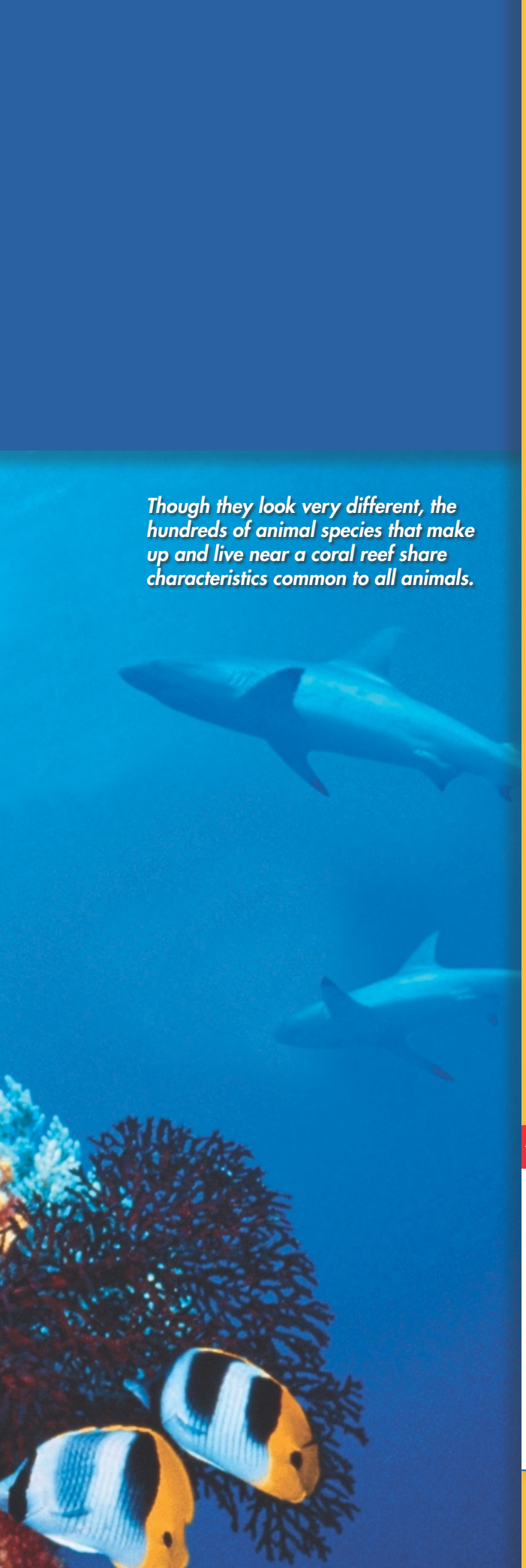
25 Introduction to Animals



Though they look very different, the hundreds of animal species that make up and live near a coral reef share characteristics common to all animals.

FOCUS ON TEKS 8B

CHAPTER MYSTERY

SLIME DAY AT THE BEACH

It was a warm October day in Massachusetts when phone calls started streaming in to beach offices, aquariums, and even 9-1-1 lines. Beaches near Boston were coated with a thick, glistening layer of jellylike ooze. Beachgoers were mystified and worried. Some thought there had been an oil spill, but police and fire personnel verified that it was not oil.

More slimy masses kept washing up onto the seashores. People noticed that some of the gooey blobs appeared to be pulsating with life. When they looked closely, investigators saw that the slime was made up of small, individual critters—each transparent and the size of a fingernail. But what were they? Look for clues in this chapter to help you determine what the slime was.

UntamedScience™

Never Stop Exploring Your World.

Discovering what the slime was is only the beginning. Take a video field trip with the ecogeeks of Untamed Science to see where the mystery leads.

Texas Essential Knowledge and Skills

READINESS TEKS: 8B Categorize organisms using a hierarchical classification system based on similarities and differences shared among groups. **10A** Describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals.

SUPPORTING TEKS: 8C Compare characteristics of taxonomic groups, including archaea, bacteria, protists, fungi, plants, and animals. **10C** Analyze the levels of organization in biological systems and relate the levels to each other and to the whole system. **11A** Describe the role of internal feedback mechanisms in the maintenance of homeostasis.

TEKS: 3F Research and describe the history of biology and contributions of scientists.

25.1 What Is an Animal?

In this lesson, you will learn about the characteristics of animals **(TEKS 8C)**, the two groups of animals **(TEKS 8B)**, and how their body systems interact **(TEKS 10A)** to maintain homeostasis **(TEKS 4B, 11A)**.

Key Questions

- ***What characteristics do all animals share?***
- ***What characteristics distinguish invertebrates and chordates?***
- ***What essential functions must animals perform to survive?***

Vocabulary

invertebrate
chordate
notochord
pharyngeal pouch
vertebrate
feedback inhibition

Taking Notes

Outline As you read, make an outline about the features of animals.

ELPS 4.F.9

Work with a partner on the "Taking Notes," page 730. As you make your outline, use the blue and green headings and the key concepts, set in bold type. For each key concept, review with your teacher and partner how sentence structure affects the meaning of the whole idea.

THINK ABOUT IT An osprey circles a salt marsh searching for prey. Suddenly, it dives, extending razor-sharp talons. With a triumphant whistle, it carries a struggling fish back to its young. On the bottom of the bay, worms burrow beneath rocks carpeted with orange sponges. In the air above, mosquitoes swarm, searching for a blood meal. What features unite all these organisms as members of the animal kingdom, and what characteristics group them into different clades within that kingdom?

Characteristics of Animals TEKS 8B, 8C

What characteristics do all animals share?

All members of the animal kingdom are heterotrophs, which obtain nutrients and energy by eating other organisms. Animal bodies are multicellular—composed of many cells. Animal cells are eukaryotic, containing a nucleus and membrane-bound organelles. Unlike the cells of algae, fungi, and plants, animal cells lack cell walls. **Animals, members of the kingdom Animalia, are multicellular, heterotrophic, eukaryotic organisms whose cells lack cell walls.**

Types of Animals TEKS 8C

What characteristics distinguish invertebrates and chordates?

Animal diversity is so vast and differences among animals so great that we need to divide these organisms into groups to even begin talking about them. Animals are often classified into two broad categories: invertebrates and chordates.

Invertebrates

More than 95 percent of animal species are informally called **invertebrates.** **Invertebrates include all animals that lack a backbone, or vertebral column.** Because this category lumps together organisms that *lack* a characteristic, rather than those that *share* a characteristic, "invertebrates" do not form a clade or any other kind of true category in the system of biological classification. Invertebrates include at least 33 phyla, which are the largest taxonomic groups of animals. Invertebrates include sea stars, worms, jellyfishes, and insects. They range in size from dust mites to colossal squid more than 14 meters long.

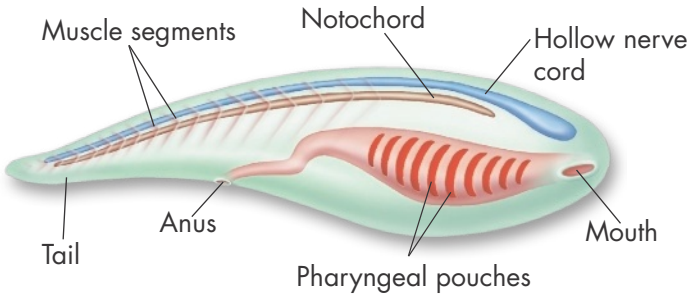


FIGURE 25–1 Characteristics of Chordates All chordates have a dorsal, hollow, nerve cord; a notochord; pharyngeal pouches; and a tail that extends beyond the anus. Some chordates possess all these traits as adults; others possess them only as embryos.

Chordates Fewer than 5 percent of animal species are **chordates,** members of the clade commonly known as Phylum Chordata. **All chordates exhibit four characteristics during at least one stage of life: a dorsal, hollow nerve cord; a notochord; a tail that extends beyond the anus; and pharyngeal** (fuh RIN jee ul) **pouches.** As you see in **Figure 25–1,** the hollow nerve cord runs along the dorsal (back) part of the body. Nerves branch from this cord at intervals. The **notochord** is a long supporting rod that runs through the body just below the nerve cord. Most chordates have a notochord only when they are embryos. At some point in their lives, all chordates have a tail that extends beyond the anus. **Pharyngeal pouches** are paired structures in the throat region, which is also called the pharynx. In some chordates, such as fishes, slits develop that connect pharyngeal pouches to the outside of the body. Pharyngeal pouches may develop into gills used for gas exchange.

