25.2 Animal Body Plans and Evolution

THINK ABOUT IT Animals alive today have typically been produced by two processes: the development of a multicellular individual from a single fertilized egg cell, 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 the genes that control embryological development are connected to the evolution of body structures. This research field, often referred to as "evo-devo," is one of the hottest areas in biology today.

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.

Features of Body Plans

What are some features of animal body plans?

Our survey of the animal kingdom focuses on how animal body structures and systems 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.

Teach for Understanding

ENDURING UNDERSTANDING Animals have evolved diverse ways to carry out basic life processes and maintain homeostasis.

GUIDING QUESTION How have different animal body plans evolved?

EVIDENCE OF UNDERSTANDING *After completing the lesson, assign students the following assessment to show their understanding of the importance of animal body plans.* Divide the class into pairs. Write the following prompt on the board, and ask each pair to spend about five minutes developing a response.

- Animals are classified into separate phyla based on their body plans and how they develop as embryos.

Have pairs present their responses for a class discussion.

Getting Started

Objectives

25.2.1 Discuss some trends in animal evolution.

25.2.2 Explain the differences among the animal phyla.

Student Resources

Study Workbooks A and B, 25.2 Worksheets

Spanish Study Workbook, 25.2 Worksheets

Lab Manual B, 25.2 Data Analysis Worksheet

BIOLOGY.com Lesson Overview • Lesson Notes • Activities: Art Review, Art in Motion, Data Analysis • Assessment: Self-Test, Lesson Assessment

For corresponding lesson in the **Foundation Edition**, see pages 611–616.

Build Background

Begin a discussion by having students brainstorm what they recall about the four levels of body organization. Then, introduce the four main types of tissues in the body: epithelial, muscle, connective, and nerve. Draw examples on the board or show photographs, and explain where each type of tissue is found.

NATIONAL SCIENCE EDUCATION STANDARDS

UNIFYING CONCEPTS AND PROCESSES

I, II, IV, V

CONTENT

C.1.f, C.3.a, C.3.b, C.3.d, C.3.e, C.5.d

INQUIRY

A.1.c, A.2.a

Teach

Use Visuals

Use **Figure 25–8** to introduce germ layers. Call on students to describe the differences among acoelomate, pseudocoelomate, and coelomate body plans. *(Acoelomate—no cavity between the body wall and digestive cavity; pseudocoelomate—cavity partially lined with tissue from the mesoderm; coelomate—body cavity completely lined with tissue from the mesoderm.)*

Ask Which cell layer develops into the lining of the digestive tract? *(endoderm)*

DIFFERENTIATED INSTRUCTION

L1 **Struggling Students** Use **Figure 25–7** to introduce the concept and vocabulary of body symmetry. Give students practice with the terms *ventral, dorsal, anterior,* and *posterior* by writing the following **Cloze Prompts** on the board and having them complete the sentences aloud.

- The head is at the _____ end of a cat. *(anterior)*
- The belly is the _____ surface of the fish. *(ventral)*
- The tail of a lizard is at its _____ end. *(posterior)*
- The back of a wasp is its _____ surface. *(dorsal)*

Study Wkbks A/B, Appendix S2, Cloze Prompts.

ELL Focus on ELL: Extend Language

ALL SPEAKERS Have students use **Cornell Notes** to help them learn the vocabulary and concepts described in **Features of Body Plans.** Pair beginning and intermediate speakers with advanced and advanced high speakers. Have pairs read the information under each blue heading, and then complete their notes on the body plan feature discussed in that subsection. Partners should use their notes to ask each other questions before continuing on to the next subsection.

Study Wkbks A/B, Appendix S22, Cornell Notes. **Transparencies,** GO5.

BIOLOGY.com Students can review body symmetry and body cavities with **Art Review: Body Symmetry and Cavities.**

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.

