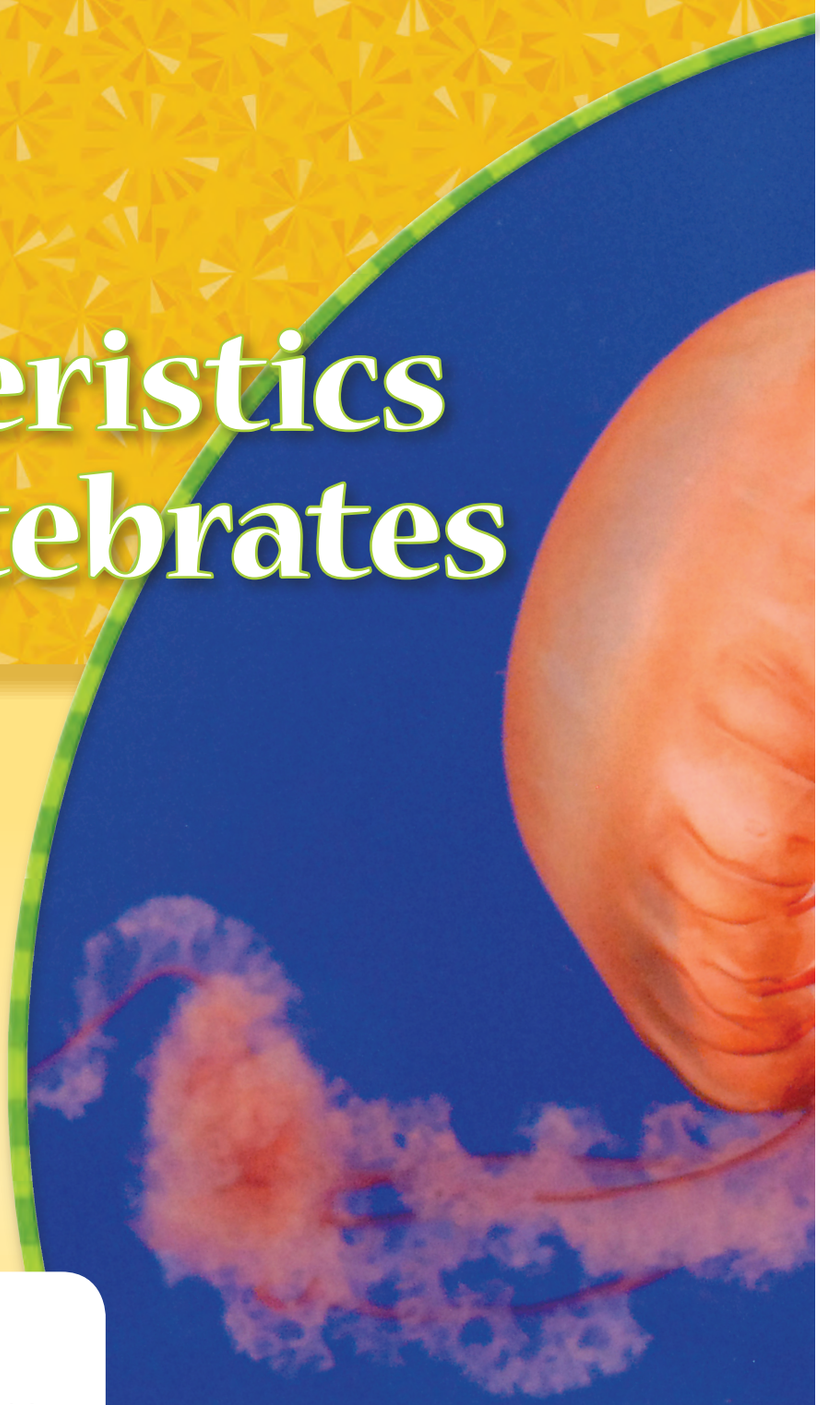
Chapter 2

Characteristics of Invertebrates

Scripture Spotlight

As you learn about invertebrates, look for evidence of God's Creativity and Design. You will read the following passages in this chapter.

John 7:24 (p. 58)
Proverbs 6:6–9 (p. 74)
Joshua 24:12 (p. 87)
1 Corinthians 2:9 (p. 89)
Deuteronomy 7:17–21 (p. 87)
Proverbs 13:14 (p. 85)
Proverbs 6:6–9 (p. 74)



Sea jellies are invertebrates. They have no bones in their bodies.

The Big Idea

God made the majority of animal species without backbones. These invertebrates are found in diverse environments and exhibit fascinating variety.

How could not having bones in its body benefit a sea jelly?

Inquiry Kick-Off Engage

Why do invertebrates move differently than vertebrates? What structures do invertebrates have that enable them to move? Use your *Science Journal* to compare the movements of vertebrates with invertebrates.

