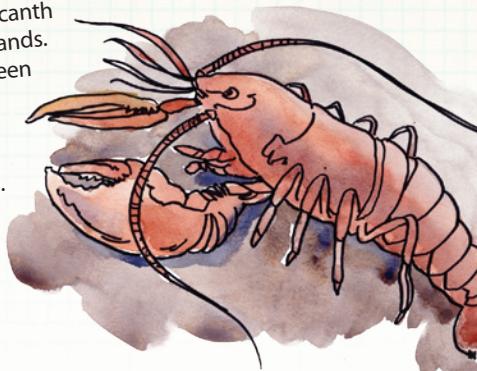


5



Animal Classification

Fossil after fossil of a large, bony fish with unusual fins had been found. Because no one had ever seen this fish alive, many scientists thought that it was extinct. But in 1938, much to everyone's surprise, a living coelacanth (SEE luuh KANTH) was caught near the Comoros Islands. Since then, many of these dark-blue fish have been caught and studied. Coelacanths are not the only animals that have surprised scientists. In the 1990s scientists noticed many robust redhorse fish living in the Oconee River in Georgia. They had thought that these fish had been extinct for more than one hundred years. Oceans and rivers are a vast area yet to be thoroughly explored by man. Throughout the world, in the water as well as on the land, God continues to care for all of His creation.



101



Chapter preview

Other preview and prereading activities may include using a K-W-L chart, a probe, or an anticipation guide.

Chapter photo

The photo at the top of the page shows a stork walking with a rhinoceros.

Student Text diagrams

Diagrams from the Student Text are included on the Teacher's Toolkit CD.

SCIENCE BACKGROUND

Coelacanth

These brown- or blue-colored fish can grow to 1.5 meters in length. They are found in the western Indian Ocean.

Comoros Islands

This group of islands lies in the Indian Ocean between the coast of Mozambique, Africa, and the large island of Madagascar.

Robust redhorse fish

Urbanization and the introduction of a catfish from Mexico had an effect on the decline of this fish. It had not been sighted for about one hundred years but was rediscovered in 1991. The robust redhorse can live up to twenty-five years and can grow to be 20 pounds.

Objectives

- Recognize invertebrates and vertebrates as a broad way to distinguish animals
- Recognize that unique animal characteristics allow classification
- Describe the unique characteristics of the phyla that include sponges, jellyfish, and mollusks

Materials

- pictures of a jellyfish, snail, octopus, and sea star
- *Animal Classification* (IA), for display (optional)

Vocabulary

invertebrate
vertebrate
nematocyst
mollusk

Introduction

Display pictures of the animals.

What similarities do you see or know about these animals? Answers will vary.

Do you think scientists classify these animals together? Answers will vary.

What are some ways you would classify these animals? Answers will vary.

Purpose for reading

Why do scientists classify animals?

What is a distinctive feature of a mollusk?

Discussion

About how many species of organisms live on Earth? about nine million

What are the seven levels of scientific classification used to group living organisms? kingdom, phylum, class, order, family, genus, species

In the kingdom Animalia, what distinguishing characteristic do scientists use to classify animals? whether or not each animal has a backbone

What are animals without backbones called? invertebrates

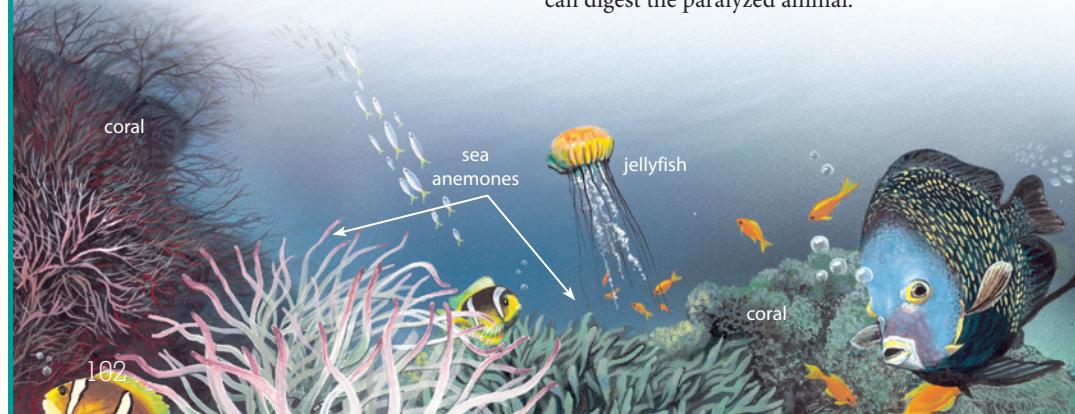
What are animals with backbones called? vertebrates

There are perhaps as many as nine million species of living organisms on Earth. Scientists are continually finding new living organisms to name and classify. Though animals make up only a small percentage of living organisms, the kingdom Animalia still consists of millions of species. Because there are so many animals, scientists further group them by their distinctive characteristics. One of the most obvious distinguishing characteristics of animals is whether or not they have backbones. With only a few exceptions, scientists can divide animals into **invertebrates**, animals without backbones, and **vertebrates**, animals with backbones.

Sponges and Stinging Animals

Sponges belong to the phylum of animals called *Porifera* (puh RIF uh ruh). Animals in this group catch their food in an unusual way. They sit on the ocean floor and pump water through their bodies. The water goes through tiny pores, or holes, in the outside of the sponge. When the water flows through the sponge, the sponge extracts nutrients and small organisms that it needs. Then the water is pushed out through the top of the sponge.

Like sponges, jellyfish are also classified by how they get their food. A jellyfish is neither jelly nor a fish. It is an aquatic animal that has a top that looks like a blob of petroleum jelly. But underneath that top are tentacles lined with tiny stinging organelles called **nematocysts** (nih MAT uh sistz). Jellyfish and other animals in the phylum *Cnidaria* (nye DAIR ee uh) use nematocysts to capture their food. These stinging organelles can paralyze any small, unsuspecting animal that brushes against them. Then the jellyfish can digest the paralyzed animal.

**SCIENCE BACKGROUND****Coral reefs**

Scientists study coral to help the reefs continue to exist. One way scientists study coral is by slicing open dead coral to study the rings inside. The rings inside a coral are much like the rings inside a tree. Not only can the age of the coral be determined by counting the rings, but the size of each ring shows the general environmental conditions of each year.

Invertebrate and vertebrate

The term *invertebrate* is not part of the Linnaean classification system. It is a characteristic of all the phyla except Chordata. The term *vertebrate* is part of the Linnaean classification system and is the name of a subphylum of Chordata.

SCIENCE MISCONCEPTIONS

Be sure that students understand that when the Student Text refers to nine million living organisms, it is referring to nine million species, not individuals.

**Animal identifications**

The organisms pictured on Student Text pages 102–3 are from left to right: anemone fish, rainbow runners, sea nettle (jellyfish), crescent tail bigeyes, French angelfish, batfish, barrel sponge, moorish idol, and southern stingray.

Though most jellyfish pose little serious danger to people, the jellyfish's nematocysts can leave painful welts on a swimmer's body. Only a few jellyfish are venomous enough to seriously harm humans.