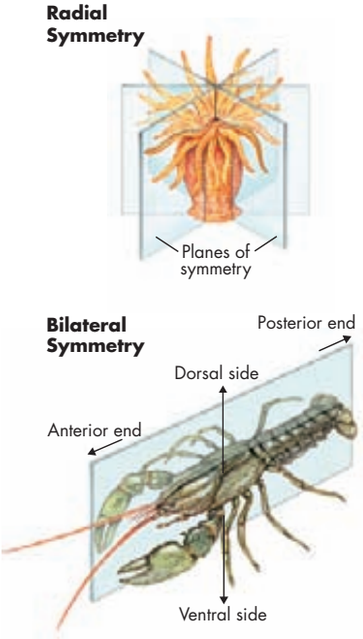
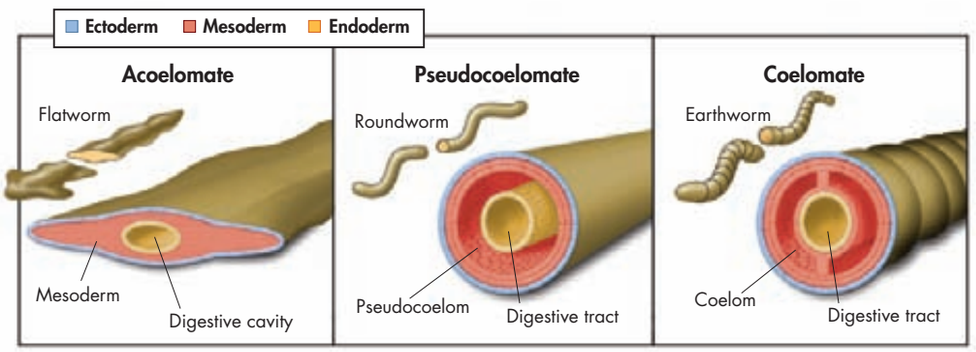


FIGURE 25–8 Body Cavities
Acoelomates lack a coelom between their body wall and digestive cavity. Pseudocoelomates have body cavities that are partially lined with tissues from the mesoderm.



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.

Quick Facts

ADVANTAGES OF A COELOM

A coelom is a fluid-filled cavity between the digestive cavity and the outer body wall, resulting in a tube-within-a-tube body construction. The coelom has a number of functions. It serves as a buffer between the outer wall and the inner organs, cushioning them against harm. It allows for the growth of internal organs without distorting the body's outer wall. For invertebrates that have an open circulatory system, the coelom is the place where circulation occurs. The fluid in the cavity further serves as a hydrostatic skeleton for animals such as roundworms. Scientists in various disciplines have competing theories about when and how often the coelom evolved.

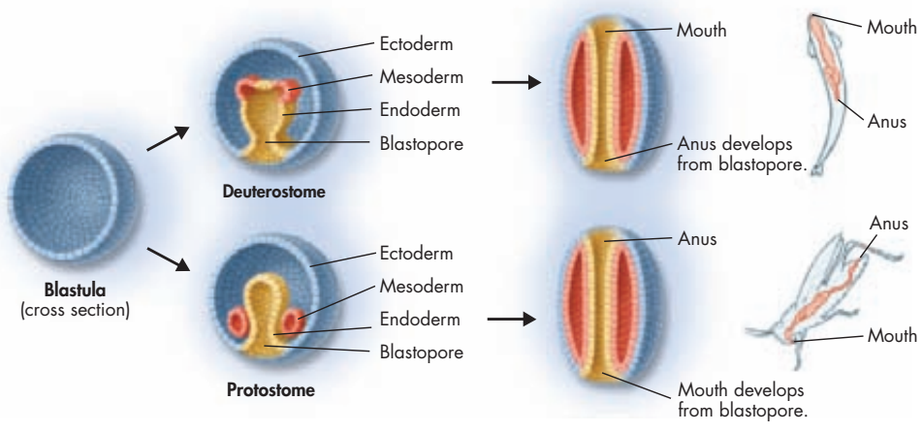


FIGURE 25–9 Blastula and Blastopore Formation During the early development of an animal embryo, a hollow ball of cells called a blastula forms. An opening called a blastopore forms in this ball. In deuterostomes, such as fishes, the blastopore forms an anus. In protostomes, such as grasshoppers, the 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. If an organism has segmentation, simple mutations can cause changes in the number of body segments. Different segments can also become specialized, such as having a head or specialized limbs.

