Name _____ Class _____ Date _____

# CHAPTER 23 Invertebrate Diversity

## Summary of Key Concepts

**Concept 23.1 Diverse animals share several key characteristics. (pp. 494–496)**
More than a million living species of animals are organized into about 35 major groups called phyla. All animals share four key characteristics. **(1)** Animals are eukaryotic. **(2)** Animals lack cell walls. **(3)** Animals are multicellular. **(4)** Animals are heterotrophs, and most ingest food. (Ingestion means to take food into the body and digest it there.) Adult male and female animals produce haploid gametes (eggs and sperm) by meiosis. During fertilization, an egg and a sperm fuse and form a zygote. The first several cell divisions result in a *blastula,* which typically is made up of a single layer of cells surrounding a hollow cavity. In many animals, one side of the blastula later folds inward, forming a stage called a *gastrula.* From the gastrula stage, many animals develop directly into adults. Others go through one or more larval stages. A *larva* is an immature form of an animal that looks different from the adult and usually eats different food. The larva undergoes a change of body form, called *metamorphosis,* and becomes an adult.

Animals without backbones are called *invertebrates.* Invertebrates, which make up about 95 percent of animals on Earth, include insects and worms. Animals with backbones are called *vertebrates* and include fishes, snakes, and humans.

**1.** What are the four key characteristics all animals share? _____

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_____

**2.** What is the difference between vertebrates and invertebrates? _____

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**Concept 23.2 Sponges are relatively simple animals with porous bodies. (pp. 497–498)**
*Sponges*—members of phylum Porifera—lack true tissues and organs. Most cells in sponges are unspecialized. The body of most sponges consists of two layers of cells. The outer layer has many pores through which water can enter. Cells in the inner layer, which lines the sponge's central cavity, are called *collar cells.* Cells called *amoebocytes* pick up food from the collar cells, digest it, and carry the nutrients to other cells. Sponges live singly or in clusters formed by budding, a type of asexual reproduction. Sponges can also reproduce sexually. Most sponges produce both male and female gametes in the same organism. Adult sponges are *sessile,* meaning they are anchored in place. Sponges have chemical defenses that protect them from predators, disease-causing organisms, and parasites.

**3.** What are the general characteristics of sponges? _____

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**4.** How do sponges reproduce? _____

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Name _____ Class _____ Date_____

**Concept 23.3 Cnidarians are radial animals with stinging cells. (pp. 499–501)**
The phylum Cnidaria includes such animals as the Portuguese man-of-war, hydras, jellies (jellyfishes), sea anemones, and coral animals. All *cnidarians* have radial symmetry and tentacles with stinging cells. An organism with *radial symmetry* has body parts arranged around an imaginary central axis, or line. Animals with radial symmetry lack a head, and most are slow-moving or attached to a surface.

Cnidarians have specialized stinging cells called *cnidocytes.* A stinging capsule is located within each cnidocyte. One type of capsule, called a *nematocyst*, has a poisonous barb at the end. Food enters the cnidarian's mouth and is digested in a sac called the *gastrovascular cavity.* Fluids in the cavity carry digested food to cells and also carry wastes away. During embryonic development, a gastrula stage occurs. Cnidarians also have some basic tissues. For example, hydras have a nerve net, a network of cells that provide a sensing function.

One cnidarian form is the *polyp,* a cylindrical body with tentacles radiating from one end, such as a hydra. The other cnidarian body form is the *medusa*, an umbrella-shaped form with tentacles around the lower edge, such as a jelly. Some cnidarian life cycles include both stages.

**5.** What characteristics do all cnidarians have? _____

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**6.** How is the structure of a hydra different from that of a jelly? _____

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**Concept 23.4 Flatworms are the simplest bilateral animals. (pp. 502–503)**
*Flatworms* are mostly small, leaflike or ribbonlike animals of the phylum Platyhelminthes. Planarians are flatworms. Like most other animals, flatworms are bilaterally symmetrical. An animal with *bilateral symmetry* has mirror-image right and left sides. A bilaterally symmetrical animal has a distinct head and a tail. In most bilateral animals, the eyes and other sense organs are located up front, on the head. Most flatworms have a gastrovascular cavity. Food enters and wastes exit from the one opening.

Flatworms can move in several ways. A planarian uses cilia on its bottom surface to slide. It also has muscles that enable it to twist and turn. The flatworm nervous system is more complex than that of cnidarians. For example, a planarian has eyespots that detect light. Some flatworms are free-living, and others are parasites. Flukes and tapeworms are parasitic flatworms.