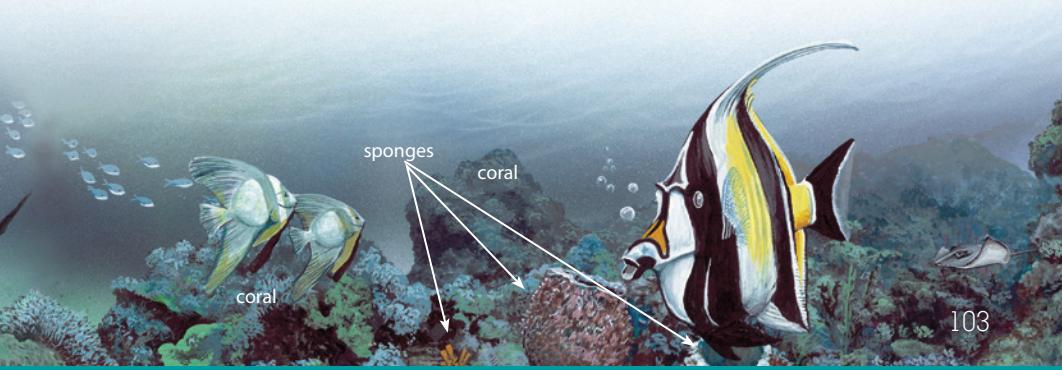
Though they seem very different from jellyfish, sea anemones (uh NEM uh neez) are part of the same phylum. Instead of floating like jellyfish, sea anemones move slowly along the ocean floor. They were once mistaken for plants because of their "petals." These "petals," or tentacles, are equipped with nematocysts that poison any small prey that might come near. The anemone then draws the prey into its mouth.

Corals are also in the same phylum as jellyfish, but each organism is much smaller. They are usually attached to one another in large colonies. They feed by waiting for water to bring prey within range of their tentacles. Usually when people think of coral, they think of coral reefs. Stony corals make limestone skeletons to protect their soft bodies. Coral reefs are a buildup of the dead skeletons of these animals.

The nematocysts of these Cnidarians work extremely quickly. In some cases they work in less than five seconds. Even the fastest of creatures that wander into the waiting tentacles of these animals may become the next meal. Although these animals cannot pursue their prey, God has provided a creative mechanism for them to get food.

FANTASTIC FACTS

The Great Barrier Reef is the largest coral reef system in the world. Made up of around 2,900 smaller reefs, this reef wraps about 2500 km (about 1,550 mi) around the northeastern Australian coast. This reef holds some of the most deadly wildlife in the world. The box jellyfish, the most venomous jellyfish in the world, lives there. The cone snail, which has a poisonous bite, also lives there. The Portuguese man-of-war, similar to a jellyfish, also lives within this massive reef. But deadliness does not mean ugliness. Many of the venomous creatures in the reef are brightly colored as if to say, "Danger! I am poisonous!" God's design for the animals of the Great Barrier Reef benefits both the predator and the prey.



103

Poriferous

This word is an adjective meaning "to have tiny holes or openings." Animals with holes (e.g., sponges) belong to the phylum Porifera.

Nemato and nemat

Both prefixes mean "thread" and have both Latin and Greek roots. A nematocyst resembles a tiny harpoon attached to a thread. Nematodes are types of worms that have bodies shaped in long, threadlike cylinders.

Which word on page 102 begins with the prefix *nemato*? *nematocysts*

Discussion

Display Animal Classification as needed throughout the chapter. You may find it helpful to use at the beginning of a lesson to review phyla discussed previously.

Are there more vertebrates or invertebrates? **invertebrates**

How many phyla are made up of invertebrates? **eight**

Is a sponge a vertebrate or an invertebrate? **an invertebrate**

To what phylum do sponges belong? **Porifera**
Phyla is the plural form of *phylum*.

How does a sponge get food? **Water flows through tiny pores in the sponge. The sponge extracts the nutrients and small organisms that it needs and pushes the water out of its top.**

Which term describes the tiny stinging organelles used by some animals to capture food? **nematocysts**
Animals in the phylum Cnidaria use nematocysts to capture food. Name some of these animals. **Possible answers: jellyfish, sea anemones, coral**

Why were sea anemones often mistaken for plants? **Their tentacles look like petals.**

What are coral reefs made of? **the skeletons of dead stony coral**

Why is it important for animals in the phylum Cnidaria to have fast-acting nematocysts? **Possible answer: Because these animals cannot pursue prey, it is important that prey not escape when it comes within their reach.**

God has provided for His creatures. He tells us that just as He has provided for the animals, He will provide for us. (Matt. 6:26) [Bible Promise: H. God as Father]

Discuss *Fantastic Facts*.

What is the name and location of the world's largest barrier reef? **Great Barrier Reef; off the northeast coast of Australia**

How does God's design benefit both the predator and the prey of the Great Barrier Reef? **Accept any reasonable answer, but elicit that while bright colors attract prey, they can also warn predators that eating one of these organisms would be harmful.**

What are some animals that live in the Great Barrier Reef? **colorful fish, coral, cone snails, man-of-war jellyfish**



Discussion

Describe a mollusk. A mollusk has a soft body and a mantle, a special part of the body that sometimes forms a shell.

Do all mollusks have shells? no

What is a difference between a univalve and a bivalve? Univalves have one shell. Bivalves have two shells connected to each other.

How do most bivalves move? They use a muscular foot that extends out of the shell.

What is another way that some bivalves move? Scallops gather water in their shells and squirt it out like a miniature jet propulsion system.

What does *gastropod* mean? stomach footed

💡 What do you think gastropods have in common? They move on their stomachs.

What is a common gastropod that does not have a shell? a slug

💡 Why do you think slugs leave slimy paths? Answers will vary, but elicit that the slime helps protect the slug's body as it slides across surfaces.

What are nudibranchs? slugs that live in the ocean

How are some nudibranchs similar to sea anemones? Some nudibranchs have nematocysts.

Discuss Science & Math.

What is the chambered nautilus famous for? It is thought to have the most perfectly proportioned shell.

What mathematical pattern is evident in the size of the chambers of a nautilus? the Fibonacci spiral

What are some other organisms in nature that demonstrate this pattern? Possible answers: pine cones, snail shells, sunflowers

Mollusks

Mollusks are animals that have soft bodies and mantles, special parts of the body that sometimes form a shell. Snails, oysters, and clams are mollusks that have shells protecting their soft bodies. Some mollusks with shells are bivalves.



bivalve

Bivalve means that the mollusk has two shells. Clams, scallops, and oysters are bivalves. Many bivalves protect themselves by hiding in the mud or sand. A bivalve usually moves slowly by using a muscular foot that extends out of the shell. Scallops, however, move quickly by gathering water into their shells and then squirting it out like a miniature jet propulsion system. Though most bivalves are small, some are quite large. The giant clam can measure as much as 1.2 m (4 ft) across and weigh 250 kg (550 lb).

Other mollusks are gastropods,

SCIENCE & MATH

The chambered nautilus is thought to have one of the most perfectly proportioned shells. As the animal grows, it builds a shell with increasingly larger chambers. The animal always lives in the largest chamber. The nautilus uses the other chambers to help control its ability to float. The size of the chambers of the shell fit closely to a mathematical pattern called the Fibonacci spiral. This pattern is based on a number sequence, the Fibonacci sequence, where each new number is obtained by adding the two previous numbers. For example, the sequence

might be 1, 1, 2, 3, 5, 8, 13, and so on. It is a pattern that occurs in living organisms such as pinecones, snail shells, sunflowers, and, of course, the chambered nautilus. What a wonderful example of God's order and design!



104

SCIENCE BACKGROUND

Mollusks

The phylum Mollusca is further divided into several classes. The classes mentioned in the Student Text are some of the most well known: Gastropoda (snails, slugs), Bivalvia (clams, scallops, oysters), and Cephalopoda (squid, octopuses). Another class of mollusks is Polyplacophora, often called chitons. These mollusks are marine organisms that cling firmly to rocks.

not have shells to protect their bodies, they feed at night and stay hidden during the day. Slugs called *nudibranchs* (NOO duh BRAHNKS) can also be found in the ocean. Different nudibranchs use camouflage, nematocysts, and poisons to protect themselves. Many nudibranchs are brightly colored. The colors warn predators that these mollusks are not tasty.