BIOLOGY.com Search Lesson 25.2 GO • Art Review • Art in Motion

How Science Works

FOLLOWING THE PATH OF STAINED CELLS

Early in animal development, the cells in a blastula are rearranged and become an embryo called the gastrula, usually with three tissue layers. The cells move from the surface of a blastula to interior locations in a process called gastrulation. How do biologists know what happens during this process? In the 1920s, German embryologist, W. Vogt, carried out classic studies of frog blastulas that revealed where cells ended up in developed frogs. His method involved staining blastula cells with different colors of non-toxic dyes. After allowing the process to proceed for different amounts of time, he would dissect the stained embryos to see where the stained cells had moved. Through this method, he charted "fate maps" for the various cells in the blastula and, thus, mapped out gastrulation. Today, similar studies are done using fluorescent substances to mark cells.

Use Visuals

Have students examine **Figure 25–9** to help them understand what a blastopore is and how it becomes either an organism's mouth or anus. Reinforce that all animal embryos form a blastula.

Ask If you were given an animal and told that the anus had arisen from the blastopore, what might you infer about the classification of the organism? *(It would be a chordate or an echinoderm.)*

Ask Are humans protostomes or deuterostomes? *(deuterostomes)*

DIFFERENTIATED INSTRUCTION

ELL **English Language Learners** Write the terms *protostome* and *deuterostome* on the board. Ask students to tell you what the two terms have in common. *(The suffix -stome)* Explain that *-stome* means "a mouth" or "mouthlike opening." Have students locate the definitions of the terms in the text, and discuss why the meaning of the suffix makes sense with the definition of the term.

BIOLOGY.com Students can review differences in early development of protostomes and deuterostomes with **Art in Motion: Protostome and Deuterostome Early Development.**

Teach continued

Lead a Discussion

After students have read about cephalization, discuss sense organs in different animals. First, ask students to identify the senses. *(hearing, odor detection, vision, taste, touch)* List the senses across the board, and then ask students to identify the sense organ associated with each sense. *(ears, nose, eyes, tongue/taste buds, skin)*

Ask Where are the sense organs (other than skin) found in most animals? *(in the anterior end, or head)*

DIFFERENTIATED INSTRUCTION

L1 **Special Needs** Arrange students into small groups. Provide animal photographs from old magazines that show the head ends of animals. Assign a sense organ to each group, and challenge students to put together a collage of photographs that illustrates that sense organ in at least five different kinds of animals. Have students present their collages to the class.

Answers

IN YOUR NOTEBOOK Sample answer: Sense organs tend to be located in the head region, so when animals move "head-first," they can sense their surroundings as they move forward.

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? MATH

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.

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

Analyzing Data

PURPOSE Students will analyze and interpret data about the length of time it takes different species of animals to reach certain stages in early development.

PLANNING Review the use of rows and columns in tables. Have students look at the table and ask questions about anything they do not understand. For instance, point out that the times given do not add up to the total time from fertilization to birth or hatching because the times given are for the early stages of development only.

ANSWERS

1. most time: rhesus monkey; least time: chicken

2. It takes the rhesus monkey zygote 32.75 hours more to reach the 4-cell stage than it takes the chicken zygote. (36 – 3.25 = 32.75 hours)

3. blastula

VISUAL SUMMARY

BODY PLANS

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

	Sponges	Cnidarians	Arthropods	Roundworms	Flatworms
Ectoderm, Mesoderm, Endoderm					
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

	Annelids	Mollusks	Echinoderms	Chordates
Ectoderm, Mesoderm, Endoderm				
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

UbD Check for Understanding

ORAL QUESTIONING

Use the following prompts to gauge students' understanding of lesson concepts.