Phylum Chordata includes some odd aquatic animals known as nonvertebrate chordates, which lack vertebrae. Most chordates, however, develop a backbone, or vertebral column, constructed of bones called vertebrae (singular: vertebra). Chordates with backbones are called **vertebrates.** Vertebrates include fishes, amphibians, reptiles and birds, and mammals.

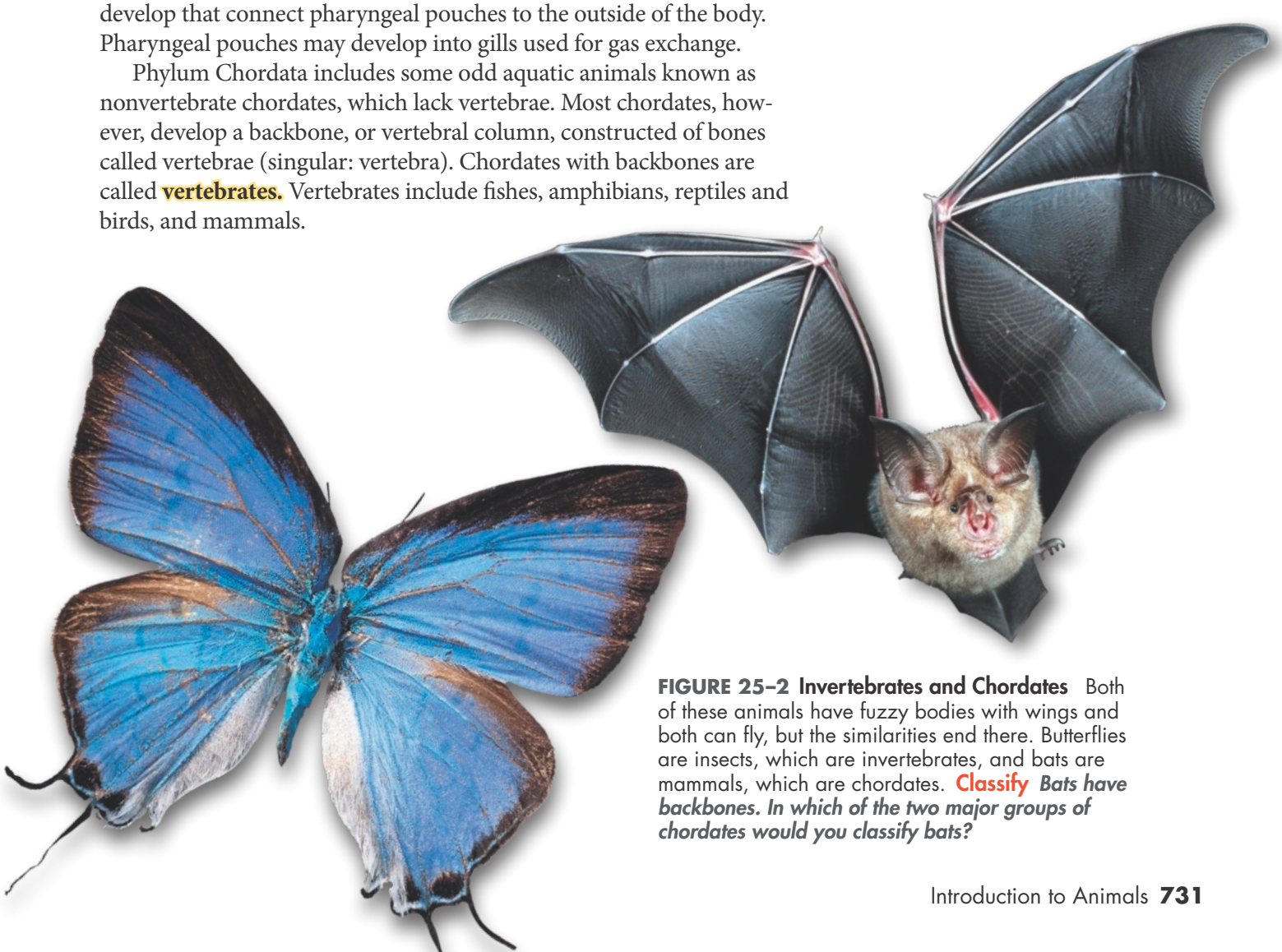


FIGURE 25–2 Invertebrates and Chordates Both of these animals have fuzzy bodies with wings and both can fly, but the similarities end there. Butterflies are insects, which are invertebrates, and bats are mammals, which are chordates. **Classify** ***Bats have backbones. In which of the two major groups of chordates would you classify bats?***

Quick Lab

DESCRIPTIVE INVESTIGATION

TEKS 5B, 12B

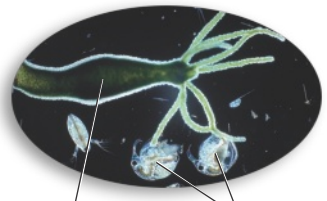
How Hydra Feed

1. Your teacher will provide you with hydra and *Daphnia*, small aquatic invertebrates. Using a dropper pipette, gently place one hydra onto a well slide.
2. Let the hydra adjust to its surroundings for 5 to 10 minutes.
3. Using your dropper, add one *Daphnia* to the slide.
4. Observe the hydra under a microscope.

Analyze and Conclude

1. Examine What happens when the *Daphnia* is added to the same slide as the hydra?

2. Draw Conclusions How do the hydra's tentacles help it to maintain homeostasis?



3. Pose Questions Formulate two questions about how the hydra survives in its environment.

What Animals Do to Survive

TEKS 10A, 4B, 11A

What essential functions must animals perform to survive?

All organisms must keep their internal environment relatively stable, a process known as maintaining homeostasis. **Animals maintain homeostasis by gathering and responding to information, obtaining and distributing oxygen and nutrients, and collecting and eliminating carbon dioxide and other wastes. They must also reproduce.** These functions are performed by body systems that can be described separately, but that are closely linked to one another. Interactions occur constantly among the systems that perform regulation, nutrient absorption, reproduction, defense from injury or illness, and other functions. Members of different phyla have evolved different body structures that perform these functions. The best way to study animal diversity is to examine how and why body structures and systems function as they do. You will study these structures in more detail in Chapters 27 and 28.

Maintaining Homeostasis Maintaining homeostasis is the most important function of all body systems—separately and together. For example, most reptiles, birds, and mammals cannot excrete salt very well. Those that hunt or feed in salt water, such as the marine iguana in **Figure 25–3,** have adaptations that allow them to remove salt from their bodies.

Often, homeostasis is maintained by internal feedback mechanisms that regulate the functions of body systems. **Feedback inhibition,** or negative feedback, is a kind of internal feedback mechanism in which the product or result of a process limits the process itself. If your house gets too cold, for example, the thermostat turns on the heat. As heat warms the house, the thermostat turns the heater off. Your body's thermostat works the same way. If you get too cold, you shiver, using muscle activity to generate heat. If you get too hot, you sweat, which helps you lose heat.

In this unit, you will learn how animal body systems work together to achieve and maintain balance through homeostasis. You will see how different groups have evolved different ways of ensuring their body systems stay in balance.

FIGURE 25–3 Homeostasis Marine iguanas are reptiles that feed in salt water. Reptile excretory systems are not adapted to process salt water. So these reptiles maintain homeostasis by sneezing a combination of salt and nasal mucus you might call "snalt." Snalt sometimes coats their bumpy heads and spiny necks, as you can see in this photo.

