SECTION 3

Invertebrates

Key Concept Invertebrates do not have backbones, but they do have other structures to perform their life functions.

What You Will Learn

- Invertebrates have many specialized structures that perform specialized functions.
- Organ systems perform basic life functions in some invertebrates.
- Invertebrates have many methods for reproduction and development.

Why It Matters

Studying the characteristics of invertebrates will help you understand how the same life function may be performed in different ways.

Vocabulary

- segment
- open circulatory system
- closed circulatory system
- metamorphosis

READING STRATEGY

Outlining In your **Science Journal,** create an outline of the section. Use the headings from the section in your outline.

Humans and snakes have them, but octopuses and butterflies don't. What are they? Backbones! Most animals do not have backbones. These animals are called *invertebrates*.

Invertebrate Characteristics

Invertebrates can be found in nearly every environment on Earth. Invertebrates also have many different shapes and sizes. For example, grasshoppers, clams, earthworms, and jellyfish are all invertebrates. Some invertebrates have heads, and others do not. Some invertebrates eat food through their mouths. Others absorb food particles through their tissues.

The structures of invertebrates show how well adapted invertebrates are to their environment. For example, insects have different kinds of wings that help them fly. Some invertebrates have legs that help them burrow through the ground. Others have strong bodies that help them swim. But all invertebrates are similar because they do not have backbones.

Body Symmetry

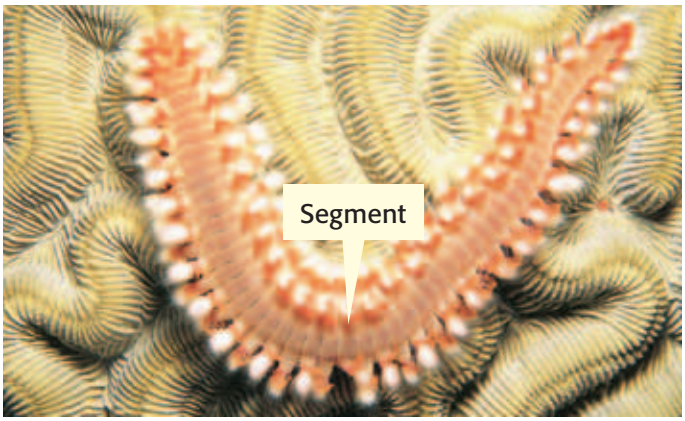
Invertebrate bodies have one of two kinds of symmetry or no symmetry at all. Sponges have irregular shapes and are therefore asymmetrical. Jellyfish have radial symmetry. In animals that have radial symmetry, many lines can be drawn through the center of the body. Each line divides the animal into opposite, or mirror images. Animals that have radial symmetry have only a top and a bottom.

Most invertebrates have "two sides," or bilateral symmetry. A body with bilateral symmetry can be divided into two parts by one vertical line. A line through the middle of the body divides the body into nearly equal right and left halves. Animals with bilateral symmetry have a top and bottom, as well as a front end and a back end. The development of a head is only seen in organisms with bilateral symmetry, such as in the sea hare seen in **Figure 1.**

Standards Check **Would you expect an animal with radial symmetry to have a head? Explain.** 7.5.a

Figure 1 *The* Aplysia californica *is a species of sea hare. This mollusk has bilaterally symmetry.*

Figure 2 **Segmentation in Invertebrate Bodies**



Segmentation

The bodies of many animals are divided into sections or **segments.** The body of the marine worm shown in **Figure 2** has many nearly equal segments. The body of the insect shown in **Figure 2** has three unequal segments. The insect has a head, a thorax, and an abdomen. Segmentation in the body has many advantages. For example, each segment in an earthworm has a set of muscles that help the earthworm push through soil.

segment (SEG muhnt) any part of a larger structure, such as the body of an organism, that is set off by natural or arbitrary boundaries

Support of the Body

Invertebrate bodies need support and protection. **Figure 3** shows three invertebrates that have different kinds of support. The body of a sponge is supported by a jelly-like material and tiny, glassy structures. Other invertebrates have tough outer coverings. For example, round worms have thick skins, and lobsters have exoskeletons. These coverings are also important because muscles that are attached to these coverings contract and relax to help invertebrates move.

Standards Check **Why are outer coverings important for movement in animals?** 7.5.a

7.2.a Students know the differences between the life cycles and reproduction methods of sexual and asexual organisms.
7.5.a Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.
7.5.b Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.
7.5.g Students know how to relate the structures of the eye and ear to their functions.