Science Journal

Lesson 1

Essential Question

How Are Invertebrates Classified?

Objectives

- Describe the difference between vertebrates and invertebrates.
- Describe the types of skeletal structures present in invertebrates.
- Explain how animals are classified by body symmetry.
- Describe common invertebrate phyla.

Vocabulary

symmetry
bilateral symmetry
radial symmetry
asymmetry

Look at the earthworm in the picture. How would you describe it? How does it move? How do you think it breathes? Earthworms inhabit every continent except for Antarctica. The world's largest earthworm, at nearly two meters long, is the giant Gippsland earthworm of Australia. Earthworms are soil-eating machines. They are nature's cultivators and recyclers. As these worms move through the soil, they mix and aerate it. Their burrows allow water to reach deep underground, and the digested soil that they produce provides important nutrients for plants. How is the earthworm similar to you? How is it similar to a clam or a mosquito?

Earthworms are familiar invertebrates.

Which body parts can you identify on this earthworm?

Classifying Animals Explain

God created thousands of kinds of animals, giving us a great deal of diversity to enjoy. Each one fills a special niche in nature. The fact that there are so many animals can make them difficult to study. Recall that scientists devised a universal method of classifying animals to make studying them easier. Scientists agree that all animals

- are eukaryotes (cells have a nucleus and organelles);
- are multicellular, and most have bodies with differentiated tissues;
- have cells that lack rigid cell walls;
- respond to stimuli;
- are heterotrophs.

In addition, most animals are capable of movement and undergo sexual reproduction (some, such as sponges, are capable of asexual reproduction). Hydra and some sea anemones reproduce by asexual budding. You may recall that scientists sort animals into groups, with each grouping composed of similar animals. Animals belong to the Animal domain. The domain is further organized into kingdoms, phyla (singular: phylum), classes, orders, families, genera (singular: genus), and species. Think of several animals you are familiar with. Do you know the phylum each belongs to? How about the class, order, or family of the animal?

When classifying animals, one of the characteristics that scientists use is the presence or absence of a backbone made of vertebrae. Vertebrates are those animals that have vertebrae; invertebrates are those animals that lack vertebrae. What physical similarities would you expect to see between these two groups of animals? What differences would you expect to see between the groups?

Animal Classification	
Domain	• Highest level of classification • Three domains: Archaea, Bacteria, Eukarya
Kingdom	• A group that makes up a domain • Six kingdoms: Archaebacteria, Eubacteria, Protists, Fungi, Plants, and Animals
Phylum	• A group that makes up a kingdom • Plural form of *phylum* is *phyla.* • This level is called *division* in Plants and Fungi.
Class	• A group that makes up a phylum
Order	• A group that makes up a class
Family	• A group that makes up an order
Genus	• A group that makes up a family • Plural form of *genus* is *genera.*
Species	• A group that makes up a genus • Species are able to reproduce and have offspring who can reproduce.

Structured Inquiry

Discover

Record your work for this inquiry. Your teacher may also assign the related Guided Inquiry.

Science Journal

Dissect an Earthworm

What are the structures of an earthworm?

Materials

- 5 paper towels
- Petri dish
- water
- balance
- dissecting kit and pan
- living earthworm
- preserved earthworm
- magnifying lens
- metric ruler

Procedure

1. Tear a paper towel in half and wet one half thoroughly. Fold the wet towel so that it will fit in the bottom half of the Petri dish. Place the living worm on the wet towel and place the cover on the Petri dish.
2. Place the preserved worm on a paper towel and cover it with another paper towel to keep it from drying.
3. **Observe** the living worm inside the Petri dish. **Identify** the external structures identified in the earthworm dissection diagram in your ***Science Journal***.
4. Take the worm out of the Petri dish. **Measure** and **record** its mass and length. Then make a labeled drawing of your living earthworm.
5. Repeat Step 4 with your preserved earthworm.
6. Carefully place the preserved worm in the dissecting pan dorsal side up. Place a pin in the worm at the anterior and posterior ends. Locate the clitellum and insert the tip of a scissors about 3 cm posterior. Carefully cut all the way up to the top of the head. Be sure to cut only through the skin.
7. Gently spread apart the skin. Use pins to hold the skin to the pan. Identify all structures and make a labeled drawing of the earthworm.
8. Locate the digestive system, beginning with the mouth and including the pharynx, esophagus, crop, gizzard, intestines, and anus.
9. Look for the worm's tiny, whitish brain near its far anterior end. Remove the intestines and find the ventral nerve cord.
10. Examine the other structures you see within the worm. Determine what other parts you can identify. Discuss the functions of each body part.

Analyze Results

Determine the mass and length of the living and preserved worms. **Identify** the number of segments in each. **Compare** the data you found.