Another group of mollusks called *cephalopods* (SEF uh luuh PODZ), meaning “head footed,” are speedy. A cephalopod moves with a jetlike motion by forcing water through a tube in its body. Squids, octopuses, and cuttlefish are all cephalopods. Even though some cephalopods have shells, their shells are not always on the outside of their bodies. A squid has a thin shell under its mantle, but an octopus is protected only by the special skin of its mantle. The nautilus, though, has a large shell around its body. Each cephalopod is a little different from the others. But most cephalopods have large eyes, arms (tentacles) with suckers around their mouths, and beaks.

Cephalopods are usually small and of little or no danger to man. A few have poison that they use to capture food. The most poisonous cephalopod is the blue-ringed octopus. Its poison paralyzes

its prey. Without immediate attention, a person who is poisoned will suffocate.

Many scary stories show the arms of octopuses or squids attacking ships. Though it seems far-fetched, sailors have actually seen giant squids attack ships. Scientists once thought that the largest invertebrate was the giant squid. However, recently they have discovered a squid that is even larger and more dangerous, the colossal squid. Instead of just having suckers, the colossal squid also has hooks on the ends of its tentacles. The discovery of this squid helped explain the cuts and scars that whalers often find on large whales.



QUICK CHECK

- How do scientists divide animals into two main groups? Which group is bigger?
- How do nematocysts help some animals get food?
- How do cephalopods move?



Snails

HISTORY *Heliculture* is the farming of snails. From the time of the Roman Empire until the present, man has considered snails an edible delicacy. This treat is still popular in some European countries, such as France. *Escargot* is the French word for snail and the popular name used to identify any dish that contains snails. Snails, like other mollusks, are safe for human consumption if they are properly prepared and cooked. Cooking kills any parasites that the snails may carry. Eating raw snails is dangerous.

Discussion

What does *cephalopod* mean? **head footed**

What is unique about the shells of some cephalopods? **The shells are not always on the outside of the animals' bodies.**

Give some examples of cephalopods. **Possible answers: octopus, cuttlefish, nautilus, squid**

How does a cephalopod move rapidly? **with a jetlike motion by forcing water through a tube in its body**

Do all cephalopods have shells? **no** What common cephalopod does not have a shell? **an octopus**

💡 Why is an octopus called head footed? **Its tentacles (arms and legs) come directly from its head.**

What is the most poisonous cephalopod? **the blue-ringed octopus**

What mollusk did scientists once think was the largest invertebrate? **the giant squid**

What animal have scientists discovered is even larger than the giant squid? **the colossal squid**

💡 If scientists have found cuts and scars on whales that could be from a colossal squid, do you think the colossal squid usually lives in the upper part of the ocean near the surface or the very deep part? **the deep part**

Answers

- Animals are grouped by whether or not they have backbones. Invertebrates make up the largest group of animals.
- Animals such as jellyfish, sea anemones, and coral use nematocysts to sting and paralyze small prey.
- A cephalopod moves with a jetlike motion by forcing water through a tube in its body.

Activity Manual

Reinforcement, page 72

This page is used for both Lesson 57 and Lesson 60. Completing the graphic organizer should help the student recognize some of the distinguishing characteristics of the invertebrate phyla.

Objectives

- Compare the spicules of a Rossella sponge with optic fibers
- Identify ways that studying a Rossella sponge may improve fiber-optic technology
- Recognize man's duplication of God's creation

Materials

- world map or globe

Vocabulary

spicules

Introduction

Some of man's engineering accomplishments are based on organisms that God created. What do you think birds have shown us? **how to fly** Hummingbirds? **how to hover** Beavers? **how to build a dam**

Even organisms in unlikely places give man new ideas. Today we will learn about a sponge that grows to be about one meter in length. It lives deep below the ocean's surface.

Locate the Ross Sea on a world map or globe. The Ross Sea is located off the coast of Antarctica in the southern Pacific Ocean.

Teach for Understanding**Purpose for reading**

What engineering achievement can be seen in a glass sponge?

What can scientists learn from the Rossella sponge?

Discussion

Why have scientists called the *Rossella racovitzae* and other similar sponges glass sponges? **The skeletons of these sponges are made of silica which is a component of glass.**

How does the sponge use silica found in the seawater? It makes glassy spines.

What are these glassy spines called? **spicules**

A spicule is about as thick as an office staple and grows to be 10 to 20 centimeters long.

**Fiber Optic Sponges**

Hundreds of meters deep in the frigid waters of Antarctica's Ross Sea

lives a sponge whose body can conduct light. The *Rossella racovitzae* belongs to a class of sponges called glass sponges. These sponges have skeletons made mostly of silicon dioxide, or silica, the major component of glass.

God has designed this sponge to take silica from the seawater that flows through its tube-shaped body. The sponge then makes glassy spines that stick out from its body. These thin, glassy spines, called **spicules**, support and protect the sponge, but they also act like optical fibers. Light enters these slender glass strands and travels through them to the base of the spicules. At the base of the spicules live tiny unicellular organisms, such as algae. Scientists think that these organisms use the light for

photosynthesis and thus provide food for the sponge.

In the 1990s scientists began to study the ability of this sponge to gather light. Biologists beamed the light from a red laser down a sponge's spicule. They observed the smooth transmission of the light through the thin fiber. They found that the spicules could gather light from many different angles. This ability is particularly important because of the sponge's dark environment. It allows the sponge to use almost any light in its deep habitat. Direct light is not necessary.

Scientists also found a small cross-shaped cap at the top of each spicule. This four-pointed cross appears to allow the sponge to gather more light. This complex system of guiding light is similar to commercial fiber optics designed by engineers.

Fiber optics use thin, threadlike glass fibers to transmit information by light waves. These fibers can be bundled together to form cables and are used for telecommunication and other purposes. Scientists have realized that the spicules of glass sponges provide natural fiber optics that work better than manmade fibers. Manmade

Isopodin Haliclona Dancoi (a glass sponge)



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SCIENCE BACKGROUND**Venus Flower Basket**

Another glass sponge being researched for its fiber-optic similarities is the *Euplectella*, or the Venus Flower Basket.

Fiber-optic cables

Fiber-optic cables are bundles of optical fibers (long, thin strands of pure glass about the same thickness as a human hair). These cables are used to transmit light signals over long distances. Compared to conventional copper wire, optical fibers are lower priced, nonflammable, thinner (so more can be bundled together), and better suited for carrying signals and digital information.

DIRECT AN ACTIVITY**Contrast spicules with manmade fibers**

Make a T-chart to contrast the formation, flexibility, and working environment of spicules and manmade fibers.

Spicules

- Form naturally at low temperatures
- Are layered, allowing them to still bend and gather light even when cracked
- Able to work in extremely cold environments

Manmade fibers

- Must be formed under high heat and require expensive equipment
- Cracks often cause the entire fiber to break
- Need special chemical treatments in order to work in cold environments



fiber optic cable

fibers must be formed under high heat and require expensive equipment, but the sponges' glass spicules form naturally under low temperatures.

Like other glass sponges, the spicules of the Rossella sponge have a different structure and chemical makeup than manmade fibers have. The spicules are tough but flexible. Bending optical fibers or spicules may cause small cracks. A crack in a manmade fiber often causes the whole fiber to break. However, the spicules of a glass sponge are layered. Its spicules stop cracks after only a few layers are penetrated. The spicules can bend and still gather light. Scientists think that layers might

improve the strength and flexibility of optical fibers.

Scientists are interested in the Rossella sponge's ability to conduct light in the extreme cold of the Ross Sea. Manmade fibers need special chemical treatments to work there. Sponge spicules can collect light from many angles. If engineers could copy this ability, they might be able to lower the cost of fiber optics. This ability would also make fiber optics more useful in places with limited light, such as in outer space. Scientists can once again go back to God's creation to make man's inventions better.

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107

DIRECT A DEMONSTRATION

Demonstrate how an optical cable transmits light

Materials: 3 cardboard tubes, tape, black paper, flashlight, 2 small mirrors

Arrange the materials as illustrated. Shine the light.