**7.** What basic characteristics do all flatworms have? _____

_____

**8.** What is the difference between an animal with radial symmetry and an animal with bilateral symmetry? _____

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**Concept 23.5 Roundworms and rotifers have complete digestive tracts. (pp. 504–505)**
Most *roundworms* are small, cylindrical worms with somewhat pointed heads and tapered tails. Roundworms, also called nematodes, make up the phylum

Nematoda. Roundworms have a complete digestive tract. A *complete digestive tract* has two openings—a mouth and an anus—at opposite ends of a continuous tube. Food travels one in direction through a complete digestive tract. In contrast, the gastrovascular cavity of cnidarians and flatworms has only one opening, where food enters and wastes exit.

Roundworms live almost every place there is rotting organic matter and are important decomposers. While free-living (non-parasitic) roundworms are the most common, some roundworms live as parasites in plants and animals. *Rotifers,* members of the phylum Rotifera, are tiny multicellular (many-celled) animals with specialized organ systems. Rotifers also have complete digestive tracts.

**9.** How is a complete digestive tract different from a gastrovascular cavity?

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**10.** How are rotifers different from roundworms? _____

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### Concept 23.6 Annelids are segmented worms. (pp. 506–507)

A segmented body is the key characteristic of earthworms and other *annelids,* members of the phylum Annelida. An annelid's body segments are all very similar, except for a distinct head and tail. Each segment contains a dense cluster of nerve cells and waste-excreting organs. Annelids have a *closed circulatory system,* which means that blood remains inside blood vessels. Each body segment contains small blood vessels connected to two main blood vessels that run the length of the animal. A digestive tract and a nerve cord also run the length of the body.

Annelids are bilaterally symmetrical. Internally, bilaterally symmetrical animals have three basic body forms. Flatworms are examples of *acoelomates*—animals that lack a body cavity. The *pseudocoelom* of roundworms is a fluid-filled body cavity in direct contact with the digestive tract. Annelids and many other animals have a *coelom*, a fluid-filled cavity that is completely lined by tissue that originated in the embryo from a tissue called mesoderm. Some annelids are free-living, and some are parasitic.

**11.** What are the characteristics of an annelid's body? _____

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**12.** What is the difference between a pseudocoelom and a coelom? _____

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### Concept 23.7 Mollusks show diverse variations on a common body form. (pp. 508–510)

*Mollusks,* members of the phylum Mollusca, have a muscular mass of tissue called a foot and a multifunctional structure called a mantle. The foot functions in movement. The *mantle* drapes over the animal and produces the shell in mollusks such as clams and snails. The mantle also functions in respiration, waste disposal,

and sensory reception. Aquatic mollusks have a gill that absorbs oxygen dissolved in the water. Many mollusks have a scraping organ called a *radula* that functions in feeding. A mollusk coelom has three cavities: one around the heart, another around the reproductive organs, and another that forms part of the kidney. Most mollusks have an open circulatory system. In an *open circulatory system,* blood vessels open into chambers where the organs are bathed directly in blood.

Class Gastropoda, the largest group of mollusks, includes snails and sea slugs. *Gastropods* have a single shell that is often spiral-shaped and are mostly marine. Class Bivalvia includes clams, oysters, mussels, and scallops. *Bivalves* have hinged shells divided into two halves, and most bivalves live in aquatic environments. Class Cephalopoda includes octopuses, squids, and chambered nautiluses. *Cephalopods* are faster and more agile than other mollusks. The chambered nautilus has an external shell, but most cephalopods have only a small internal shell or none at all.

**13.** What features do all mollusks have in common? _____

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**14.** How is an open circulatory system different from a closed circulatory system?

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**Concept 23.8 Echinoderms have spiny skin and a water vascular system. (pp. 511–513)**

*Echinoderms,* members of the phylum Echinodermata, lack body segments. In most adults, such as sea stars, the external parts of the animal radiate from the center like spokes of a wheel. Most echinoderms have a rough and spiny surface. The spines and plates on echinoderms are actually parts of an *endoskeleton,* an internal skeleton. A unique feature of echinoderms is the *water vascular system,* a network of water-filled canals. The water vascular system includes structures called *tube feet,* which function in movement, feeding, and gas exchange.

Echinoderm larvae are bilaterally symmetrical, while adult echinoderms appear to show radial symmetry. However, small features mark adult echinoderms as bilateral as well.