- What type of symmetry do snails exhibit? *(bilateral symmetry)*
- What germ layer do muscles develop from? *(mesoderm)*
- In protostomes, the blastopore becomes what structure? *(mouth)*

ADJUST INSTRUCTION

If students have difficulty answering the questions, have them outline the information under **Features of Body Plans.** Then, have pairs use their outlines and **Figure 25–10** to quiz each other on animal body plans.

VISUAL SUMMARY

Ask the following questions about trends in animal body plans as shown in **Figure 25–10.** Note that the different shades of green only serve to help students quickly identify differences across groups for any trait.

Ask What two general statements could you make about the levels of organization in animal groups? *(Sample answer: All have specialized cells; most have tissues and organs.)*

Ask What type of body cavity do most groups have? *(true coelom)*

Ask What is the most common means of embryological development? *(Most groups are protostomes.)*

Ask In what ways are echinoderms unusual? *(Sample answer: As adults, they break the trends in body symmetry, segmentation, and cephalization; they are also the only invertebrates that are deuterostomes.)*

Call attention to the germ layer color key showing ectoderm, mesoderm, and endoderm.

DIFFERENTIATED INSTRUCTION

L1 **Struggling Students** Some students might become overwhelmed by the amount of information in the table. Reinforce the main idea of the table, that is, that the body plans of modern animals suggest evolution from a common ancestor. Then, take the time to point out a few body plan characteristics that clearly show this concept. For example, walk students through the **Body Cavity** row and point out how it suggests the evolution of a true coelom.

Teach continued

Use Visuals

Use the cladogram in **Figure 25–11** to review the concepts covered in the chapter.

Ask Upon what three things is the evolutionary history presented in a cladogram based? *(characteristics of living species, fossil evidence, and comparative genomic studies)*

Ask What characteristic do all of the animal groups have in common? *(multicellularity)*

Explain that all groups to the right of echinoderms (represented by a sea star) are members of the same phyla—chordata. Then, have students work in small groups to write two questions based on the cladogram. Use these questions as a basis for a class discussion.

DIFFERENTIATED INSTRUCTION

LPR **Less Proficient Readers** Write this question on the board: How are animal phyla defined? Then, have students work in pairs to read the text under **The Cladogram of Animals,** find the answer, and write an answer to the question in their own words. *(Sample answer: Animal phyla are usually defined by what their adult bodies look like. They are also defined by how they develop as embryos.)*

MYSTERY CLUE To help students arrive at the answer, have them use the cladogram to determine that the organisms likely belong to the group positioned to the right of the echinoderms. Explain that these organisms are called tunicates. To learn more, suggest they look up nonvertebrate chordates in **The Diversity of Life** guide on pages 46–47.

BIOLOGY.com Students learn what types of data are analyzed to classify *Trichoplax* in **Data Analysis: The Simplest Animal?**

Answers

FIGURE 25–11

acoelom: along the base before the cnidarian branch and along the flatworm branch