Create Explanations

1. What are the structures of an earthworm?
2. Based on your observations, explain how an earthworm moves.
3. Determine the phylum of the earthworm.

Vertebrates Versus Invertebrates

Many of the larger animals you are familiar with are vertebrates. The backbone inside their body protects the spinal cord and supports the animal's body. However, most animals are invertebrates. Some invertebrates lack any kind of hard skeleton and are quite soft, or jellylike. Squid have a flexible structure that supports their body, while earthworms and sea jellies use body fluids under pressure for support. Other invertebrates, such as sea stars and insects, do have a rigid skeleton that gives them shape, protects them, and allows them to move.

Most invertebrates have one of four main types of these skeletal structures:

- Skeleton made of calcium, silica, and organic fibers (for example, many sponges)
- Skeleton of interlocked calcium-carbonate plates and spines (for example, sea stars and sea urchins)
- Skeleton made of chitin (for example, arthropods)
- Skeleton made of a calcium-carbonate shell (for example, many mollusks)

There are many more types of invertebrate animals than there are vertebrate animals. In fact, invertebrates make up about 97 percent of all animal species. Scientists group invertebrates into eight major phyla, including sponges, cnidarians, worms, mollusks, echinoderms, and arthropods. Many invertebrate phyla may be divided into more than one class. You will learn more about these animals later in this lesson and in Lesson 2. What evidence of God's Design can you see in the body forms of animals?

Red rose sea anemone

Why might someone incorrectly think this anemone is a plant?

Classifying Animals by Symmetry Explain

In addition to classifying animals by whether they have a backbone, scientists classify animals by studying symmetry. **Symmetry** describes the balanced distribution of an animal's parts around an axis. Animals can have bilateral symmetry, radial symmetry, or no symmetry, known as asymmetry.

Bilateral Symmetry

Most animals have **bilateral symmetry**, which means their body parts are arranged in the same way on their left and right sides. You have bilateral symmetry, with one arm and one leg on each side of your body. Bilateral animals have a front, a back, and two sides. Many animals with bilateral symmetry have a head with centralized nerve tissue, or a brain. Vertebrates have bilateral symmetry. The backbone typically divides the vertebrate's body into two halves that are mirror images of each other.

Imagine a pet dog. Where could you draw a line on the dog to get two equal halves? How does bilateral symmetry help this dog survive in its environment? To what other animals did God give this design?

This peacock butterfly has a hard, outer shell covering its body and is an example of an invertebrate with bilateral symmetry.

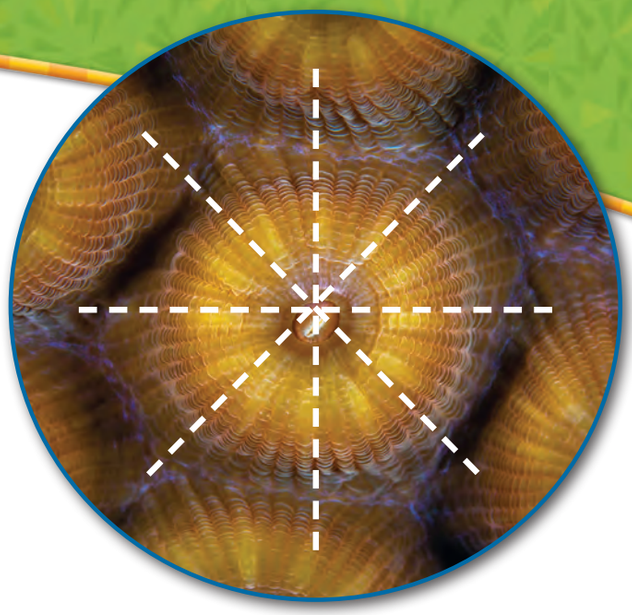
Where is the butterfly's line of symmetry?

Scripture Spotlight

What adjectives might you use to describe different invertebrates? While some may look graceful and beautiful, others may appear plain, slimy, prickly, or even menacing. What does **John 7:24** say about appearances, and how might that relate to the people around you?

Radial Symmetry

The body parts of some animals are arranged in a circle around a center point, like a bicycle wheel with spokes. This arrangement is called **radial symmetry**. For example, a sea jelly has a circular shape. It is the same all the way around, with no front or back or sides. The radial design God gave these animals allows them to reach out in all directions to obtain food. They can also easily sense danger in all directions. Can you think of other creatures that have radial symmetry?



These coral polyps have radial symmetry.

If you had radial symmetry, how would life in your classroom be different?

Asymmetry

Some animals, including most sponges, lack any symmetry and have **asymmetry**. Their bodies are shaped irregularly, and they cannot be split into equal parts. How many organisms can you think of that have asymmetry?