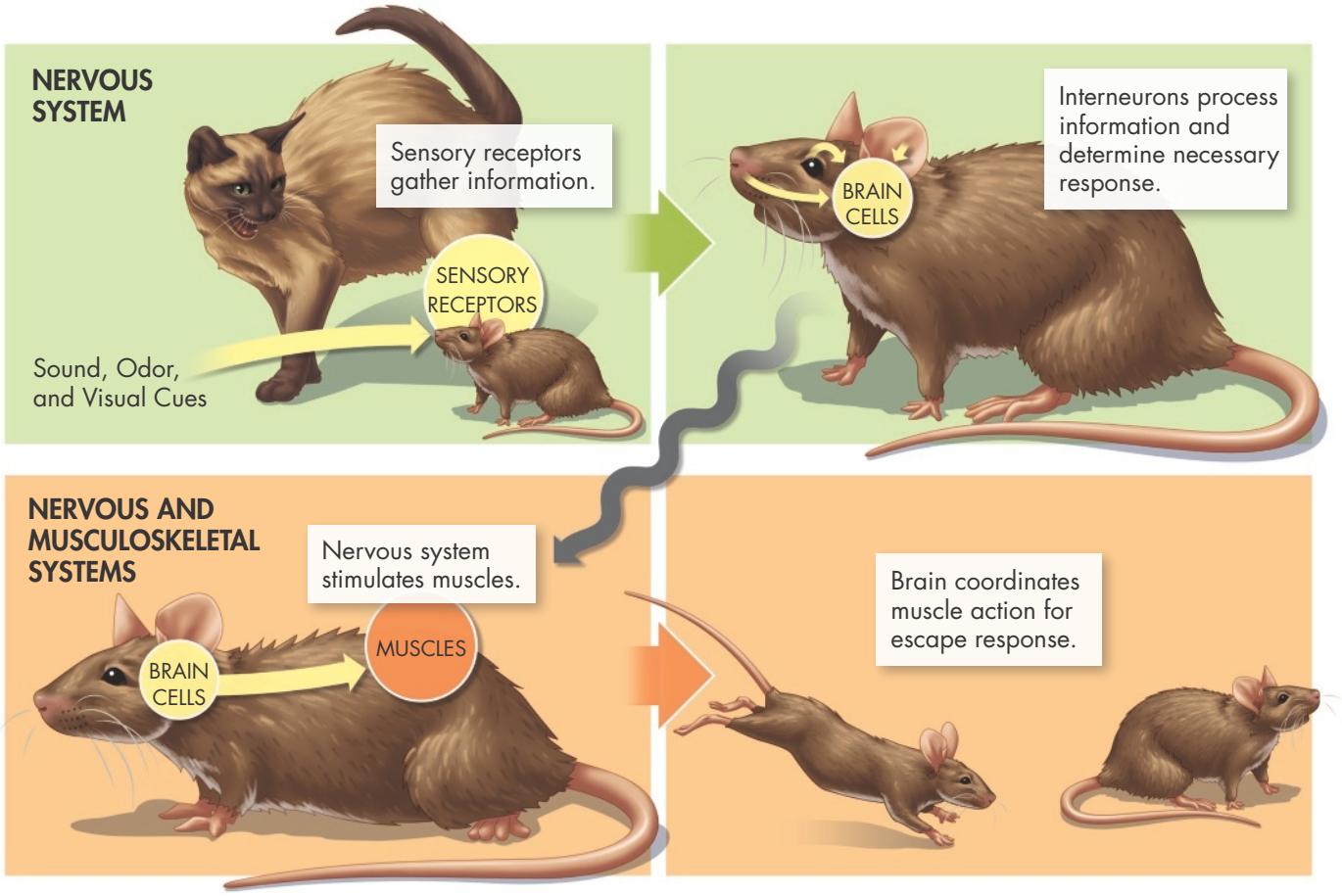
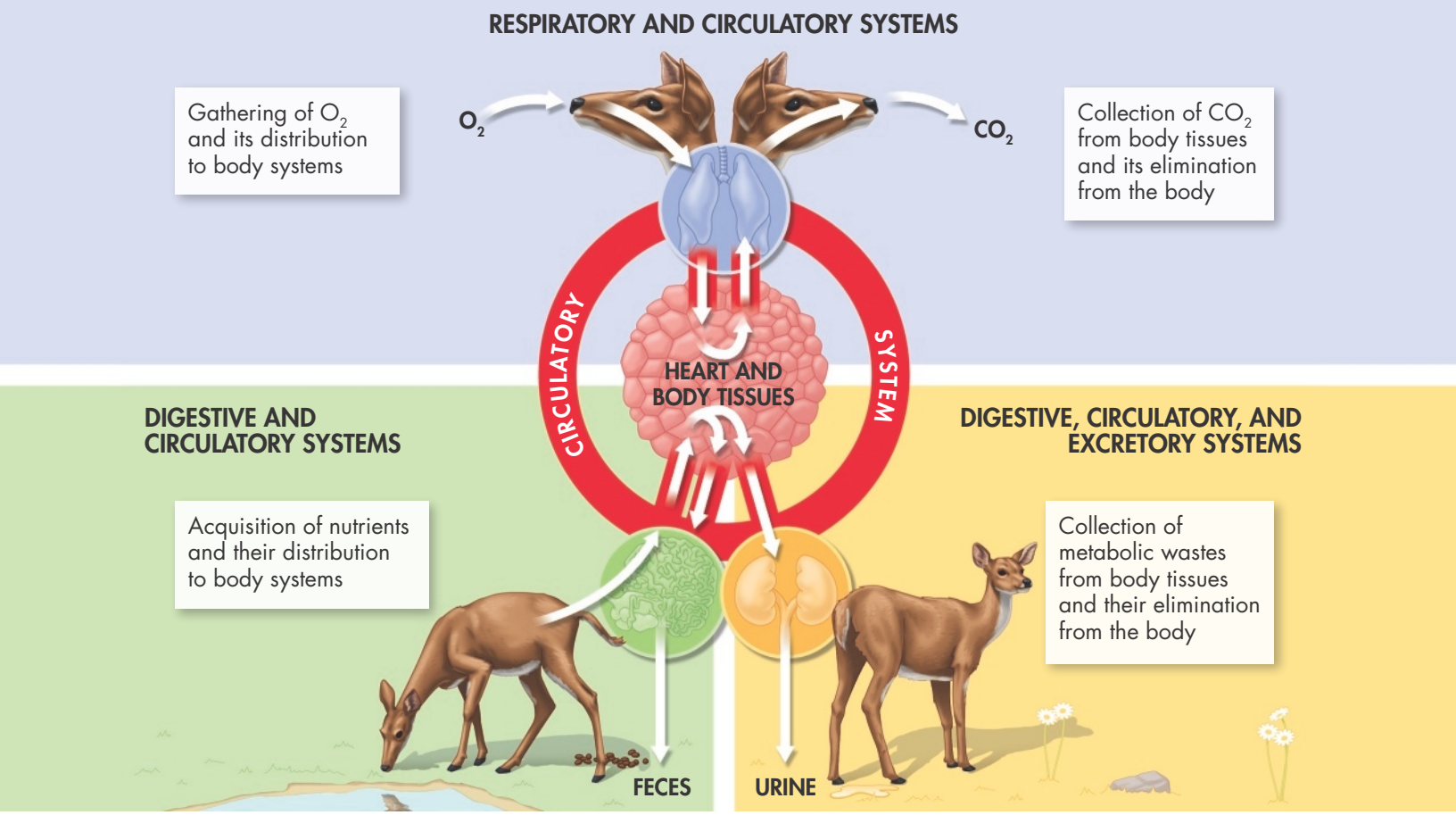


FIGURE 25–4 Gathering and Responding to Information The nervous and muscular systems work together to produce a response. **Predict** ***Would an animal with a malfunctioning nervous system be likely to produce an appropriate muscular response to a predator? Explain.***

Gathering and Responding to Information Most chordates use several interacting body systems to respond to external factors in their environment, as shown in **Figure 25–4.** The nervous system gathers information about external factors using cells called receptors that respond to sound, light, chemicals, and other stimuli. Other nerve cells collect and process that information and determine how to respond. Some invertebrates have only a loose network of nerve cells, with no real center. Other invertebrates and most chordates have large numbers of nerve cells concentrated into a brain.

The nervous system interacts with several other systems in ways that enable animals to respond to external factors by moving around. Muscle tissue generates force by becoming shorter when stimulated by the nervous system. Muscles work together with a supporting structure called a skeleton to make up the musculoskeletal system. Skeletons vary widely from phylum to phylum. Some invertebrates, such as earthworms, have skeletons that are flexible and function through the use of fluid pressure. Insects and some other invertebrates have external skeletons. The bones of vertebrates form an internal skeleton. For example, the hard shell of a lobster is an external skeleton, while your bones are part of your internal skeleton.