Figure 3 **Support in Invertebrate Bodies**

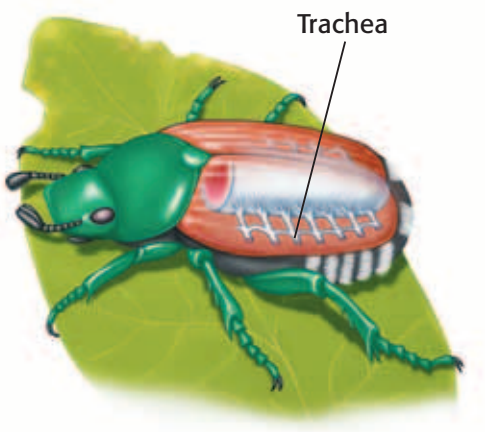


Figure 4 *This beetle moves air into its body and out of its body through small holes along the sides of its body.*

Respiratory and Circulatory Systems

All animals need oxygen to live. Animals take oxygen into their bodies and release carbon dioxide from their bodies through respiration. Respiration is performed by the *respiratory system* (RES puhr uh TAWR ee SIS tuhm). In lobsters, gills are the main organs that perform respiration. In insects, such as the beetle in **Figure 4,** a network of tubes inside the body, called *tracheae* (TRAY kee EE), performs respiration.

Oxygen, carbon dioxide, and nutrients must be moved or circulated throughout the body. The *circulatory system* transports many substances in a fluid called *blood*. Most mollusks have an **open circulatory system.** In open circulatory systems, blood moves through open spaces in the body. Invertebrates, such as annelids, have a **closed circulatory system.** In closed circulatory systems, blood moves through tubes that form a closed loop.

Standards Check **What would happen to an insect if its tracheae became clogged?** 7.5.b

INTERNET ACTIVITY

Human Metamorphosis

How would you help a friend who turned into a larva? Using pictures, describe the changes that your friend would go through. Go to **go.hrw.com,** and type in the keyword HY7INVW.

Digestive and Excretory Systems

Animals obtain the energy they need by digesting food. Digestion is performed by the *digestive system*. Food is digested as it is consumed and broken down. Any remaining material is expelled from the body. Invertebrates have relatively simple digestive systems. The mouth and anus form two ends of a tube called a *digestive tract*. The snail shown in **Figure 5** has a stomach and other specialized areas along the digestive tract.

As cells in the body use up nutrients, wastes are formed. The *excretory system* (EKS kruh TAWR ee SIS tuhm) eliminates these wastes from cells with any excess water. In many invertebrates, the digestive tract also eliminates this kind of waste. Other invertebrates have separate excretory systems. These systems have specialized organs to eliminate excess water and waste from cells.

Figure 5 *The digestive system in the snail is made up of a digestive tract that has four parts: a mouth, a stomach, an intestine, and an anus.*

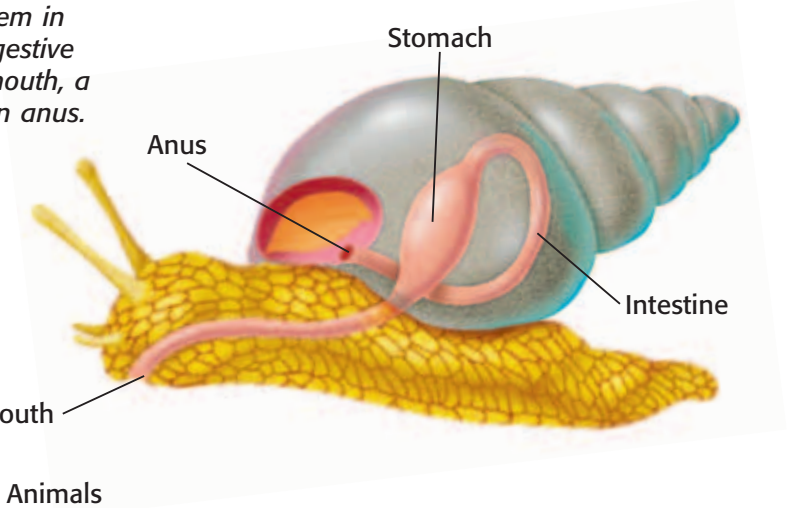
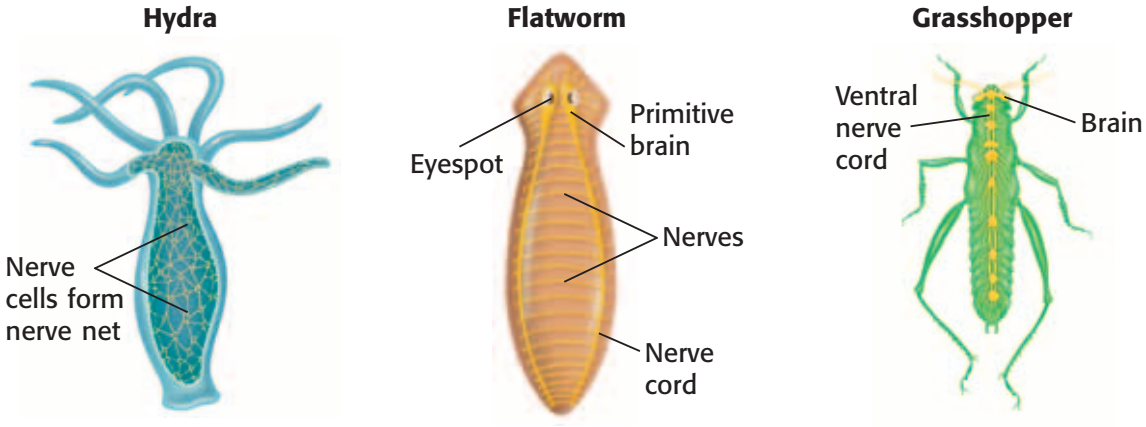