Does the light shine onto the black paper? **yes**

Arrange the materials as illustrated. Shine the light.



Discussion

What three functions do the sponge's spicules have? **They support the sponge, protect it, and act like optical fibers.**

What are optical fibers? **thin, threadlike glass fibers that transmit information by light waves**

Fiber optics are used in telecommunications, computer networks, and medical technology. They are also used to inspect pipes and engines.

How do unicellular organisms and sponges both benefit from the light-transmission ability of the sponges? **The unicellular organisms receive the light they need for photosynthesis from the sponge's spicules and then produce food for the sponge.**

The spicules of a glass sponge are able to collect light from many different angles. Why is this ability so important? **This ability enables the sponge to use almost any light available in its dark environment.**

What part of the spicule seems to help the sponge gather more light? **the cross-shaped cap at the end of the spicule**

Discuss the differences between the sponge's spicules and manmade fibers. Make a T-chart that contrasts the two.

How are manmade optical fibers formed? **with high heat and expensive equipment**

Do a sponge's spicules need the same temperatures to form that manmade fibers do? **no**

Why are layers beneficial to spicules? **Even if some of the layers crack, the spicule can still bend and gather light.**

How do scientists think adding layers might benefit manmade fibers? **The layers might improve the strength and flexibility of the fibers.**

What do manmade fibers need if they are able to work in cold conditions like the Rossella sponge? **special chemical treatments**

How would manmade fibers become more beneficial if engineers could imitate the sponge's ability to collect light from many angles? **Fiber optics might become less expensive. They might also be able to be used in places with limited light.**

Activity Manual Technology, page 73

Objectives

- Construct a terrarium
- Observe land snails
- Record observations

Materials

- fishbowl or large glass jar
- small pebbles or sand
- damp soil
- twigs and dried leaves
- one land snail
- wire screen or lid with holes

Introduction

What is a terrarium? a container of plants and sometimes animals that is made to imitate a specific environment

Have you ever seen a terrarium?

Teach for Understanding**Purpose for reading**

The student should read all the pages before beginning the exploration.

Discussion

To which phylum does the land snail belong? **the phylum of mollusks**

Where do land snails like to live? **in cool, dark, shady places**

Why are snails important for the environment?

They help balance the environment by turning decaying matter into materials useful for plants.

What to do

Guide the student in setting up the terrarium and recording his observations in his Activity Manual.

Activity Manual

Exploration, page 74

Assessment**Rubrics**

Select the prepared rubric, or design a rubric to include your chosen criteria.

**Snail Terrarium**

Land snails are soft-bodied univalves—mollusks that have only one shell. They can be found throughout the world in places where there is moisture and vegetation.

Generally, snails live in cool, dark, and shady places. Evening and early morning hours are the best times to find snails under leaves, twigs, and rocks, or in gardens munching on plants.

A large foot underneath the snail makes the snail look like it is dragging its belly while hauling its shell on its back. To make movement easier and less destructive to its soft body, the land snail secretes slime and moves on top of it.

Snails are important for the balance of Earth's ecological system. Millions of snails live in dark, damp forests, shredding decaying leaves and scraping off pieces of fungi for food. Snails help to balance our environment by recycling decaying matter into chemicals that plants can use. Someday scientists may even discover a way to make snail slime useful to man.

What to do

1. Make a terrarium using a fishbowl or a large glass jar. Put one inch of small pebbles or sand on the bottom of the bowl. Add a layer of damp soil and top it with twigs, dried leaves, and a few small stones. Add one land snail. Cover the bowl with a wire screen or the jar with a lid containing nail holes. The snail can climb out of the terrarium if it is left uncovered.
2. Keep plenty of fresh, soft, green leaves or lettuce in the terrarium. Leftover food should be removed regularly. Add fresh water in the lid of a baby food jar each day. The terrarium will need to be cleaned after several days.
3. Follow the directions and record your findings in your Activity Manual.



The *Achatina achatina* snail (giant African land snail) is the largest land snail in the world.

108

**Terrarium tips**

Aquariums and large glass jars make great terrariums.

Since snails reproduce quickly, start with only one land snail in the terrarium.

A slug may be substituted for a snail.



cushion star starfish

Echinoderms

Echinoderms (ih KYE nuh DURMZ) are animals that have radial symmetry.

Radial symmetry means that these animals have body parts that repeat around a central part. Many adult echinoderms have bodies shaped like the spokes of a wheel. Each of the spokes is the same. All echinoderms live in water and move around by using thousands of little *tube feet* located on their undersides. All of these feet have tiny suckers on them that help the animals stick to different surfaces, such as the ground or a rock. Most echinoderms have arms in multiples of five. Sea stars, commonly called starfish, and sea urchins are echinoderms.

Since their mouths are on their undersides, echinoderms have to be on top of prey in order to eat it. Some echinoderms eat whatever comes floating through the water, such as plankton and other tiny life

forms. These echinoderms are called **filter feeders**. Many echinoderms, however, eat mollusks or even other echinoderms.

Unlike mollusks and sponges, most echinoderms have hard skeletons. Perhaps you have found a sand dollar washed up on the seashore. You were looking at the skeleton that was left after the animal had died and the soft body parts had been eaten or rotted away.

Echinoderms cannot move quickly, so they depend on other ways to protect themselves. The spines on their bodies offer one line of defense. They also defend themselves by hiding in cracks or by using camouflage. If a predator grabs the arm of a brittle star, a kind of echinoderm, the arm may break off. While the predator eats the arm, the brittle star escapes. The brittle star slowly grows another arm. Some other types of sea stars can also regrow arms that have been lost.

109

SCIENCE BACKGROUND

Filter feeders

Animals that are filter feeders eat by filtering or straining tiny living organisms out of the water that passes around or through their bodies. Clams, sponges, some fish and sharks, flamingoes, and baleen whales are filter feeders.

Echinoderm characteristics

Animals that are echinoderms have radial symmetry, an endoskeleton (hard, internal support structure), and a water-vascular system, which is a system of fluid-filled tubes that allow the animals to move and breathe and is used to circulate food and waste products.

Sea stars

Sea stars eat oysters, clams, mussels, and barnacles. They open shells by using their sucker-tipped tube feet. The tube feet are located in rows on the underside of each of their arms. Each tube foot is like a tiny finger with a sucker on the end. The sea star attaches itself to a shell, and its tube feet pull the shell open. One tube foot would not be able to open the shell. Prying apart the shell takes the effort of several arms and hundreds of tube feet working together.

Objectives

- Identify characteristics of echinoderms
- Compare characteristics of flatworms, round-worms, and segmented worms
- Compare a free-living worm with a parasite
- Explain why worms can be both helpful and harmful to man

Materials

- several suction cups
- small notepad with plastic cover

Vocabulary

radial symmetry	parasite
filter feeder	free-living
bilateral symmetry	setae

Introduction

Place one suction cup on the notebook. Try to lift the notebook with the suction cup. Keep adding suction cups until it is possible to lift the notebook.

Sea stars (starfish) have tiny cuplike suckers on their undersides. These suckers help the sea stars move.

What other animals have suckers? **cephalopods**

Teach for Understanding

Purpose for reading

What is radial symmetry?

What are three groups of worms?

Discussion

What does *radial symmetry* mean? **Animals with radial symmetry have body parts that repeat around a central part.**

How do echinoderms move? **They use thousands of tube feet located on their undersides.**

Why do echinoderms not slide off the surfaces they move on? **The tube feet have tiny suckers that help them stick to surfaces.**

Which term describes echinoderms that eat life forms that float in the water? **filter feeders**

What is the outside of an echinoderm like? **It has a hard skeleton.**

What are some ways that echinoderms protect themselves? **Possible answers: the spines on their bodies; hiding; camouflage; breaking off an arm and being able to regrow it**



Discussion

Allow the student to complete the rest of Activity Manual page 72 during the discussion.

