get food inside, and they have been trained to perform different tasks for a reward or to avoid punishment.

Movement Mollusks move in many different ways. Snails secrete mucus along the base of the foot, and then move over surfaces using a rippling motion of the foot. The fast-moving octopus uses a form of jet propulsion. It draws water into the mantle cavity and then forces the water out through a siphon. Water leaving the body propels the octopus in the opposite direction.

Reproduction Mollusks reproduce in a variety of ways. Many snails and two-shelled mollusks reproduce sexually by external fertilization. They release enormous numbers of eggs and sperm into the open water. The eggs are fertilized in the water and then develop into free-swimming larvae. In tentacled mollusks and certain snails, fertilization takes place inside the body of the female. Some mollusks are hermaphrodites, having both male and female reproductive organs. Individuals of these species usually fertilize eggs from another individual.

BIO INSIGHTS

FACTS AND FIGURES

A chiton is a marine mollusk that has an elongated body; a large, broad foot; and a radula. Chitons eat algae, hydrozoans, and other low-growing organisms.

The dorsal shells of chitons display beautiful variations of pattern and color. The dorsal shells, which are divided into a series of eight plates, are also very practical. These plates make the shell flexible enough that the chiton can roll up into a smaller ball when it is dislodged from its attachment. Thus, it can protect itself until it can safely unroll and reattach elsewhere.

Another defense mechanism of the chiton is its ability to anchor itself to its substrate when it is disturbed or when it is exposed by a receding tide. The muscles in its foot pull the animal down tightly so that the edge of the mantle, which partly or completely covers the shell plates, can function like the rim of a suction cup. In this way, it becomes extremely difficult to dislodge the chiton.

Groups of Mollusks

Mollusks are divided into several classes according to characteristics of the foot and the shell. The three major classes of mollusks are gastropods, bivalves, and cephalopods.

Gastropods Members of the class Gastropoda, or gastropods (GAS-truh-pahdz), include pond snails, land slugs, sea butterflies, sea hares, limpets, and nudibranchs (NOO-duh-branks). **Gastropods are shell-less or single-shelled mollusks that move by using a muscular foot located on the ventral side.**

Many gastropods, such as the snails shown on the top right in **Figure 27–25,** have a single shell that protects their bodies. When threatened, they can pull completely into their coiled shells. Some snails are also protected by a hard disk on the foot that forms a solid "door" at the mouth of their shell when they withdraw.

Land slugs and nudibranchs have no shell but protect themselves in other ways. Most land slugs spend daylight hours hiding under rocks and logs, hidden from birds and other potential predators. Some sea hares, when threatened, can squirt ink into the surrounding water, producing a "smoke screen" that confuses predators.

Some nudibranchs have chemicals in their bodies that taste bad or are poisonous. When a predator bites one of these nudibranchs, the predator becomes ill. Many nudibranchs are able to recycle the nematocysts from cnidarians they eat, using them to sting predators. These "booby-trapped" nudibranchs are usually brightly colored. The bright coloring serves as a warning to potential predators.

CHECKPOINT *How do shell-less gastropods protect themselves?*

Figure 27–25 Gastropods move by using a large, muscular foot located on the ventral side. They can be shell-less, such as the nudibranch or sea slug (top left), or have a single shell, such as the tree snail (top right). Many sea hares (bottom) have a reduced shell covered by the mantle. The sea hare defends itself by "inking"—squirting ink at potential predators.

BIO INSIGHTS

FACTS AND FIGURES

How the gastropod got its twist

The coiled shell of the snail and other gastropods is the result of an internal realignment process called torsion. During a gastropod's development, the animal's visceral mass begins to grow upward. This growth is uneven on the right and left sides. The uneven growth, coupled with the contraction of certain muscles, causes the posterior mantle cavity to twist around to the right. At a critical moment, the body rotates a full 180° so that the back end of the body comes to rest just behind the head. The result is that the gastropod balances its internal organs above the rest of the body much as a human would carry a backpack. The coiled shell provides a retreat for the animal's head in times of danger. The twisted body arrangement has its drawbacks, though. The gastropod has its anus and kidney openings above the head, creating somewhat of a sanitation problem.

Groups of Mollusks

Build Science Skills

Observing Set up a 20-to-40 liter freshwater aquarium in the classroom. Have students add 3 to 4 centimeters of sand on the bottom. Then, have students fill the container with pond water to about 10 centimeters from the top. Add aquatic plants and several pond snails. Also, place a top over the aquarium so that the snails won't escape. Have students observe the snails, with the unaided eye and with a hand lens. They should study the shell, head, foot, and any other feature of snail anatomy they can see. Have students make drawings and write a description of what they see. L2

Build Science Skills

Observing To help students—especially those who are visually impaired—understand gastropod form and function, place a land snail in a student's hand. Once the animal acclimates itself to the surface, it will move across the hand. Tell the student to feel for the action of the snail's radula. Then, have the student use his or her other hand to feel the snail's shell. Because the snail's shell can be quite fragile, caution the student to touch the animal gently. Students should wash their hands thoroughly after touching the snail. L2

Answers to . . .