Asymmetry is a sign that the animal's body parts aren't very specialized. The more specialized the body parts of an organism are, the more symmetrical it generally is. Sponges, for example, do not have specialized tasks for various parts of the body. Each part must absorb food on its own. Sea stars with their radial symmetry have some specialized parts to absorb nutrients and excrete waste within each segment. How many specialized parts does your bilaterally symmetrical body have? Would your body function as well if it had radial symmetry? Explain.

Faith Connection

Notice the order and beauty of bilateral and radial symmetry and the simplicity of asymmetry. Can you think of any spiritual applications of symmetry to a Christian's personality, character, or relationship with Jesus?

Explore-a-Lab

Structured Inquiry

How can you identify the lines of symmetry in invertebrates?

Working with a partner, take turns searching the Internet or other sources for 10 images of invertebrates. Print the images. Swap your set of images with your partner's. Use a ruler to define the lines of symmetry in each image. Label each image with the type of symmetry you observed. Then compile the images and review your results. Do you concur with each other's classification?

Invertebrate Phyla Explain

Invertebrates	
Phylum Description	**Examples**
Porifera (Sponges) Sponges have a central cavity and live underwater. They may seem like plants, because they are attached to the sea bottom. Sponges have no true body cavity and no specialized organs. Sponges are assymmetrical. Animals that you are more familiar with, such as insects and birds, have some type of body cavity in which we find organs for specialized body functions.	Sea sponges are often harvested for people to use for bathing. Freshwater sponges live in lakes and slow-moving water.
Cnidaria (Cnidarians) Cnidarians are made of a jellylike substance with connecting tissues but have no specialized organs. Tentacles surround the opening to the central cavity. Cnidarians have radial symmetry.	Examples of cnidarians include sea jellies, often mistakenly called jellyfish. Corals and sea anemones are also cnidarians.
Platyhelminthes (Flatworms) Platyhelminthes have flattened bodies with no body cavity, lack body segments, have distinct heads and tails, and may be free living or live as parasites. Platyhelminthes have bilateral symmetry.	The tapeworm is a common flatworm that is a parasite in many animals, including humans. Planaria and trematodes are other platyhelminthes. One type of trematode causes schistosomiasis, the second-most devastating parasite caused disease affecting humans.
Nematoda (Roundworms) Nematodes have cylindrical bodies, lack body segments, are often microscopic, and may be free living or live as parasites. Some parasitic nematodes cause disease in humans. Roundworms have bilateral symmetry.	One parasitic nematode is the trichina worm, which enters the human body through undercooked meat (usually pork). It causes the disease trichinosis. Hookworm is another parasitic nematode.
Annelida (Segmented Worms) Annelids have cylindrical bodies divided into many segments, well-developed organ systems, and may be free living or live as parasites. The body segments of annelids contain specialized organs for body functions, such as blood circulation, blood purification, and breathing. Segmented worms have bilateral symmetry.	The common earthworm is an annelid as are leeches.

Invertebrates (cont.)	
Phylum Description	**Examples**
Mollusca (Mollusks) Mollusks have a soft body covered in a cloak-like mantle. They often use shells to protect themselves. They have three main body parts: the brain, the visceral mass containing the internal organs, and the foot. Mollusks have bilateral symmetry.	Oysters, snails, and squid are all members of the Mollusca phylum.
Echinodermata (Echinoderms) Adult echinoderms have rays or arms, often in multiples of five. The large majority of echinoderms live in marine environments. They use tube feet for movement and food collection. Adult echinoderms have radial symmetry.	Sea urchins and sea stars, sometimes erroneously called starfish, are echinoderms. Sea cucumbers are also echinoderms.
Arthropoda (Arthropods) Members of this category have exoskeletons and may have segmented bodies and multiple jointed legs. As arthropods grow, they must shed, or molt, their exoskeleton to produce a larger one. Arthropods have bilateral symmetry.	Arthropods include insects, spiders, centipedes, and crustaceans.

In your ***Science Journal,*** investigate how scientists classify vertebrates and invertebrates.
Extend

Concept Check Assess/Reflect

Summary: How are invertebrates classified? An invertebrate is an animal without a backbone. A vertebrate is an animal with a backbone. Most vertebrates have bilateral symmetry. Invertebrates can have bilateral or radial symmetry, or they can be asymmetrical. Bilateral symmetry means that the animal is arranged in the same way on both sides. Radial symmetry means the body parts are arranged in a circle around a central point. Asymmetry means that the body shape is irregular and cannot be divided equally. Invertebrates are classified into several phyla, including Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Mollusca, Echinodermata, and Arthropoda.

1. What are two characteristics that animals classified as vertebrates might share? What are two characteristics that invertebrates might share?
2. Would an animal with radial symmetry be able to move better on land or in water? Explain your answer.
3. If an animal is asymmetrical, what can you tell about its body parts?
4. How do bilateral symmetry, radial symmetry, and asymmetry affect the feeding habits of an animal?