Figure 6 Examples of Invertebrate Nervous Systems



Nervous Systems

The *nervous system* is specialized for receiving and sending electrical signals that control all of the functions of the body. **Figure 6** shows examples of the nervous systems of three invertebrates. Many nervous systems have a specialized area called the *brain*. The brain acts as the control center. Nervous systems also have specialized areas called *sense organs*. Sense organs collect information, such as sound and light, from outside and inside the body. For example, eyes are organs that sense light. When light enters the eye, signals are sent to the brain. The brain interprets the signals as an image.

open circulatory system (OH puhn SUHR kyuh luh TAWR ee SIS tuhm) a circulatory system in which the circulatory fluid is not contained entirely within vessels

closed circulatory system (KLOHZD SUHR kyuh luh TAWR ee SIS tuhm) a circulatory system in which the heart circulates blood through a network of vessels that form a closed loop

Quick Lab

Seeing Like an Insect

7.5.g

Insects have a compound eye made up of repeating units. Each unit has its own lens.

Try It!

1. Use a **ruler** to draw a grid with dimensions of about 10 cm × 10 cm on a **sheet of tracing paper.** The grid lines should be separated by 0.5 cm.
2. Place the **grid** over a **black-and-white image.** Secure the grid with **tape.**
3. Note the relative amount of black ink that shows through in each box.
4. Use a **black marker** to fill in the grid boxes that are on top of an area that is mostly black. Don't fill in the grid boxes that are above squares that are mostly white.

Think About It!

5. Remove your grid, and examine it from across the room. Describe what you see?
6. What part of the activity mimicked the repeating units in the eye of an insect?
7. How might the curve of the insect eye further change how an insect sees images?

20 min

Figure 7 *Hydra reproduce by asexual reproduction. The offspring look similar to and are genetically identical to the parent.*

metamorphosis (met uh MAWR fuh sis) a process in the lifecycle of many animals during which a rapid change from the immature organism to the adult takes place

Reproduction and Development

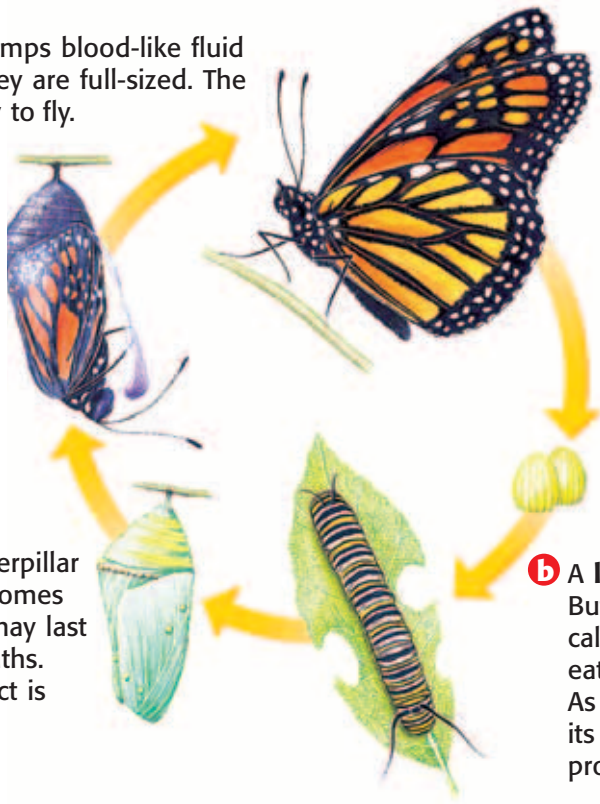
Many invertebrates reproduce asexually. One kind of asexual reproduction is called *budding*. Budding happens when a part of the parent organism develops into a new organism. The new organism then pinches off from the parent and lives independently. The hydra, shown in **Figure 7,** reproduces by budding. The new hydra is genetically identical to its parent. Fragmentation is a second kind of asexual reproduction. In fragmentation, parts of an organism break off and then develop into a new individual that is identical to the original organism. Certain organisms, such as flatworms called *planaria,* reproduce by fragmentation.