CHECKPOINT *Most land slugs spend the daylight hours hiding under rocks and logs. Some sea hares squirt ink into the surrounding water, confusing predators. Some nudibranchs have chemicals in their bodies that taste bad or are poisonous. Many nudibranchs recycle cnidarian nematocysts, moving the stinging cells to their own exterior.*

Figure 27–24 *By blocking the opening in the shell, the hard plate helps keep moisture inside the shell.*

27–4 (continued)

Build Science Skills

Using Models Help students understand how bivalves obtain nutrients by filter feeding through a demonstration of filtering particles from water. Divide a sample of water from a pond, lake, or ocean into several parts, pouring each into a separate container. Then, filter the water in each container into a beaker using one of these filter devices: a sieve, a coffee filter, a piece of screen or wire mesh, and a piece of cheesecloth. Have students observe the materials that remain after the water has been filtered, first with the unaided eye and then with a microscope. Ask: **Do you think any of these materials might be useful to an organism as food?** *(Answers may vary. In many cases, the correct answer is yes.)* Have students relate what they have observed to the filter-feeding mechanism of a bivalve. Point out that the gills of a bivalve are able to trap particles of exactly the right size so that the animal can obtain the type of food it needs. L2

Demonstration

Show students a cuttlebone, which can be purchased in many pet stores. Explain that cuttlebones are used by bird owners to condition and sharpen birds' beaks. After students have had a chance to examine the cuttlebone, ask: **What mollusk class includes the cuttlefish?** *(Cephalopoda)* Explain that a cuttlefish, like a nautilus, can regulate its buoyancy—and therefore its depth in the water—by altering the amount of fluid and gas in the chambers of its shell. L1

Word Origins

Pseudopod means "false foot." L2

▲ **Figure 27–26** Bivalves **are two-shelled mollusks that include clams, mussels, oysters, and scallops like the one above.** Observe the tiny blue eyespots along the open edges of the shell.

Word Origins

Cephalopod comes from the Greek *kephale*, meaning "head," and *podos*, meaning "foot." **Pseudopods** are structures found in some single-celled organisms. **If *pseudo-* means "false," what does *pseudopod* mean?**

Bivalves

Members of the class Bivalvia have two shells that are held together by one or two powerful muscles. Common bivalves include clams, oysters, mussels, and scallops. Most bivalves stay in one place for much of the time. Clams burrow in mud or sand, whereas mussels use sticky threads to attach themselves to rocks. Scallops, such as the one shown in **Figure 27–26,** are the least sedentary bivalves and can move around rapidly by flapping their shells when threatened.

Currents created by cilia on the gills circulate water through the body cavities of bivalves. Once water is inside the body, filter-feeding bivalves use mucus and cilia on their gills to trap food particles in the water. Some bivalves feed on material deposited in sand or mud. They use long, muscular extensions of tissue that surround the mouth to collect food particles from the surrounding sediments. The indigestible sand or mud particles are expelled from the mantle cavity.

CHECKPOINT *What are some common bivalves?*

Cephalopods

Cephalopods (SEF-uh-luh-pahdz)—members of the class Cephalopoda—are the most active of the mollusks. This class includes octopi, squids, cuttlefishes, and nautiluses. **Cephalopods are typically soft-bodied mollusks in which the head is attached to a single foot. The foot is divided into tentacles or arms.** Cephalopods have eight or more tentacles equipped with sucking disks that grab and hold prey. Nautiluses have many more tentacles than other cephalopods—in some cases up to 90! Their tentacles lack suckers but have a sticky, mucuslike covering.

As with some of the gastropods, most modern cephalopods have only small internal shells or no shells at all. The only present-day cephalopods with external shells are nautiluses, such as the one shown in **Figure 27–27.** These animals can control their depth in the water by regulating the amount of gas in their shells. Ancestors of the nautilus dominated the seas more then 500 million years ago.