Annelids, mollusks, and echinoderms are coelomates. Coelomates are divided into two groups: protostomes and deuterostomes. One difference between these groups is the origin of the coelom. In *protostomes,* the coelom forms from solid masses of cells in the embryo. Annelids and mollusks are protostomes. In *deuterostomes,* the coelom forms from a portion of the digestive tube of the early embryo. Echinoderms as well as chordates—the phylum that includes humans—are deuterostomes.

**15.** What are the characteristics of echinoderms? _____

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**16.** What is one difference between protostomes and deuterostomes? _____

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Name _____ Class _____ Date _____

**Concept 23.9 Animal diversity "exploded" during the Cambrian period. (pp. 514–519)**

Fossils show that most animal phyla evolved during a period more than 500 million years ago. The oldest known animal fossils come from Precambrian rocks that are about 700 million years old.

Cell specialization is a key characteristic of multicellular organisms. One hypothesis about how specialization arose is that animals evolved from protists that lived in hollow spherical colonies. Over time, some of these cells may gradually have become specialized. Another key characteristic of animals is that they have multiple cell layers. One hypothesis about how this characteristic arose is that a hollow spherical colony may have folded inward—just as a gastrula develops from a blastula in an animal embryo.

Most of the major animal phyla make their first fossil appearance in the Cambrian period. This burst of animal diversity, called the *Cambrian explosion,* probably lasted about 40 million years—565–525 million years ago. Biologists use Cambrian fossils as well as data from comparative anatomy, embryology, genetics, and molecular studies of living species to search for clues about common ancestry among animals. One set of hypotheses proposes that millions of years ago there was a split between animals with no true tissues and animals with tissues. Among the "tissue" animals, the next split divided animals with radial symmetry from animals with bilateral symmetry. The animals with bilateral symmetry further split into protostomes and deuterostomes.

**17.** What are two key characteristics of animals? _____

_____

**18.** What is the Cambrian explosion? _____

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### *Reading Skills Practice*

**Summarizing** Study the table in Figure 23-26 on pages 518–519. Use the information in this table to write your own summary for each of the phyla listed.

## Vocabulary Review and Reinforcement

*In 1–7, fill in the blanks with the appropriate terms from the chapter.*

**1.** A(n) _____ is an immature form of an animal that looks different from the adult form and usually eats different food.

**2.** An embryonic stage consisting of a single layer of cells surrounding a hollow cavity is a(n) _____.

**3.** A network of water-filled canals in an echinoderm is called the _____.

**4.** An embryonic stage that forms as one side of the blastula folds inward is the _____.

**5.** The cells that line the central cavity of a sponge are called _____.

Name _____ Class _____ Date_____

**6.** The change that a larva undergoes as it becomes an adult is called _____.

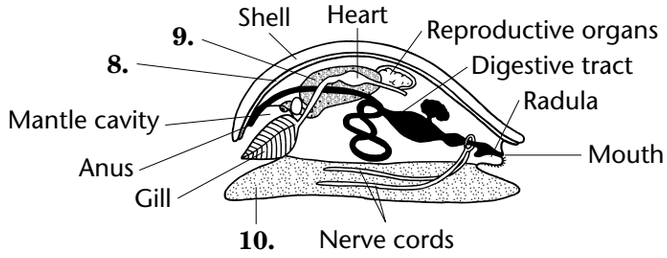
**7.** Organisms that are anchored in place are said to be _____.

*In 8–10, study the diagram. Then fill in the blanks with the appropriate terms from the chapter.*

**8.** _____

**9.** _____

**10.** _____




## WordWise

*Match each definition in the left column with the correct term in the right column. Then write the number of each term in the appropriate box below. When you have filled in all the boxes, add up the numbers in each column, row, and two diagonals. All the sums should be the same.*

**A.** umbrella-shaped cnidarian body form

**B.** structures in echinoderms that function in movement, feeding, and gas exchange

**C.** sponge cells that pick up food from collar cells and carry the nutrients to other cells

**D.** fluid-filled body cavity in direct contact with the digestive tract

**E.** digestive tract of a cnidarian

**F.** animal that lacks a body cavity

**G.** cylindrical cnidarian body form with tentacles radiating from one end

**H.** stinging cells in cnidarians

**I.** hard internal skeleton

**1.** tube feet

**2.** polyp

**3.** acoelomate

**4.** endoskeleton

**5.** gastrovascular cavity

**6.** medusa

**7.** pseudocoelom

**8.** amoebocytes

**9.** cnidocytes

| | | | |
|---|---|---|---|
| A<br>_____ | B<br>_____ | C<br>_____ | = _____ |
| D<br>_____ | E<br>_____ | F<br>_____ | = _____ |
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