Online Journal *Construct a flowchart showing the events in* ***Figure 25–4*** *in chronological order.*



VISUAL SUMMARY

MOVING MATERIALS IN, AROUND, AND OUT OF THE BODY

FIGURE 25–5 The structures of an animal's respiratory, digestive, and excretory systems must work together with those of its circulatory system.

Obtaining and Distributing Oxygen and Nutrients All animals must breathe in some way to obtain oxygen. Small animals that live in water or in wet places can "breathe" by allowing oxygen to diffuse across their skin. Larger animals use a respiratory system based on one of many different kinds of gills, lungs, or air passages. In addition, all animals must eat to obtain nutrients. Most animals have a digestive system that acquires food and breaks it down into forms cells can use.

After acquiring oxygen and nutrients, animals must transport them to cells throughout their bodies. For many animals, this task requires interactions between the respiratory and digestive systems and some kind of circulatory system as shown in **Figure 25–5.** Several kinds of internal feedback mechanisms control these interactions to maintain homeostasis. Among vertebrates, including humans, proper functioning of the circulatory system is essential in supplying oxygen and nutrients. In humans, for example, brain cells begin to die within moments if their blood supply is interrupted by a stroke.

Collecting and Eliminating CO_2 and Other Wastes Animals' metabolic processes generate carbon dioxide and other waste products. Some of those waste products contain nitrogen, often in the form of ammonia. Both carbon dioxide and ammonia are toxic in high concentrations to humans. So these wastes must be excreted, or eliminated from the body.

Many animals eliminate carbon dioxide by using their respiratory systems alone. But most complex animals have a separate specialized organ system—the excretory system—for eliminating other wastes, such as ammonia. The excretory system concentrates or processes these wastes and either expels them immediately or stores them before eliminating them.

But before waste products can be discharged from the body, they must be collected from cells throughout body tissues and delivered to the respiratory or excretory system. Here again, some sort of circulatory system is often necessary. So the collection and elimination of wastes also requires close interactions among the structures and functions of three body systems, as shown in **Figure 25–5** on the previous page.

Reproducing Most animals reproduce sexually by producing haploid gametes. Sexual reproduction helps create and maintain genetic diversity, which increases a species' ability to evolve and adapt as the environment changes. Many invertebrates and a few vertebrates can also reproduce asexually. Asexual reproduction usually produces offspring that are genetically identical to the parent. It allows animals to increase their numbers rapidly but does not generate genetic diversity. All forms of reproduction require interactions among the digestive, respiratory, circulatory, and excretory systems. Egg-laying species must produce eggs containing nutritious yolks, and keep those eggs alive until they are laid. Mammals must provide for the respiratory and excretory needs of developing young in the womb. And most sexually-reproducing species depend on their nervous systems to locate and mate with members of the opposite sex. Interactions between the nervous and endocrine systems are also essential parts of the process of growth and development, as you will learn in more detail in Chapter 28.

FIGURE 25–6 Reproduction Like many vertebrates, this pygmy marsupial frog is caring for her young while they develop. Unlike most animals, she is carrying her eggs on her back!

25.1 Review Key Concepts TEKS 8C, 10A

1. a. Review Which characteristics do all animals share?

b. Classify A classmate is looking at a unicellular organism under a microscope. She asks you if it is an animal. What would you say, and why?

2. a. Review What characteristic do the animals informally called "invertebrates" share? What are four characteristics of chordates?

b. Explain Why would you be unlikely to find a notochord in an adult chordate?

c. Compare and Contrast How do vertebrates differ from other chordates?

3. a. Review Describe the essential functions performed by all animals.

b. Explain Why must waste products produced by metabolic processes be eliminated from an animal's body?

c. Sequence Which body system delivers waste products to the respiratory and excretory systems?

VISUAL THINKING

4. Make a two-column chart that lists the ways that animals gather and respond to information. In the first column, list each function. In the second column, include a drawing, photograph, or clipping of a structure that performs that function.

Careers & BIOLOGY

TEKS 3F

Are you interested in a career with animals? If so, you might be interested in one of the careers below.

ZOO CURATOR

When you think of a zoo worker, you likely picture a keeper feeding animals, right? Zookeepers are not the only people working in zoos, however! Zoo curators are responsible for overseeing a specific part of a zoo's work. There are many different kinds of curators, including research curators, animal curators, and conservation curators. Each contributes to the zoo's mission of wildlife protection and preservation.

BEEKEEPER

More than one quarter of the American diet comes from food plants that are pollinated by bees. Beekeepers maintain beehives and are therefore a vital part of the agriculture business. Bees are rented to farmers for pollination of crops such as almonds, apples, peaches, soybeans, and many types of berries. Beekeepers may also use their hives to produce beeswax and honey.

INVERTEBRATE BIOLOGIST

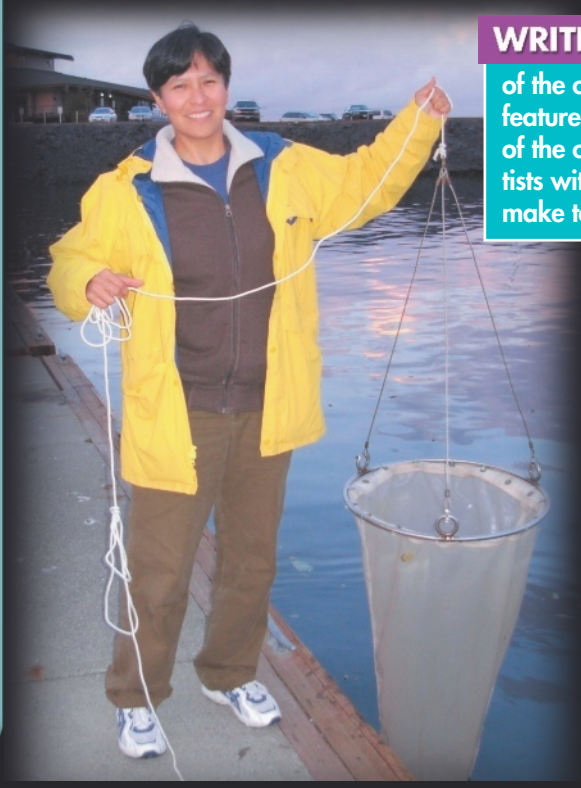
More than 95 percent of animals lack a backbone. From corals to spiders, earthworms to sea stars, the variety is amazing! Biologists may study invertebrate behavior, evolution, ecology, or anatomy. With so many species to choose from, the research is as varied as the animals themselves.

CAREER CLOSE-UP

Dr. Scottie Yvette Henderson, Invertebrate Biologist

The strange and diverse creatures of the ocean inspire Dr. Scottie Henderson, an instructor of biology at the University of Puget Sound in Tacoma, Washington. Her current research focuses on tiny, potentially parasitic crabs that infest a clam called *Nuttallia obscurata*. Dr. Henderson and her colleagues are looking at the interactions of the clam and crab to better understand the nature of their symbiotic relationship. Some evidence points to parasitism, but the relationship may be commensal. Nothing, however, is as important to Dr. Henderson as getting her students interested in and excited about science.

"Stop and take a look at the world around you. Biology is exciting! There are many unanswered questions . . . and many questions waiting to be asked."



WRITING Research one of the careers described in this feature. Then, describe some of the contributions that scientists with that particular career make to society.

25.2 Animal Body Plans and Evolution

In this lesson, you will learn the features of various animal body plans, the levels of organization within these plans, and how the different levels relate to each other **(TEKS 10C).** Also covered: **TEKS 8C.**

THINK ABOUT IT Animals alive today have typically been produced by two processes: the development of a multicellular individual from a single fertilized egg, and the evolution of a modern species from its ancestors over many millions of years. The history of the evolutionary changes to animal body structures has been known for years. Today, exciting research is revealing how changes in genes that control embryological development have played a major role in the evolution of body structures. This field, often referred to as "evo-devo," is one of the hottest areas in biology today.

Features of Body Plans TEKS 8C, 10C

What are some features of animal body plans?