Figure 27–27 Nautiluses like the one shown here are the most primitive group of cephalopods. **Comparing and Contrasting** *How does this nautilus differ from most cephalopods?*

BIO INSIGHTS

FACTS AND FIGURES

A coiled shell with many chambers

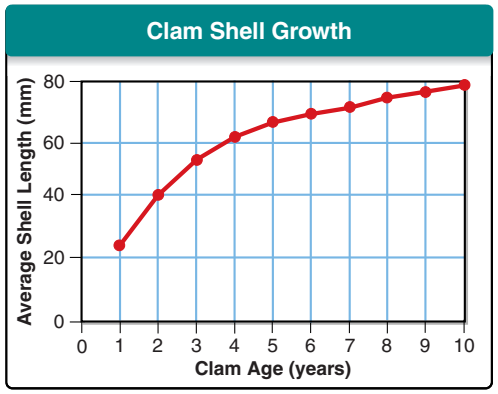
The chambered nautilus is so named because of its coiled shell of many chambers. By taking in and releasing gas from chambers in its shell, a nautilus can change its buoyancy. This means that it can move from the surface down to more than 400 meters. The body of the chambered nautilus is divided into two sections. The first section is the head, which is covered by a tough tissue called the hood. The hood acts as a shield. Tentacles—of which a nautilus may have more than 90—are located in the head. Unlike tentacles of other cephalopods, the tentacles of the nautilus do not have suckers. Instead, they are covered with a sticky substance that helps to hold prey. The second section of the body consists primarily of a large sac that contains the nautilus's organs. This sac is enclosed by the mantle. Between the mantle and the sac are four large gills.

Analyzing Data

Raising Clams

Aquaculture is the growth of aquatic animals and plants for use by humans. In one example of aquaculture, hard clams are first grown in commercial hatcheries under very favorable conditions. The young clams are then removed from the hatcheries and placed into the mud beds of creeks, where they develop into adults. At that time, the size of the young clams is around 40 millimeters.

Because Georgian clams grow so quickly, they are ideal for aquaculture. Unlike the hard clams in the northeastern United States that grow only during the warm months, Georgian hard clams grow year-round. As a result, the Georgian clams grow to market size in less than half the time that the northeastern clams need to grow. The graph shows how clam shells grow over a period of 10 years.



1. **Using Tables and Graphs** Approximately how many years does it take clams to reach a size at which they can be removed from hatcheries and put in creeks?
2. **Applying Concepts** How does climate affect the growth of most clams?
3. **Using Tables and Graphs** How much did the clams grow during the first 5 years? The next 5?
4. **Formulating Hypotheses** Formulate a hypothesis to explain the slower growth rate from years 5 to 10.
5. **Drawing Conclusions** What general trends do you observe about growth from the graph?

6IIE 7.c, BIIE 1.l

Cuttlefishes have small shells inside their bodies. These are the cuttlebones given to pet birds to condition their beaks. A squid's internal shell has evolved into a thin supporting rod known as a pen. Octopi have lost their shells completely.

Cephalopods also have numerous complex sense organs that help them detect and respond to external stimuli. Cephalopods distinguish shapes by sight and texture by touch. The eyes of many cephalopods, such as the squid shown in **Figure 27–28,** are as complex as those of some vertebrates, such as fishes and humans. Cephalopod eyes can be large—the size of a dinner plate in some species—and can distinguish objects as small as 0.5 centimeters from a meter away, allowing squids to locate a wide variety of prey. Though cephalopod eyes may look something like vertebrate eyes from the outside, their internal structures are quite different.

Figure 27–28 Most cephalopods are mollusks in which the head is attached to a single foot that is divided into tentacles or arms. They have the most complex nervous system of all the mollusks, with a highly developed brain and sense organs, such as the eye of this common squid.

BIO INSIGHTS FACTS AND FIGURES

There are some giant mollusks

Biologists have described about 50,000 living mollusk species, and another 60,000 are known by their fossils. Some mollusks are quite small; the shells of some freshwater bivalves are almost never over 2 millimeters across. Yet, there are some really large mollusks. For example, the largest bivalve is the giant tropical clam, *Tridacna,* whose shells can measure more than 1.2 meters across. One species, *T. gigas,* can have a mass of over 400 kilograms. The largest octopus is the common Pacific octopus, *Octopus hongkongensis,* which can measure up to 9.7 meters from the tip of one tentacle to the tip of the opposite tentacle. The largest squid is the giant squid, *Architeuthis,* which can have a body 4 meters long with tentacles over 9 meters long.

Analyzing Data

Aquaculture is the cultivation of fish or other marine animals for food. It is a growing industry. L2 L3

Answers

1. Approximately 2 years

2. Most clams grow only during warm months.

3. The clams grew to about 68 mm during the first five years. They grew an additional 12 mm, to 80 mm, during the next five years.

4. Sample hypothesis: The older the clam, the less frequently its cells divide.

5. Clam growth is greatest in the first four or five years. Then, it levels off to a slow but steady growth.

Build Science Skills

Comparing and Contrasting

Explain to students that the cephalopod eye is similar in many ways to the eyes of vertebrates, though they are not exactly the same. The two types of eyes are often cited by biologists as a good example of convergent evolution, the process by which unrelated species independently evolve similar adaptations. Encourage interested students who need a challenge to investigate the structure and function of the cephalopod eye and draw a comparison with the human eye. Suggest that they find out how the cephalopod eye works and whether it forms images and sees colors. L3

Answers to . . .