pseudocoelom: on the roundworm branch

coelom: on the base after the cnidarian branch

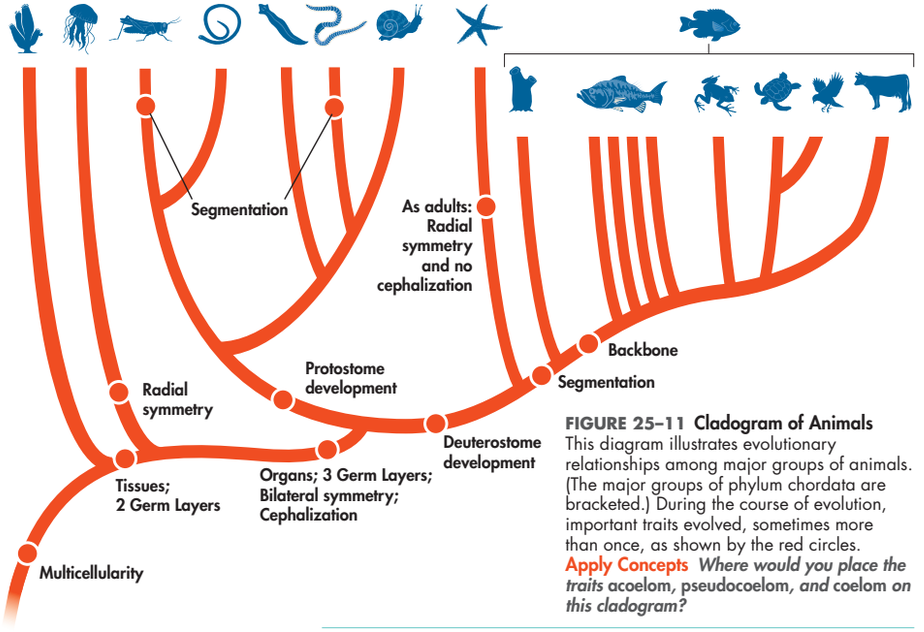


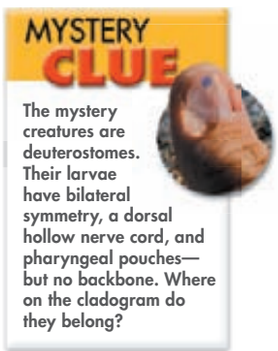
FIGURE 25–11 Cladogram of Animals This diagram illustrates evolutionary relationships among major groups of animals. (The major groups of phylum chordata are bracketed.) During the course of evolution, important traits evolved, sometimes more than once, as shown by the red circles. Apply Concepts *Where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

The Cladogram of Animals

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 the evolutionary history presented in a cladogram represents a set of evolutionary hypotheses based on characteristics of living species, 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 phylum Arthropoda is defined by a body plan that 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 system found in living animals functions well enough to enable those animals to survive and reproduce. For example, most chordate brains are more complex than the brains of flatworms. But flatworm brains obviously work well enough to enable flatworms, as a group, to survive.



UbD Check for Understanding

FOLLOW-UP PROBES

Ask Do you agree or disagree that the cladogram of animals can change? Explain your answer. *(The cladogram of animals could change if research were to reveal new information about the evolutionary relationships between groups of animals.)*

ADJUST INSTRUCTION

If students struggle to answer the question, have them reread the first paragraph under **The Cladogram of Animals.** Point out that a cladogram represents "our current understanding of relationships among animal phyla." Using the information in the first paragraph, begin a class discussion about why the current cladogram is likely to change.

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.

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.

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

25.2 Assessment

Review Key Concepts

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.

BIOLOGY.com Search Lesson 25.2 GO • Self-Test • Lesson Assessment

Lead a Discussion

Have students brainstorm variations on basic phylum body plans, such as the limbs of land chordates (tetrapods). Ask students to explain the meaning of the term *evolutionary experiment.* (Try to elicit responses that reflect the randomness in which body plans arise.) Then, ask students to explain how a phylum's body plan would become a successful "experiment." *(Answers should include mention of adaptation to a changing environment that enables members with that body plan to survive and reproduce.)*

DIFFERENTIATED INSTRUCTION

LPR **Less Proficient Readers** Ask students why some phyla still exist while others have become extinct. If they cannot answer the question, have them reread each sentence, one-by-one, in the section, **Evolutionary Experiments,** to find the answer.

Assess and Remediate

EVALUATE UNDERSTANDING

Have students write a paragraph explaining what a cladogram shows about animal body plan features. Then, have them complete the 25.2 Assessment.

REMEDIATION SUGGESTION

L1 **Struggling Students** If students have trouble answering **Question 2b,** have them work in small groups to brainstorm a reasonable example that would show how a particular body plan characteristic might lead a phylum to extinction.