Our survey of the animal kingdom focuses on how animal body structures and systems interact to perform life's essential functions. Each animal phylum has a unique organization of particular body structures that is often referred to as a body plan. **Features of animal body plans include levels of organization, body symmetry, differentiation of germ layers, formation of body cavities, patterns of embryological development, segmentation, cephalization, and limb formation.**

Levels of Organization

As the first cells of most animals develop, they differentiate into specialized cells that are organized into tissues. Recall that a tissue is a group of cells that perform a similar function. Animals typically have several types of tissues, including epithelial, muscle, connective, and nervous tissues. Epithelial tissues cover body surfaces, inside and out. The epithelial cells that line lung surfaces, for example, have thin, flat structures through which gases can diffuse easily. Tissues combine during growth and development to form organs. Organs work together to make up organ systems that carry out complex functions. Your digestive system, for example, includes tissues and organs such as your lips, mouth, stomach, intestines, and anus.

Key Questions

What are some features of animal body plans?

How are animal phyla defined?

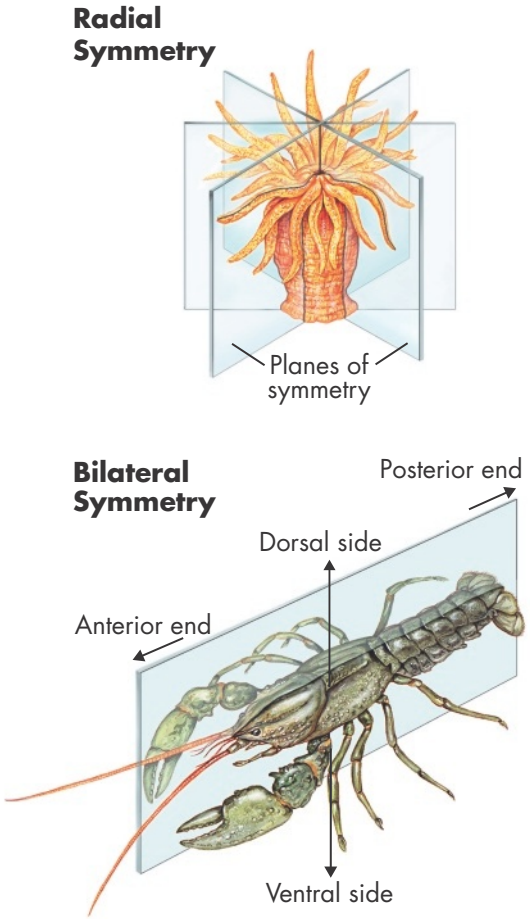
Vocabulary

radial symmetry • bilateral symmetry • endoderm • mesoderm • ectoderm • coelom • pseudocoelom • zygote • blastula • protostome • deuterostome • cephalization

Taking Notes

Concept Map Draw a concept map showing the different features of animal body plans and the different types of each feature.

FIGURE 25–7 Body Symmetry
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.



Body Symmetry

The bodies of most animals exhibit some type of symmetry. Some animals, such as the sea anemone in **Figure 25–7,** have body parts that extend outward from the center, like the spokes of a bicycle wheel. These animals exhibit **radial symmetry,** in which any number of imaginary planes drawn through the center of the body could divide it into equal halves. The most successful animal groups exhibit **bilateral symmetry,** in which a single imaginary plane divides the body into left and right sides that are mirror images of one another. Animals with bilateral symmetry have a definite front, or anterior, end and a back, or posterior, end. Bilaterally symmetrical animals also have an upper, or dorsal, side and a lower, or ventral, side. When you ride a horse, you are riding on its dorsal side.

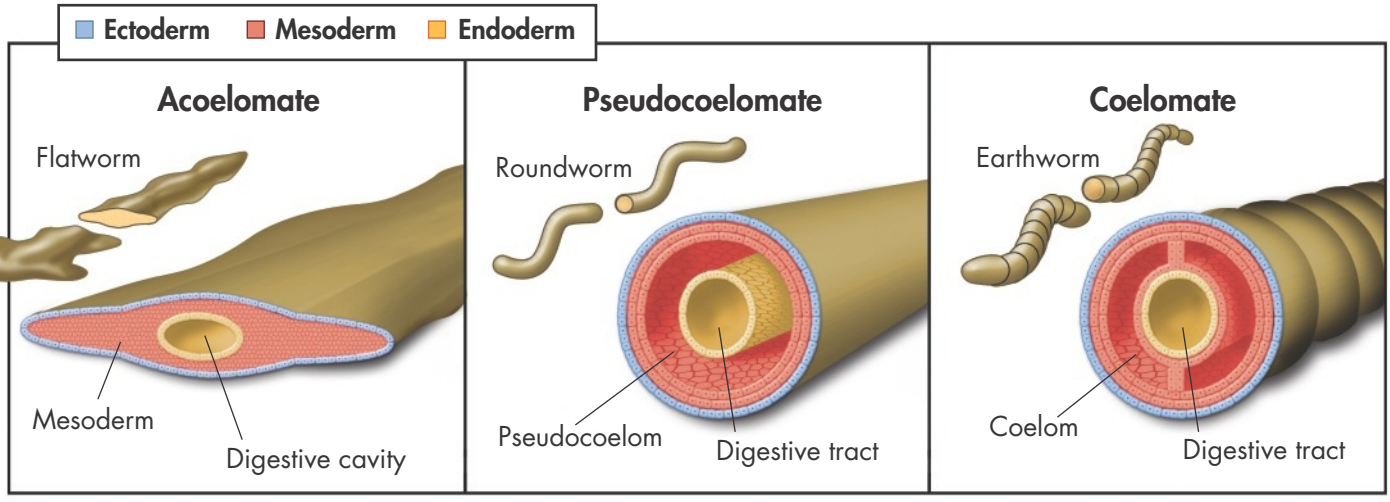
Differentiation of Germ Layers

During embryological development, the cells of most animal embryos differentiate into three layers called germ layers. Cells of the **endoderm,** or innermost germ layer, develop into the linings of the digestive tract and much of the respiratory system. 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, produces sense organs, nerves, and the outer layer of the skin.

Formation of a Body Cavity

Most animals have some kind of body cavity—a fluid-filled space between the digestive tract and body wall. A body cavity provides a space in which internal organs can be suspended, and room for those organs to grow. For example, your stomach and other digestive organs are suspended in your body cavity. Most complex animal phyla have a true **coelom** (SEE lum), a body cavity that develops within the mesoderm and is completely lined with tissue derived from mesoderm. Some invertebrates have only a primitive jellylike layer between the ectoderm and endoderm. Other invertebrates lack a body cavity altogether, and are called acoelomates. Still other invertebrate groups have a **pseudocoelom,** which is only partially lined with mesoderm. **Figure 25–8** summarizes the tissue structures of animals with and without coeloms.

FIGURE 25–8 Body Cavities
Acoelomates lack a coelom between their body wall and digestive cavity. Pseudocoelomates have body cavities that are partially lined with tissues from the mesoderm.