CHECKPOINT *Clams, mussels, oysters, and scallops*

Figure 27–27 *Unlike most cephalopods, the nautilus has an external shell.*

Ecology of Mollusks

Use Community Resources

Students can call the state environmental protection agency and find out whether it has a program to test bivalves for pollutants. Have the students report to the class about their findings. L2 L3

3 ASSESS

Evaluate Understanding

Have students make drawings of a snail, a squid, and a clam similar to those in Figure 27–21. Then, direct their attention to the labeled drawing in Figure 27–22. Challenge students to use as many of the labels on the second figure as they can to label their drawings of the three mollusks.

Reteach

Have students make a compare/contrast table of the three major classes of mollusks. In this table, they should include the names of the classes, important characteristics of each class, and examples of each.

Focus on the BIG Idea

Students should compare the mutualism of bivalves and bacteria with the parasitism of various flatworms and roundworms, as described in the chapter. Whereas in mutualism both species benefit from the relationship, in parasitism one organism—a fluke or *Ascaris*, for instance—lives on or inside another organism and harms it.

Interactive Textbook

If your class subscribes to the iText, use it to review the Key Concepts in Section 27–4.

▲ **Figure 27–29** These clams will find their way to many people's dinner tables. **Applying Concepts** *Besides providing food for humans and other animals, what are some other roles that mollusks play in ecosystems?*

Ecology of Mollusks

Mollusks play many different roles in living systems. For example, they feed on plants, prey on animals, and "clean up" their surroundings by filtering algae out of the water or by eating detritus. Some of them are hosts to symbiotic algae or to parasites; others are themselves parasites. In addition, mollusks are an important source of food for many organisms, including humans. **Figure 27–29** shows clams caught for human use.

Biologists' understanding of molluskan diversity and ecology is growing all the time. Recent explorations around deep-sea volcanic vents called "black smokers" have revealed a fascinating community that includes several bivalves. Researchers have discovered symbiotic bacteria within the foot-long bivalves clustered around these vents. These bacteria extract chemical energy from simple compounds released in the superheated water. From this energy, the bacteria produce food molecules that the mollusks can use. Without this mutualistic relationship with the bacteria, these mollusks would be unable to inhabit this extreme environment. Other research has discovered a similar symbiosis between related bacteria and bivalves that live in the mud of salt marshes and mangrove swamps.

Scientists have found some new uses for mollusks. Because filter-feeding bivalves concentrate dangerous pollutants and microorganisms in their tissues, they can be used to monitor water quality. Careful checks of bivalves can warn biologists and public health officials of health problems long before scientists can detect these dangers in the open water. Besides acting as environmental monitors, mollusks also serve as subjects in biological research. Some current investigations are based on the observation that snails and other mollusks never seem to develop any form of cancer. If scientists can determine what protects the cells of these animals from cancer, they will gain valuable insights into how to fight cancer in humans.

27–4 Section Assessment

1. **Key Concept** What is a mollusk?
2. **Key Concept** List and describe the four parts of the mollusk body plan.
3. **Key Concept** Describe the main characteristics of the three major classes of mollusks.
4. Why are land snails restricted to moist environments?
5. Describe how a cephalopod responds to external stimuli and explain how a cephalopod's nervous system is more complex than that of other mollusks.
6. **Critical Thinking** **Comparing and Contrasting** Compare open and closed circulatory systems. Why are open circulatory systems found mostly in small animals that move slowly?

Focus on the BIG Idea

Interdependence in Nature Recall from Chapter 4 the definition of symbiosis. The mutualism that exists between bivalves and bacteria near deep-sea vents is one type of symbiosis. Describe an example of another type of symbiosis that you have read about in this chapter. How is it different from mutualism?

27–4 Section Assessment

1. A mollusk is a soft-bodied animal that usually has an internal or external shell.
2. Foot, mantle, shell, visceral mass. Descriptions should agree with information on page 702.
3. Gastropods—shell-less or one shell, ventral foot; bivalves—two shells; cephalopods—head attached to foot.
4. Land snails respire using a mantle cavity lined with blood vessels. This lining must be kept moist.
5. Cephalopods exhibit complex behavior and can locate a variety of prey. Students should describe cephalopods' complex sense organs.
6. In an open circulatory system, blood leaves the vessels and moves through sinuses. In a closed circulatory system, blood is contained within vessels. A closed circulatory system supports greater oxygen needs because blood moves quickly.

Answer to . . .

Figure 27–29 *Mollusks feed on—and provide food for—other organisms; they filter water; they are hosts and parasites.*