BIOLOGY.com Students can check their understanding of lesson concepts with the **Self-Test** assessment. They can then take an online version of the **Lesson Assessment.**

Assessment Answers

1a. level of organization, body symmetry, differentiation of germ layers, formation of a body cavity, patterns of embryological development, segmentation, cephalization, limb formation

1b. Both are deuterostomes, which indicates that echinoderms are closely related to chordates.

2a. adult body plans and patterns of embryological development

2b. The phylum becomes extinct.

WRITE ABOUT SCIENCE

3. Sample answer: A phylum's body plan is an evolutionary "experiment," because it is a set of body structures that may be either successful or unsuccessful. A successful body plan performs the functions essential for keeping the group alive, so members survive and reproduce over time. An unsuccessful body plan is not well adapted to changing conditions, so its members go extinct.

CHAPTER LAB

Pre-Lab

Introduce students to the concepts they will explore in the chapter lab by assigning the Pre-Lab questions.

Lab

Tell students they will perform the chapter lab *Comparing Invertebrate Body Plans* described in **Lab Manual A.**

L1 **Struggling Students** A simpler version of the chapter lab is provided in **Lab Manual B.**

SAFETY

Caution students to keep water away from electrical equipment. Check for tangled cords, and disconnect microscopes when not in use. Tell students to be careful with sharp edges on microscope slides and to report any broken glass to you.

BIOLOGY.com Look online for **Editable Lab Worksheets.**

For corresponding pre-lab in the **Foundation Edition**, see page 617.

NATIONAL SCIENCE EDUCATION STANDARDS

UCP I, V

CONTENT C.1.f, C.5.d

Skills Lab GUIDED INQUIRY

Pre-Lab: Comparing Invertebrate Body Plans

Problem What characteristics can be used to classify invertebrates?

Materials compound microscope; prepared slides of cnidarian, roundworm, and earthworm cross sections; red, blue, and yellow colored pencils

Lab Manual Chapter 25 Lab

Skills Focus Observe, Classify, Compare and Contrast

Connect to the Big idea All members of Kingdom Animalia share a set of characteristics that define them as animals. However, the diversity within the kingdom is vast. For example, some animals have a backbone, but many do not. Some animals have radial symmetry, but many do not. In this lab, you will use preserved cross sections to compare the body plans of three invertebrates. You will pay particular attention to germ layers and body cavities.

BIOLOGY.com Search Chapter 25 GO

Visit Chapter 25 online to test yourself on chapter content and to find activities to help you learn.

Untamed Science Video Learn how scientists determine that an organism is an animal as the Untamed Science crew visits a research facility on Coconut Island.

Art in Motion View an animation that shows the differences in early development in protostomes and deuterostomes.

Art Review Review your understanding of body symmetry with this drag-and-drop activity.

Data Analysis Compare *Trichoplax* to other animals to get an appreciation of the difficulty of classifying animals.

Background Questions

a. Review Describe three characteristics that all animals share.

b. Review What are the three germ layers, and what structures do they give rise to?

c. Explain What is the function of a body cavity?

Pre-Lab Questions

Preview the procedure in the lab manual.

1. Compare and Contrast Which two features of animal body plans will you be comparing in this lab?

2. Apply Concepts Where will you look for tissue that formed from the ectoderm layer?

3. Infer Is a hydra smaller than, larger than, or about the same size as an earthworm? Base your answer on the procedure in this lab.

Pre-Lab Answers

BACKGROUND QUESTIONS

a. Sample answer: Animals are multicellular, obtain nutrients and energy by eating other organisms, and have eukaryotic cells.

b. The endoderm gives rise to linings of the digestive tract and the respiratory system. The mesoderm gives rise to muscles plus much of the circulatory, reproductive, and excretory systems. The ectoderm gives rise to the sense organs, nerves, and outer layer of skin.

c. A body cavity provides a space in which organs can be suspended and room for those organs to grow.

PRE-LAB QUESTIONS

1. type of body cavity and number of germ layers

2. the outermost layer of each organism

3. Sample answer: I think a hydra is smaller than an earthworm because I will be able to view the earthworm under low power, but I will need to use high power to view the hydra.