What is the distinguishing characteristic of a flatworm? It is flat.

What does it mean to have bilateral symmetry? Something that is bilaterally symmetrical can be divided down the middle and be the same on both sides.

What is the difference between a free-living worm and a parasitic worm? Free-living worms are independent of other organisms. Parasitic worms live on or in other living organisms. Parasites get their nourishment from their host.

Why is it important to cook meat thoroughly?

Possible answer: Some parasitic worms can get into humans if meat is not properly cooked to kill the parasite's eggs.

What is an example of a free-living flatworm? planarian

What are the distinguishing characteristics of roundworms? They are smooth and round on the outside.

What conditions may increase the chances of an animal or person getting parasitic roundworms? unclean, unsanitary conditions

Unsanitary conditions occur where trash and animal or human waste are not properly disposed of.

What do free-living roundworms do to the soil to help plants? They help decompose dead organisms, which fertilizes the soil and helps plants get the proper food.

What is an annelid? a segmented worm

What is an earthworm's body made up of? segments

Are the segments of an earthworm similar or different? **similar**

What parts of the earthworm are not segmented? the head and the end area

How does a segmented worm move? Tiny hairlike structures called setae help the worm to grip the ground and move.

Are most annelids free-living or parasitic? free-living

Which annelid is parasitic? the leech

How do leeches get their food? They suck blood from outside the host.

Flatworms

Flatworms are just that—flat. These worms have **bilateral symmetry**, meaning that they can be divided down the middle and be the same on each side. Flatworms are either parasitic or free-living. **Parasites** live on or in other living organisms, called *hosts*. Parasites depend on their hosts for nourishment. Animals, and even humans, can be hosts for parasitic flatworms. Some flatworms can get into humans when humans eat meat that has not been cooked enough to kill all of the parasite's eggs.

Other flatworms are **free-living**, meaning they are independent of other organisms. Free-living worms are very small. They feed on tiny organisms in the places where they live. Planarians are free-living flatworms that live in soil or fresh water. Usually brown or gray, freshwater flatworms blend in with their environments. Some brightly colored flatworms live in salt water.



flatworms—planaria

110

SCIENCE BACKGROUND

Worm phyla

Flatworms make up the phylum Platyhelminthes. Roundworms are in the phylum Nematoda, and segmented worms are the phylum Annelida.

Trichinella spiralis

This flatworm parasite is sometimes carried by pigs and other wild animals and can be transmitted to humans. *Trichinosis* is the name for the human disease. If left untreated, these flatworms can attack the brain, eventually resulting in death.

Flatworms

Flatworms do not die when cut in half. They can grow back the missing parts to form two complete flatworms.

roundworms—*ascaris worms*

Roundworms

Roundworms are smooth and round on the outside. Many of these worms are parasites. Livestock are the most common hosts of roundworms.

However, people can become infected by roundworms when they are around areas where infected animals have been. Some roundworms cause serious diseases in humans. Parasitic roundworms are usually found in places where conditions are unsanitary.

Not all roundworms are parasites. Free-living roundworms usually live in soil, water, dead plants, and dead animals. They help decompose dead organisms, and thus they help to fertilize the soil. Thousands of roundworms may live in the soil in your flower bed, but they are so small that you may not be able to see them.

Segmented Worms

When you think of a worm, you probably think first of a segmented worm, or *annelid*. Annelids, such as earthworms, have soft bodies and are made up of many *segments*, or similar pieces. Only the head and the end area of the worm are not segmented. Each segment has some of the same things inside it. Sometimes a worm can regenerate segments that have been broken off. Many segmented worms

Nicknames

"Intestines of the earth" was an earthworm name used by Aristotle. "Nature's plough" is another frequently used nickname for an earthworm.

Large earthworms

The Giant Gippsland Earthworm of Australia can measure 80 cm long and 2 cm in diameter.

Leech locomotion

Leeches do not have setae like other annelids. They have mouthparts at both ends of their bodies. These mouthparts grip the surface of the earth and move the leech along, similar to the way inchworms and caterpillars move.

move using hairlike structures called **setae** (SEE tee). The worm grips the ground (or whatever it is crawling on) with the setae and pulls itself along.

Most annelids are free-living, but the leech is one exception. Unlike parasitic flatworms and roundworms, the leech does not get inside its host. It sucks blood only from the outside. Some annelids live in the sea and eat plankton and algae in the water. Unlike land worms, sea worms have paddles and bristles along their bodies. Some sea worms have long tentacles on their heads. The tubeworms that live in deep-sea vents are annelids.

Earthworms are probably the most familiar annelids. As they get their food from the soil, earthworms also serve an important purpose in the soil. They burrow around and make holes for air to get into the soil. The air helps plants in the soil to grow. Also, like the roundworms,



segmented worm—earthworm

earthworms break down complex plant matter into nutrients that the plants around it can use. The earthworm is so useful that some people buy them to put in their flower gardens.



QUICK CHECK

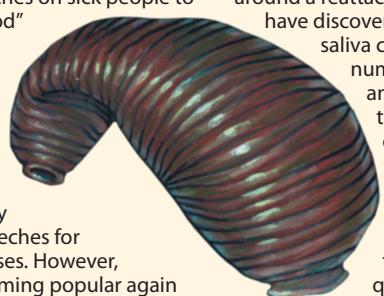
- What kinds of food do echinoderms eat?
- What is the difference between parasites and free-living worms?
- How are worms helpful? How are worms harmful?

SCIENCE & HISTORY

In the nineteenth century, doctors often placed leeches on sick people to get the “bad blood” out of them.

Eventually, people realized that bad blood was not the cause of illnesses.

Doctors gradually stopped using leeches for medicinal purposes. However, leeches are becoming popular again for certain medical treatments. Today



doctors may apply leeches to the area around a reattached body part. They have discovered that the leech’s saliva contains a chemical that numbs the area of sucking and another chemical that keeps blood from clotting. The leech keeps blood flowing through the veins and arteries around the injury, which helps the wound heal more quickly.

111

DIRECT A DEMONSTRATION

Observe earthworms

Materials: earthworm from garden or pet store, piece of clear glass or plastic, magnifying glass (optional)

The student should keep his hands moist when handling earthworms to prevent the worms from drying out and sticking to his hands.

Direct the student to place the earthworm on a piece of clear glass or plastic.

Describe an earthworm’s body. It is made up of parts, or segments.

How does an earthworm move? It inches along, thrusting forward and pulling the segments along.

Direct the student to look at the underside of the earthworm through the glass or plastic to see how the earthworm moves.

What do you see under the earthworm that helps the earthworm to move? little hairs

How many eyes does the earthworm have on its head? none

Explain to the student that the earthworm has no eyes but that it has cells that are sensitive to light. Earthworms do not have lungs to help them breathe. They breathe through their skin. To take in oxygen and let out carbon dioxide, their skin must stay moist.

Discussion

How are sea worms different from land worms? Sea worms have paddles and bristles instead of setae.

What do seaworms usually eat? plankton and algae

How do earthworms get their food? from the soil

Why do some gardeners buy earthworms?

Earthworms make holes in the ground so that air can get into the soil. Worms break down plant matter into useful nutrients.

Discuss *Science & History*.

Why did doctors in the nineteenth century use leeches on people? They were trying to get the bad blood out of them.

Why might a doctor use leeches today? Doctors may use leeches on reattached body parts. A leech’s saliva not only numbs but also keeps the blood from clotting in order to speed up the healing process.

Answers

- Some echinoderms eat mollusks or other echinoderms. Other echinoderms are filter feeders, eating whatever comes floating through the water.
- Free-living worms are independent of other organisms. Parasitic worms live on or in other living organisms. They depend on the host for their nourishment.
- Some roundworms and segmented worms help break down plant matter in the soil and burrow holes in the soil, thus increasing air circulation needed by plants. Some worms are parasites and can cause diseases.