Complete Metamorphosis

Many insects reproduce sexually and lay eggs. As an insect hatches from an egg and develops, the insect changes form through a process called **metamorphosis.** Most insects go through a complex change called *complete metamorphosis*. As shown in **Figure 8,** complete metamorphosis has four main stages: egg, larva, pupa (PYOO puh), and adult. Butterflies, beetles, flies, bees, wasps, and ants go through this change.

Standards Check **Compare the life cycle of a hydra with the life cycle of a butterfly.** 7.2.a

Figure 8 **The Stages of Complete Metamorphosis**



a An adult lays **eggs.** An embryo forms inside each egg.

b A **larva** hatches from the egg. Butterfly and moth larvae are called *caterpillars*. The caterpillar eats leaves and grows rapidly. As the caterpillar grows, it sheds its outer layer several times. This process is called *molting*.

c After its final molt, the caterpillar makes a chrysalis and becomes a **pupa.** The pupal stage may last a few days or several months. During this stage, the insect is inactive.

d Adult body parts replace the larval body parts. The **adult** splits its chrysalis and emerges.

e The adult butterfly pumps blood-like fluid into its wings until they are full-sized. The butterfly is now ready to fly.

Incomplete Metamorphosis

Grasshoppers and cockroaches are two kinds of insects that go through *incomplete metamorphosis*. Incomplete metamorphosis is less complicated than complete metamorphosis. As shown in **Figure 9,** incomplete metamorphosis has three main stages: egg, nymph, and adult. Some nymphs shed their exoskeleton several times in a process called *molting*. An insect in the nymph stage looks very much like an adult insect. But a nymph does not have wings and is smaller than an adult. Through molting, the nymph develops into an adult.

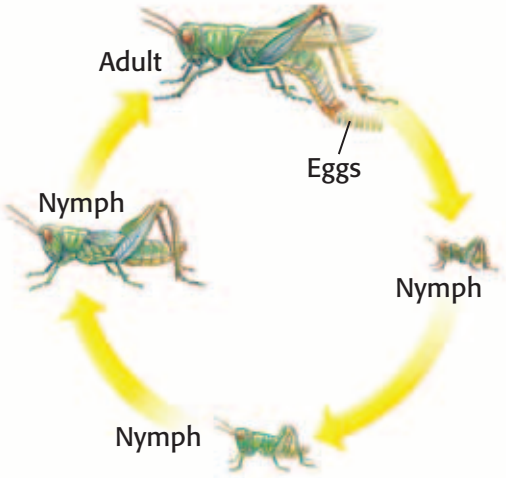


Figure 9 *The grasshopper nymphs look like smaller versions of the adult.*

SECTION Review

7.2.a, 7.5.a, 7.5.b, 7.5.g

Summary

- Invertebrate bodies are asymmetrical, have radial symmetry, or bilateral symmetry.
- The bodies of many invertebrates are divided into segments.
- Invertebrates have protective outer coverings that provide support and serve as a place for muscles to attach.
- Invertebrates may have many basic organ systems, such as a respiratory system, a circulatory system, a digestive system, an excretory system, a nervous system, and a reproductive system.
- Invertebrates reproduce asexually and sexually. Invertebrates develop from embryos into larvae and from larvae into adults.

Understanding Concepts

1. **Describing** Explain why respiration is important. Be sure to include an example of an invertebrate respiratory system.
2. **Comparing** How is the support in the body of a sponge different from the support in the body of an insect?
3. **Identifying** How do invertebrates remove wastes that are produced by cells in their bodies?
4. **Comparing** In the life cycle of a grasshopper, what are two main differences between nymphs and adults?
5. **Inferring** If an animal has a head, which kind of body symmetry would you expect the animal to have?

Critical Thinking

6. **Analyzing Processes** Describe metamorphosis in the life cycle of a butterfly and in the life cycle of a grasshopper.
7. **Making Comparisons** Compare an open circulatory system and a closed circulatory system.
8. **Expressing Opinions** Why are earthworms in a different group than roundworms? Explain.
9. **Applying Concepts** Why can't insects see in complete darkness?

Math Skills

10. **Making Calculations** A sea urchin lost 12 of its 178 spines in a storm. What percentage of its spines does the sea urchin still have?

Challenge

11. **Applying Concepts** If the head of an insect became stuck underwater, would the insect drown? Explain your answer.
12. **Making Inferences** What other body part do invertebrates that have ears or noses have?

Internet Resources

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Sponges; Echinoderms

SciLinks code: HY71443; HY70458