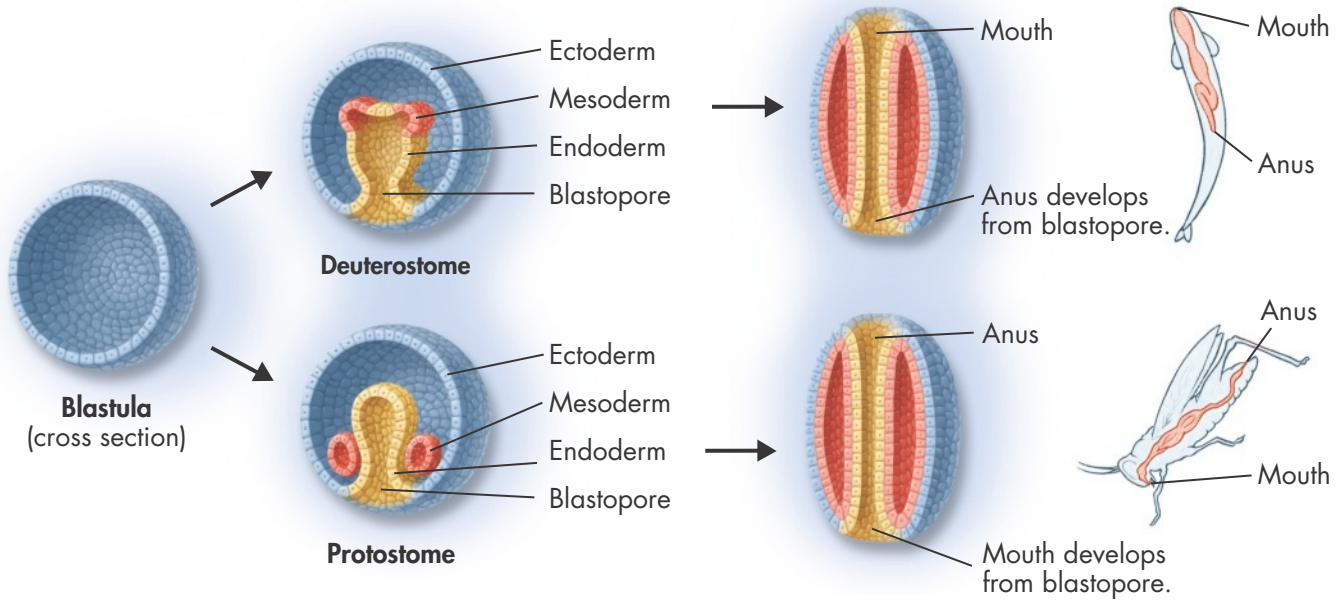


FIGURE 25–9 Blastula and Blastopore Formation During the early development of an animal embryo, a hollow ball of cells called a blastula forms. An opening called a blastopore forms in this ball. In deuterostomes, such as fishes, the blastopore forms an anus. In protostomes, such as grasshoppers, the blastopore develops into the mouth.

Patterns of Embryological Development Every animal that reproduces sexually begins life as a **zygote,** or fertilized egg. As the zygote begins to develop, it forms a **blastula** (BLAS tyoo luh), a hollow ball of cells like an inflated balloon. As the blastula develops, it folds in on itself, as if you were holding the balloon and pushing your thumbs toward the center. This folding changes a ball of cells into an elongated structure with a tube that runs from one end to the other. This tube becomes the digestive tract, as shown in **Figure 25–9.**

At first, this digestive tract has only a single opening to the outside, called a blastopore. An efficient digestive tract, however, needs two openings: a mouth through which food enters and an anus through which wastes leave. In phyla that are **protostomes** (PROH tuh stohms), the blastopore becomes the mouth. In protostomes, including most invertebrates, the anus develops at the opposite end of the tube. In phyla that are **deuterostomes** (DOO tur uh stohms), the blastopore becomes the anus, and the mouth is formed from the second opening that develops. Chordates and echinoderms are deuterostomes. This similarity in development is one of several characteristics that indicate that echinoderms are closely related to chordates.

Segmentation: Repeating Parts As many bilaterally symmetrical animals develop, their bodies become divided into numerous repeated parts, or segments. These animals are said to exhibit segmentation. Segmented animals, such as worms, insects, and vertebrates, typically have at least some internal and external body parts that repeat on each side of the body. Bilateral symmetry and segmentation are found together in many of the most successful animal groups.

Segmentation has been important in animal evolution because of the way genes control the production and growth of body segments. In segmented animals, simple mutations can cause changes in the number of, and form of, body segments. Different segments can evolve specializations that perform different functions, such as information gathering, feeding, or movement.

Analyzing Data

Differences in Differentiation

The table shows the length of time it takes various animals to reach important stages in their early development. Study the data table and answer the questions.

Time Variations in Developmental Stages of Various Animals

Stage	Chicken	Hamster	Rabbit	Rhesus Monkey
2 cells	3 hours	16 hours	8 hours	24 hours
4 cells	3.25 hours	40 hours	11 hours	36 hours
Three germ layers begin to form	1.5 days	6.5–7 days	6.5 days	19 days
Three germ layers differentiate	3 days	8 days	9 days	25 days
Formation of tail bud	3.25 days	8.5 days	9.5 days	26 days
Birth/Hatching	22 days	16 days	32 days	164 days

1. Compare and Contrast Which animal takes the most time to reach the differentiation stage? Which takes the least time?

2. Calculate How much longer does it take a rhesus monkey zygote to reach the 4-cell stage than it does a chicken zygote?

3. Infer In all these animals, which developmental stage would you expect to occur first—formation of the coelom or formation of the blastula?

BUILD Vocabulary

SUFFIXES The word **cephalization** has two suffixes: *-ize*, meaning "to make of," and *-ation*, meaning "the process of." When these suffixes are added to the root word *cephal-*, meaning "head," the new word means "the process of making a head."

Cephalization: Getting a Head

Animals with bilateral symmetry typically exhibit **cephalization** (sef uh lih ZAY shun), the concentration of sense organs and nerve cells at their anterior end. This anterior end is often different enough from the rest of the body that it is called a head. The most successful animal groups, including arthropods and vertebrates, exhibit pronounced cephalization.

Close examination of insect and vertebrate embryos shows that their heads are formed by the fusion and specialization of several body segments during development. As those segments fuse, their internal and external parts combine in ways that concentrate sense organs, such as eyes, in the head. Nerve cells that process information and "decide" what the animal should do also become concentrated in the head. Not surprisingly, animals with heads usually move in a "head-first" direction. This is so that the concentration of sense organs and nerve cells comes in contact with new parts of the environment first.

Limb Formation: Legs, Flippers, and Wings

Segmented, bilaterally symmetrical animals typically have external appendages on both sides of the body. These appendages vary from simple groups of bristles in some worms, to jointed legs in spiders, wings in dragonflies, and a wide range of limbs, including bird wings, dolphin flippers, and monkey arms. These very different kinds of appendages have evolved several times, and have been lost several times, in various animal groups.

Online Journal *Explain in your own words why animals with heads tend to move in a "head-first" direction.*

VISUAL SUMMARY

BODY PLANS

FIGURE 25–10 The body plans of modern invertebrates and chordates suggest evolution from a common ancestor.

Ectoderm Mesoderm Endoderm	Sponges	Cnidarians	Arthropods	Roundworms	Flatworms
Levels of Organization	Specialized cells	Specialized cells, tissues	Specialized cells, tissues, organs	Specialized cells, tissues, organs	Specialized cells, tissues, organs
Body Symmetry	Absent	Radial	Bilateral	Bilateral	Bilateral
Germ Layers	Absent	Two	Three	Three	Three
Body Cavity	–	Acoelom	True coelom	Pseudocoelom	Acoelom
Embryological Development	–	–	Protostome	Protostome	Protostome
Segmentation	Absent	Absent	Present	Absent	Absent
Cephalization	Absent	Absent	Present	Present	Present

Ectoderm Mesoderm Endoderm	Annelids	Mollusks	Echinoderms	Chordates
Levels of Organization	Specialized cells, tissues, organs	Specialized cells, tissues, organs	Specialized cells, tissues, organs	Specialized cells, tissues, organs
Body Symmetry	Bilateral	Bilateral	Radial (as adults)	Bilateral
Germ Layers	Three	Three	Three	Three
Body Cavity	True coelom	True coelom	True coelom	True coelom
Embryological Development	Protostome	Protostome	Deuterostome	Deuterostome
Segmentation	Present	Absent	Absent	Present
Cephalization	Present	Present	Absent (as adults)	Present