Activity Manual

Reinforcement, page 72

Review, page 75

These pages review Lessons 57 and 60.

Assessment

Quiz 5-A

The quiz may be given any time after completion of this lesson.

Objectives

- Identify crustaceans, arachnids, centipedes, millipedes, and insects as arthropods
- Describe basic characteristics of each kind of arthropod

Materials

- live grasshopper in a jar or a picture of a grasshopper
- magnifying glass

Vocabulary

arthropod	insect
exoskeleton	metamorphosis
molt	incomplete metamorphosis
crustacean	complete metamorphosis
arachnid	

Introduction

Display the grasshopper.

How many main body segments do you see? 3
(head, thorax, and abdomen)

How would you classify a grasshopper? Possible answers: arthropod, insect

What other body parts do you see? Possible answers: six legs, wings, antennae

Have you ever held a grasshopper and watched it spit brown liquid? Why do you think it does this?
Possible answer: The liquid scares off predators.

Give the student an opportunity to view the grasshopper with a magnifying glass.

Teach for Understanding**Purpose for reading**

What is the difference between crustaceans and arachnids?

Which group of arthropods is the largest?

Discussion

Which invertebrate phylum is the largest?
arthropods

What does the word *arthropod* mean? jointed foot

Arthropods

Arthropods (AHR thruh PAHDZ) are the most numerous animals on the earth. Scientists estimate that at least half of the known animal species are arthropods. **Arthropod** means “jointed foot.” Animals in this phylum have jointed legs and segmented bodies. But the segments of an arthropod are not like those of an annelid. Each segment of an arthropod has a specific purpose.

Another characteristic of an arthropod is its exoskeleton. An **exoskeleton** (EK so SKEL ih tun) is a hard covering that acts like a knight’s armor, protecting the arthropod’s body. In order to grow, arthropods must **molt**, or shed this exoskeleton and grow a new one. Sometimes you can find the old exoskeletons of cicadas on trees. Many arthropods also have antennae. All arthropods have some of the same characteristics, but scientists divide them further by some of their unique features.

Crustaceans

If you go to a seafood restaurant, you will probably see several crustaceans, such as shrimp, lobsters, and crabs.

Crustaceans (kruh STAY shunz) have at least five pairs of jointed legs and two pairs of antennae. They breathe through gills, and most crustaceans have some sort of claw.

The blue crab is a very common North American crustacean. It has five pairs of legs. The middle three pairs are used for walking, the back pair is used for swimming, and the front pair has claws for getting food. The blue crab’s

claws can hold on to food or a predator with a vise-like grip.

One crustacean that does not look like a typical crustacean is the barnacle. Barnacles look more like mollusks because they have shells. Barnacles attach themselves to surfaces by their sticky antennae and then build themselves little caves to live in. This means that a barnacle is always standing on its head! Inside its mollusk-like shell, a barnacle has a segmented body and six pairs of legs. Barnacles use their twelve legs to filter food out of the water. Barnacles can live in tide pool areas where they are not covered by water all day, but many live fully submerged all the time. Although they do not look like other crustaceans, barnacles have the antennae, segmented bodies, and legs necessary to be classified as crustaceans.



112

SCIENCE BACKGROUND
Rocky Mountain spotted fever

The rickettsia pathogen causes this disease. The wood tick, dog tick, and lone star tick can transmit it.

Lyme disease

This is a bacterial disease spread most often by tiny deer ticks. One of the first symptoms of this disease is inflammation in the shape of a bull’s eye surrounding the bite site. As the disease progresses, it affects the muscles and other systems. In 1975 the disease was named after Lyme, Connecticut, the community where it was first discovered. In 1982 Willy Burgdorfer identified the specific bacteria that causes Lyme disease.

Arachnids

Arachnids (uh RAK nidz), such as spiders, scorpions, ticks, and mites, have eight legs and two body segments. Most arachnids are not harmful to humans. But a few can be both painful and dangerous. A black widow spider's bite can cause severe pain and muscle spasms. A provoked scorpion can deliver a painful sting. But tiny ticks probably cause the most serious human health problems. Ticks are parasitic and use both animals and humans as hosts. Though their bites are not often painful, certain ticks can spread diseases such as Rocky Mountain spotted fever and Lyme disease.

Spiders are the most familiar arachnids. Most spiders have eight eyes. However, this many eyes does not necessarily give a spider good eyesight. Spiders that actively seek their prey do have good eyesight. These spiders do not spin webs. Other spiders have poor vision but can detect prey by smell, sound, touch, and the vibrations of their webs.

Spider webs are some of the most beautiful and complex creations of any

orb weaving spider

Spiders in mythology

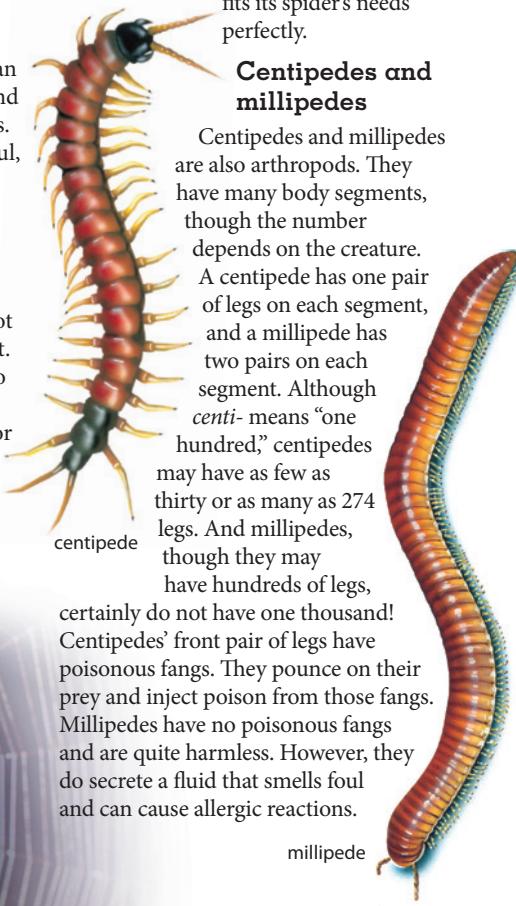
According to Greek mythology, Arachne, whose name means "spider," was a mortal weaver. She challenged the Greek goddess Athena to a weaving contest to see who really was the goddess of the loom. Arachne won the contest with a tapestry that mocked the gods. The tapestry depicted both the gods' successes and errors. Athena, though very angry and jealous, mercifully spared Arachne's life but turned her into a spider.

This fictitious story is part of Ovid's *Metamorphoses*. *Arachnid*, the name for the class of spiders, scorpions, ticks, and mites, probably came from this piece of Greek mythology.

arthropod. The silk is secreted from *spinnerets*, silk-spinning organs in the back of the spider. The spider weaves a web that snares passing insects and other prey. But not all webs are the same. Some webs are like lace, and others are like tunnels. Still others look as if they are just random strands of silk. But each web fits its spider's needs perfectly.

Centipedes and millipedes

Centipedes and millipedes are also arthropods. They have many body segments, though the number depends on the creature. A centipede has one pair of legs on each segment, and a millipede has two pairs on each segment. Although *centi-* means "one hundred," centipedes may have as few as thirty or as many as 274 legs. And millipedes, though they may have hundreds of legs, certainly do not have one thousand! Centipedes' front pair of legs have poisonous fangs. They pounce on their prey and inject poison from those fangs. Millipedes have no poisonous fangs and are quite harmless. However, they do secrete a fluid that smells foul and can cause allergic reactions.



113

Discussion

Describe the legs and body of an arthropod.

Arthropods have jointed legs and segmented bodies.

How are the segments of an arthropod different from the segments of an earthworm? **The segments of an earthworm are alike. The segments of an arthropod are different and have different functions.**

What is an exoskeleton? **a hard covering that protects the body of an arthropod**

Why must an arthropod molt? **As the arthropod grows, its exoskeleton becomes too small. It sheds the small exoskeleton and grows a new one.**

What are crustaceans? **Crustaceans are arthropods with at least five pairs of jointed legs and two pairs of antennae. They breathe with gills, and most have some sort of claw.**

What are some examples of crustaceans? **Possible answers: shrimp, lobsters, crabs, barnacles**

How is a barnacle different from other crustaceans? **It has a shell like a mollusk and it attaches itself to a surface.**

Most crustaceans move freely, but adult barnacles do not move after attaching themselves to a surface.

Describe the characteristics of an arachnid. **Arachnids are arthropods with eight legs and two body segments.**

Give two examples of arachnids. **Possible answers: spiders, scorpions, ticks, mites**

What dangers do some arachnids pose to humans? **They can deliver painful bites and stings. Some can transmit diseases to humans.**

What are some diseases that ticks can transmit to humans? **Possible answers: Lyme disease and Rocky Mountain spotted fever**

How do spiders with poor eyesight detect prey? **by smell, sound, touch, and the vibrations of their webs**

Which body part does a spider use to spin its web? **spinnerets**

Why are all spider webs not the same? **They are designed to suit each spider's method of obtaining food.**

What is the difference between a centipede and a millipede? **Centipedes have one pair of legs on each segment, and millipedes have two pairs of legs on each segment. Centipedes have poisonous fangs, but millipedes are harmless.**



Discussion

What is the most common type of arthropod? **the insect**

What percentage of arthropods are insects? **about 90 percent**

Discuss the circle graph. Compare the percentages.

What percentage of animals are arthropods? 85.5% (73.4% + 12.1%)

What percentage of animals are vertebrates? 4.1%

Which animal group is the smallest? mammals

Describe the body of an insect. Insects have three body segments: head, thorax, and abdomen. Three pairs of legs are on the thorax. Most insects have two pairs of wings.

Why are spiders not classified as insects? Spiders have two body segments, and insects have three. Spiders have eight legs, and insects have six.

What type of insect has chewing mouthparts? a beetle

Why do mosquitoes need piercing and sucking mouthparts? They need piercing mouthparts to break the skin or hide of their victims and sucking mouthparts to suck up the blood.

Why do butterflies need siphoning mouthparts rather than chewing mouthparts? They need a way to get nectar from flowers.

What is metamorphosis? the process of an insect becoming an adult

Discuss the diagram of incomplete metamorphosis.

What are the stages of incomplete metamorphosis? egg, nymph, and adult

What does a nymph resemble? an adult

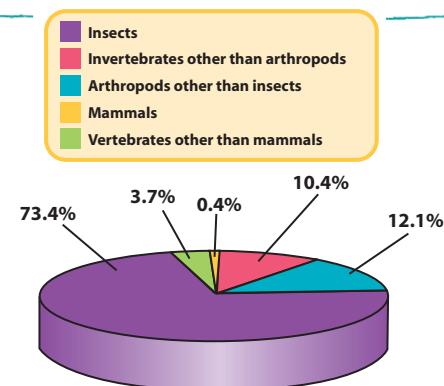
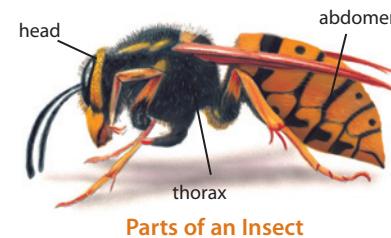
Although a nymph looks like an adult, how is it different? **Its wings are not fully functional.**

What happens to a nymph as it changes to an adult? **It grows and molts.**

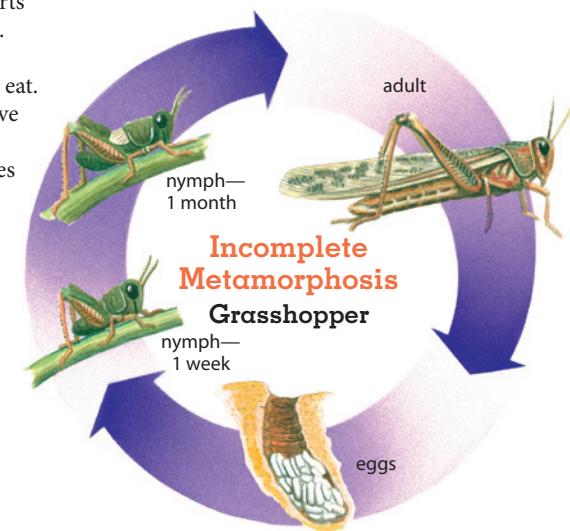
Why does a nymph need to molt as it grows? **Its exoskeleton does not grow.**

Insects

Insects are one of the largest and most diverse groups of animals. In fact, scientists estimate that 90 percent of all arthropods are insects. Although there are many kinds of insects, all insects have certain specific characteristics. **Insects** have three body segments: the *head*, the *thorax*, and the *abdomen*. They have three pairs of legs on the thorax, and most also have two pairs of wings.



egg hatches, the immature insect looks much like the adult; however, its wings are not fully functional. This immature insect is called a *nymph*. The nymph molts many times as it grows and becomes an adult. During this time of molting, the insect's wings become functional.



114

SCIENCE BACKGROUND

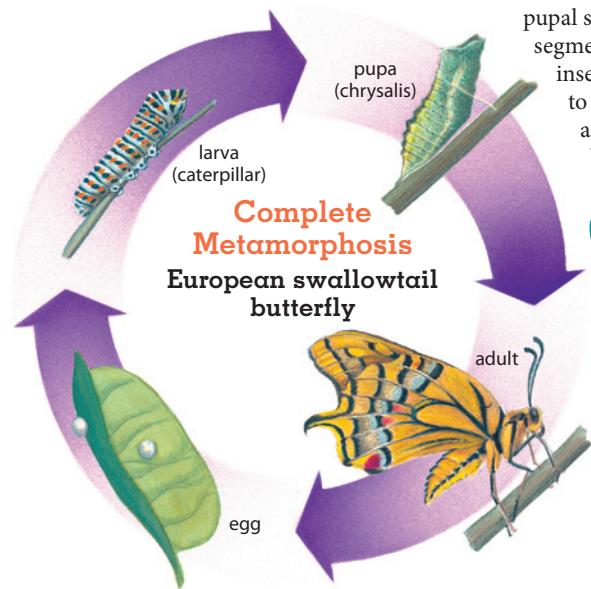
Siphon

This is a tube used to take in or expel a liquid through the use of pressure.

Metamorphosis

Metamorphosis is the process of transformation, or a change in form, that certain animals undergo as they develop into adults. Both amphibians and insects undergo metamorphosis.

Complete metamorphosis has four stages. The egg hatches into what is called the *larva*. The larva does not look like the adult insect; in fact, you would not think it was even related to the adult. Caterpillars and grubs are



SCIENCE & THE BIBLE

The Bible mentions several instances in which God used arthropods. God sent locusts and flies to plague Pharaoh when the children of Israel were in Egypt. John the Baptist ate locusts and honey during his wandering in the wilderness.

God also uses arthropods to teach us lessons. Proverbs 30:25–27 mentions

larvae of different-looking adult insects. The larva eats as much as possible in order to be ready for the next stage of its growth—the *pupa*. During the pupal stage the insect is in transition. It may be covered with a chrysalis or cocoon. The insect does not eat while it is in the pupal stage. It grows wings and body segments during this time. Finally, the insect emerges from its covering to begin its adult stage. When an adult female lays eggs, the cycle begins all over again.

- QUICK CHECK**
1. Describe two characteristics of arthropods.
 2. Why is a spider not an insect?
 3. Describe the stages of incomplete and complete metamorphosis.

that the ants are little and not strong, yet they are hard workers that prepare their food in the summer. These verses also mention the locusts, who have no king, but still go forth in bands or organized groups. All of God's animals behave in a manner that glorifies Him. How much more should we who bear His image also live in a way that glorifies Him?