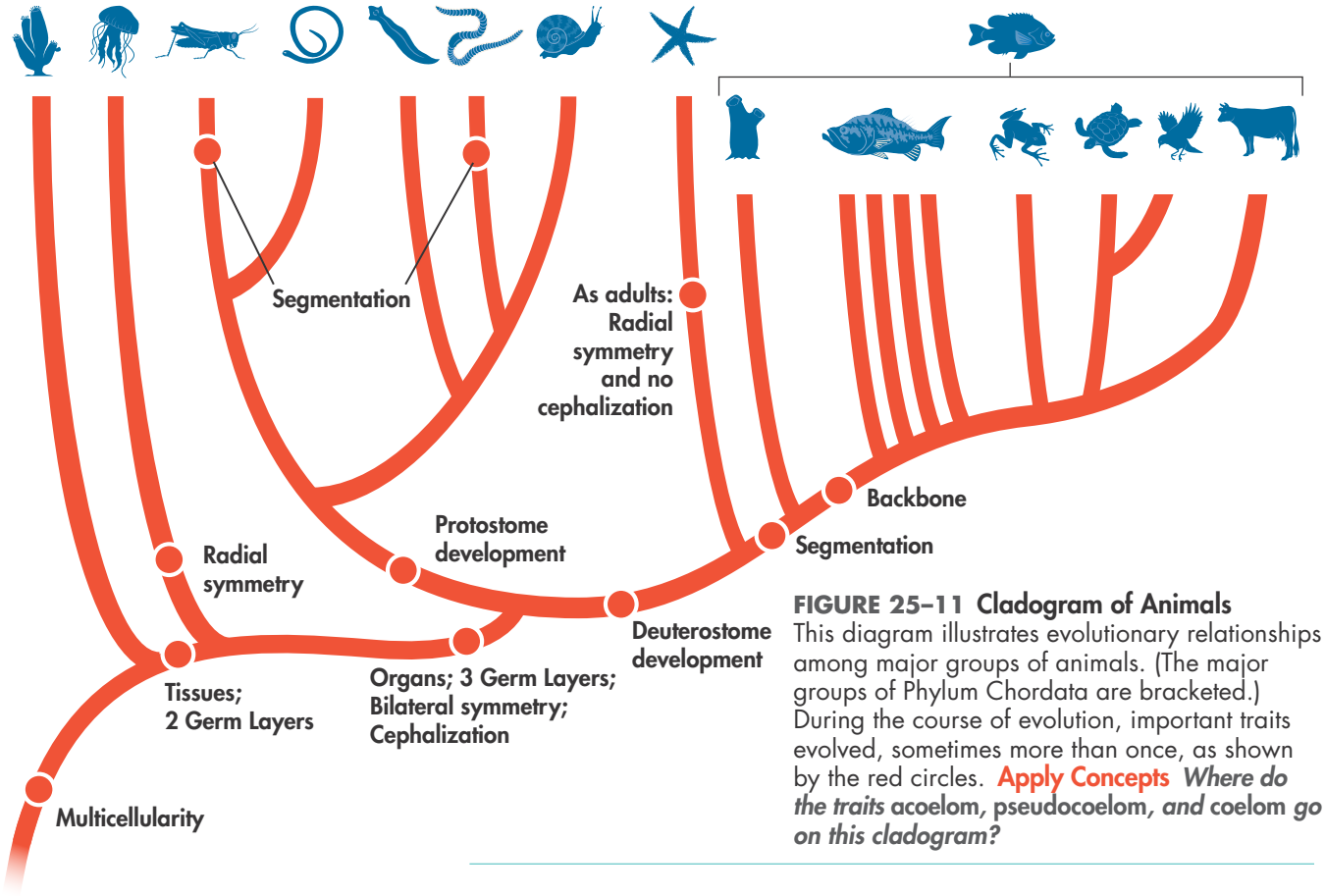


FIGURE 25–11 Cladogram of Animals This diagram illustrates evolutionary relationships among major groups of animals. (The major groups of Phylum Chordata are bracketed.) During the course of evolution, important traits evolved, sometimes more than once, as shown by the red circles. **Apply Concepts** ***Where do the traits* acoelom, pseudocoelom, *and* coelom *go on this cladogram?***

The Cladogram of Animals TEKS 8C

How are animal phyla defined?

The features of animal body plans you have just learned about provide information for building the cladogram, or phylogenetic tree, of animals. Recall that a cladogram is a branching, hierarchical classification system that presents hypotheses based on shared similarities and differences in living species, similar evidence from the fossil record, and comparative genomic studies. The cladogram in **Figure 25–11** presents our current understanding of relationships among animal phyla. **Animal phyla are typically defined according to adult body plans and patterns of embryological development.** For example, the body plan of the phylum Arthropoda includes bilateral symmetry, segmentation, cephalization, an external skeleton, and jointed legs.

Differences Between Phyla The cladogram of animals indicates the sequence in which important body plan features evolved. Every phylum has a unique combination of ancient traits inherited from its ancestors and new traits found only in that particular phylum. It may be tempting to think of a cladogram as a story about "improvements" from one phylum to the next over time. But that isn't the case. The complicated body systems of vertebrates aren't necessarily better than the "simpler" systems of invertebrates. Any body system found in living animals functions well enough to enable those animals to survive and reproduce. For example, vertebrate brains are more complex than flatworm "brains." But flatworm nervous systems obviously work well enough to enable flatworms, as a group, to survive.

Changes Within Phyla: Themes and Variations

Within each phylum, different groups represent different variations on the basic body plan themes that have evolved over time. Land vertebrates, for example, typically have four limbs. Many, such as frogs, walk (or hop) on four limbs that we call "legs." Among birds, the front limbs have evolved into wings. In many primates, the front limbs have evolved into what we call "arms." Both wings and arms evolved through changes in the standard vertebrate forelimb.

FIGURE 25–12 Limb Variations Birds have evolved front limbs specialized as wings, whereas frogs have evolved four "legs."

Evolutionary Experiments In a sense, you can think of each phylum's body plan as an evolutionary "experiment," in which a particular set of body structures performs essential functions. An organism's first appearance represents the beginning of this "experiment." The very first versions of most major animal body plans were established hundreds of millions of years ago, as you'll learn in the next chapter. Ever since that time, each phylum's evolutionary history has shown variations in body plan as species have adapted to changing conditions. If the changes have enabled members of a phylum to survive and reproduce, the phylum still exists. If the body plan hasn't functioned well enough over time, members of the phylum, or particular groups within the phylum, have become extinct.

25.2 Review Key Concepts TEKS 8C

1. a. Review List eight features of animal body plans.
b. Infer How is the embryology of echinoderms similar to that of vertebrates? What might this similarity indicate about their evolutionary relationship?

2. a. Review What two features define animal phyla?
b. Relate Cause and Effect What happens to a phylum over time if its body plan doesn't enable its members to survive and reproduce?

WRITE ABOUT SCIENCE

Description

3. Explain the description of a body plan as an evolutionary "experiment." In your explanation, describe the difference between successful and unsuccessful body plans in terms of the different outcomes.

APPLY THE TEKS 8B

solve the CHAPTER MYSTERY

SLIME DAY AT THE BEACH

Although most people had never seen creatures like these before, biologists had no trouble categorizing them. They were salps—descendants of the most ancient members of phylum Chordata. Salps belong to a group of chordates called tunicates. As adults, most tunicates live attached to rocks or the seafloor. Salps are unusual among tunicates: The adults are free-swimming. They pump water in through their mouths and out the other end, feeding and propelling themselves through the water at the same time. Salps are usually found in the surface waters of tropical seas, but they can be carried north by the Gulf Stream and are sometimes washed onto beaches by storms.

1. **Identify** Scientists verified that the organisms were young animals that had a stiff rod running along the tail. What is the rod called? How does it help you categorize the organism?
2. **Categorize** The mystery creatures are deuterostomes. Their larvae have bilateral symmetry, a dorsal hollow nerve cord, and pharyngeal pouches—but no backbone. Where on the cladogram do they belong?
3. **Compare and Contrast** How are salps similar to jellyfishes? How are they different?
4. **Research** Use the Internet or library sources to research salps and other tunicates. Explain why these peculiar-looking animals are classified in the phylum Chordata.

25 TEKS Practice

TEKS 8C, 10A, 10C, 11A

Review Content

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

2. Which of the following is characteristic of all chordates but not found in invertebrates?
   a. a notochord **c.** a circulatory system
   b. four legs **d.** an exoskeleton

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

4. The job of collecting waste materials from a complex animal's body cells and delivering them to organs that will release them from the body is carried out by the
   a. excretory system. **c.** circulatory system.
   b. nervous system. **d.** digestive system.

5. Most animals reproduce
   a. sexually by producing diploid gametes.
   b. asexually by cloning.
   c. sexually by producing haploid gametes.
   d. asexually by fission.

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

7. An animal whose mouth is formed from the blastopore is a(n)
   a. deuterostome. **c.** protostome.
   b. endoderm. **d.** mesoderm.

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.** multicellularity.

9. Which of the following animals shows radial symmetry?
   a. earthworm **c.** insect
   b. fish **d.** sea anemone

10. Which germ layer produces the nerves and sense organs of animals?
    a. ectoderm **c.** mesoderm
    b. endoderm **d.** periderm

Understand Concepts

11. Explain why the word *invertebrate* may be a useful word but is not a true category in the system of classification.
12. Which body systems are most involved when a raccoon discovers that a full trash can is a food source, and it knocks over the can to find the food?
13. What is an acoelomate?
14. Describe the major developmental difference that distinguishes protostomes from deuterostomes.
15. What is a blastula?
16. List the three germ layers.
17. Name two body plan characteristics shared by all arthropods and vertebrates.
18. What is one major advantage of cephalization?

Think Critically

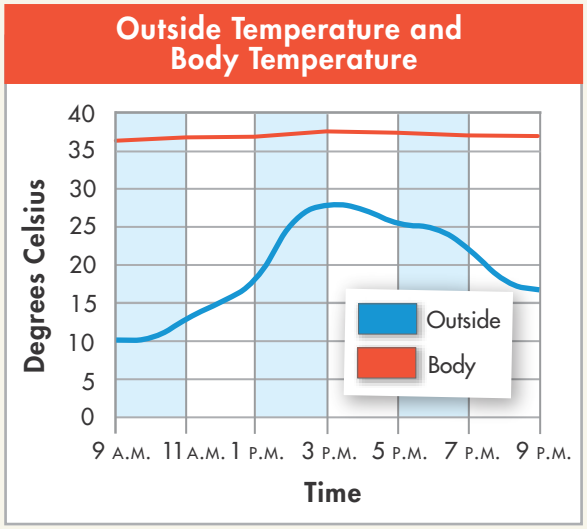
19. **Classify** What characteristic distinguishes vertebrates from nonvertebrate chordates?
20. **Compare** Make a table that compares the characteristics of the taxonomic groups, including archaea, bacteria, protists, fungi, plants, and animals.
21. **Describe** Describe the role of internal feedback mechanisms in the maintenance of homeostasis in animals.
22. **Analyze** What are the levels of organization in biological systems, starting with the simplest level? Analyze how organs and organ systems are related.
23. **Relate** What is homeostasis? How does homeostasis relate the levels of organization in a biological system to the whole system?
24. **Describe** In what ways do the digestive and respiratory systems depend on the circulatory system to carry out the functions of obtaining nutrients and eliminating wastes?
25. **Compare and Contrast** How does the way animals dispose of carbon dioxide differ from the way they dispose of ammonia?

TEKS Practice

26. **Relate Cause and Effect** Describe generally how the nervous and musculoskeletal systems of a rabbit react when it sees a predator such as a coyote.
27. **Apply Concepts** Why is bilateral symmetry an important development in the evolution of animals? Draw evidence from the text to support your analysis.
28. **Sequence** Rank the following developments in the order of their appearance during evolution: tissues, deuterostome development, multicellularity, protostome development.
29. **Form a Hypothesis** Animals with radial symmetry, such as sea anemones, lack cephalization, while animals with bilateral symmetry have it. State a hypothesis that would explain this observation.
30. **Infer** Why is it inaccurate to state that the cladogram of animals shows the improvements in body plans that have occurred over time?
31. **Explain** How have cephalization and segmentation helped animals achieve such great diversity?

Use Science Graphics

Use the graph to answer questions 32–34.



32. **Interpret Graphs** At what time of day is the body temperature closest to that of the outside environment?
33. **Draw Conclusions** What is the relationship between body temperature and the temperature of the environment?
34. **Infer** How do you explain the shape of the graph for body temperature?

Biology Chapter 25

Lesson 1

Lesson 25.1 describes the characteristics of the animal taxonomic group. Animals are multicellular, heterotrophic, eukaryotic organisms whose cells lack cell walls. There are two categories of animals: invertebrates (animals that lack a backbone) and chordates. In order to survive, all animals must maintain homeostasis, or a relatively stable internal environment. The body systems of all animals interact and work together in order to maintain homeostasis. They do this by gathering and responding to information, obtaining and distributing oxygen and nutrients, and collecting and eliminating carbon dioxide and other wastes. They also must reproduce.

Readiness TEKS: 4B, 8B, 10A
Supporting TEKS: 8C, 11A

Lesson 2

In lesson 25.2, you learned about the various body plans of animals as well as how these body plans have evolved over time. Some features of animal body plans include levels of organization, body symmetry, differentiation of germ layers, formation of body cavities, patterns of embryological development, segmentation, cephalization, and limb formation Animals are further defined according to their adult body plans and patterns of embryological development.

Supporting TEKS: 8C, 10C

★ TEKS Practice: Chapter Review

1 A scientist explained that a single cell can be used to determine that an organism is an animal and neither a plant nor a fungus. Is this reasonable?

A No, a single cell cannot be used to provide information about all cells in a multicellular organism.

B No, the individual cells in different organisms are indistinguishable.

C Yes, animal cells do not have any characteristics in common with plant or fungi cells, so they can be easily distinguished.

D Yes, a sample of a single cell could show whether or not a cell wall was present.

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2 The table shows categorized groups of organisms.

Group A	Group B
Eubacteria	Animals
Archaea	Plants

What column headings correctly identify the groups of organisms in the table shown?

F Group A: Invertebrates; Group B: Vertebrates

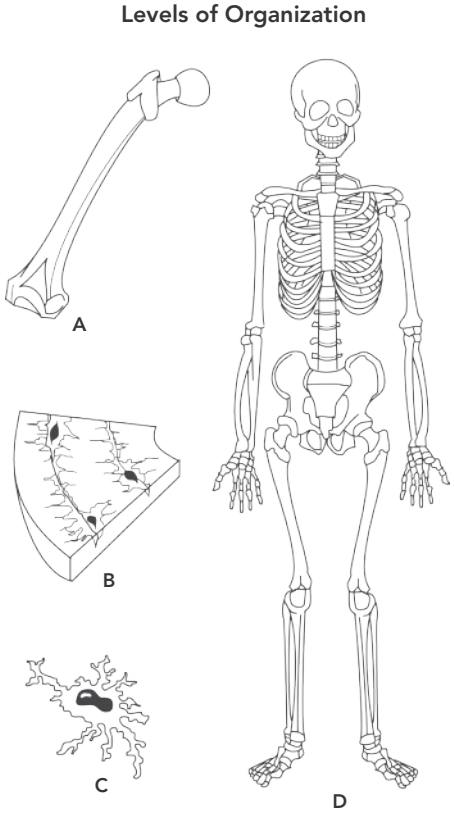
G Group A: Autotrophs; Group B: Heterotrophs

H Group A: Prokaryotes; Group B: Eukaryotes

J All of these

3 The diagram shows examples of the levels of organization found in humans and other chordates. Note that the levels of organization are not labeled in the correct order.

Which levels of organization shown in the diagram can be found in all types of animals?



A C

B C, B

C C, B, A

D C, B, A, D

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4 Testing performed on a diseased farm animal shows steadily declining levels of oxygen in the cells of the animal's body tissues. Based on these test results, which is the best inference about the disease?

F The disease has damaged the digestive and circulatory systems of the animal.

G The disease is affecting the respiratory system, the circulatory system, or both.

H The disease has damaged the animal's excretory system only.

J The disease is affecting the animal's respiratory system only.

★ TEKS Practice: Cumulative Review

5 Fertilizer labels typically display the percent of the fertilizer by weight that is made up of each of the following three nutrients: nitrogen, phosphorus, and potassium.

Which phrase best summarizes how the essential nutrients found in fertilizers are taken in to be used by most plants?

A Through unspecialized cells of the apical meristem in the root

B Through stomata that open due to the action of guard cells

C By active transport that occurs in root epidermal cells

D By osmosis in the cells of vascular tissue

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6 A scientist investigating adaptations of a particular tree species finds that short exposure to extreme heat is required for the tree's seeds to be released.

What advantage does this adaptation provide in a forest ecosystem that experiences forest fires?

F These seeds germinate quickly after a fire when there is little competition for resources.

G The heat changes the genetic material in the seeds, providing increased variation.

H These seeds are able to survive until there is enough moisture for growth.

J Releasing seeds after a fire allows seedlings to avoid cold winter conditions.

If You Have Trouble With . . .

Question	1	2	3	4	5	6
See Lesson	25.1	25.1	25.2	25.1	23.2	24.2
TEKS	8C, 3A	8C	10C	10A, 2G	4B, 3B	12B