115

Discussion

Discuss the diagram of complete metamorphosis.

What is the insect called at each stage of complete metamorphosis? **egg, larva, pupa, and adult**

What stage of metamorphosis is a caterpillar? **larva**

Which stage of metamorphosis usually has a chrysalis or cocoon? **pupa**

Why does the larva of an insect eat as much as possible in the larva stage? **It needs to store energy for the pupal stage, when it does not eat.**

In which stage is the insect when it emerges from its cocoon or chrysalis? **adult**

How does metamorphosis demonstrate one of the characteristics of living things? **It shows a life cycle.**

Discuss *Science & the Bible*.

Which two insects were used by God to plague Egypt? **locusts and flies**

What can we learn from ants? **to be hard workers; to prepare ahead of time for what might be needed**

What can we learn from locusts? **to work together for a common purpose**

God's creatures always give glory to Him. What should that teach us? **that we should give God glory as well**

Answers

1. Possible answers: jointed legs, segmented bodies, exoskeletons
2. A spider has eight legs and only two body parts. An insect has six legs and three body parts.
3. An insect such as a grasshopper goes through incomplete metamorphosis, developing from an egg to a nymph to an adult. Complete metamorphosis has four stages. For example, a butterfly grows from an egg to a larva (a caterpillar) to a pupa (a chrysalis) to an adult (a butterfly).

Activity Manual

Reinforcement, page 76

Review, pages 77–78

These pages review Lesson 61.

Assessment

Quiz 5-B

The quiz may be given any time after completion of this lesson.

Objectives

- Observe the larval stage of complete metamorphosis
- Observe the pupal stage of complete metamorphosis
- Collect and record observation data

Materials

- See Student Text page
- Observation Log (IA), for each student

Introduction

Why are observations important for learning?

Possible answers: to utilize all five senses when gathering information; to understand things better; to note the effects of changed variables

Have you ever seen a beetle or a mealworm?

Where?

Mealworms and beetles infest grains and their products, such as flours and cereals.

Teach for Understanding**Purpose for reading**

The student should read all the pages before beginning the activity.

Discussion

What are the four stages of complete metamorphosis? egg, larval, pupal, and adult

At what growth stage is the mealworm? **larval**

Why is a mealworm not a worm? **because in the adult stage it has all the characteristics of an insect—three body parts, six legs, and two antennae**

What kind of activity can you expect during the pupal stage? **no movement and no eating**

What does the mealworm become by the time it reaches the adult stage? **a beetle**

**Mealworm Movement**

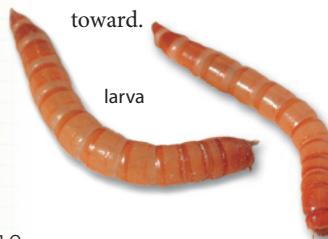
The grain beetle goes through the four stages of complete metamorphosis. The egg is only about 12 mm long and is very difficult to see. The larva of a grain beetle is called a mealworm. Observation of the body parts of a mealworm shows that it is an insect and should not be confused with members of the worm family. Mealworms can be found feeding on grain or grain products. During the pupal stage, the mealworm does not move or eat, and it remains in a small, firm form. After two to three weeks, the adult beetle appears.

Problem

How does a mealworm respond to different stimuli?

Procedure

1. Prepare a habitat for your mealworms. Place 100 mL of oatmeal and a slice of apple in the jar.
2. Observe the characteristics of your mealworms by placing them on a sheet of paper. Use a toothpick to gently move the mealworms while you observe them with the magnifying glass. Count the number of legs and measure the length and width of each mealworm. Record your observations in your Activity Manual.
3. Test the reaction of a mealworm to **light and dark**. Tape together a piece of white paper and a piece of black paper. Place a mealworm in the center. Record the color the mealworm crawls toward.



116

Materials

large-mouth glass jar	lamp
100 mL oatmeal or wheat bran	ice
apple or potato slice	cotton swabs
4–6 mealworms	water
magnifying glass	ammonia or vinegar
ruler	blocks or other materials to make a maze
toothpick	cheesecloth
white paper	rubber band
black paper	observation log
plastic cup	Activity Manual



residue in the bottom of the habitat, eggs are nearly impossible to see. If eggs are laid and hatch, small mealworms may become visible about a month after the beetles develop.

Testing mealworms

The mealworm will probably have a more visible reaction to the ammonia than to the vinegar.

Remind the student to handle his mealworms responsibly. The tests in this activity will not hurt the mealworms.

**Health note**

Mealworms can cause respiratory difficulties for people with asthma tendencies. Respiratory difficulties from mealworms can also happen to people who do not have asthma. People who have asthma may want to wear a mask and gloves when observing and handling mealworms.

Finding mealworms

Most pet or bait stores sell mealworms.

Habitats

Glass or metal containers are the best to use. Apple or potato slices provide moisture. Check regularly for mold, and replace the slices as needed.

After the adult develops from the pupal stage, you may allow the beetles to continue to multiply. Because of waste

-  4. Test the reaction of a mealworm to **warmth and coldness**. Place the mealworm in a plastic cup. Observe its reactions when the cup is placed over a lit light bulb and when it is placed over an ice cube. Record your observations.



-  5. Test the reaction of a mealworm to **a smell**. Place a mealworm on a sheet of paper. Dip a cotton swab in water and hold it near the head of the mealworm. Dip a cotton swab in the ammonia or vinegar and hold it near the head of the mealworm. Record your observations.
-  6. Test to find out if a mealworm repeatedly goes the same **direction**. Make a maze with blocks similar to illustration A in your Activity Manual. Place a mealworm at the start of the maze. Record your observations. Make a maze with blocks similar to illustration B. Place a mealworm at the start of the maze. Record your observations. Compare the results of each test.
7. Place your mealworms in their new home. Cover the opening of the jar with a piece of cheesecloth and secure it with a rubber band.
-  8. After testing, observe your mealworms two to three times a week. Record your observations on the observation log that your teacher gives you.

Conclusions

- How did the mealworms respond to the different stimuli?
- Did any of your mealworms develop into other stages?

Follow-up

- Perform the same tests on adult beetles and compare the results.

117

SCIENCE BACKGROUND

Mealworm development

A mealworm egg is very difficult, if not impossible, to see.

The larval stage of a mealworm lasts about 10 weeks. As the larva grows, it sheds its exoskeleton 9–20 times. The temperature and amount of moisture have some effect on the number of times shedding takes place. Also, the larva turns into a pupa more quickly in warmer temperatures.

The pupal stage may last only 1–2 weeks.

Complete metamorphosis from egg to adult may take 6–9 months.

The types of beetles that develop from mealworms vary. Some common names are grain beetle and darkling beetle.

SCIENCE PROCESS SKILLS

Observing

What information can a person gain by making observations and collecting and recording data? **growth records; responses to stimuli such as light, cold, and odors**

Why are observations important to scientific research and thinking? **to increase knowledge**

Why is recording data important in scientific research? **to ensure accuracy**

Procedure

Guide the student in preparing the habitat for his mealworms. Discuss necessary precautions, such as washing hands after touching the mealworms. Examine the mealworms according to the given criteria before placing them in the prepared habitat. Observe the mealworms two or three days each week. Identify which days the student should check on his mealworms. Provide a copy of the Observation Log or a similar page for him to record his observations.

Conclusions

Describe the larval stage of metamorphosis in a grain beetle. **wormlike, six legs, two antennae, hard exoskeleton or covering**

What kind of response did the mealworm have to the light bulb, the ice cube, and the ammonia or vinegar? **It moved away from the light, the ice cube, and the odor.**

Describe the pupal stage of complete metamorphosis of the grain beetle. **small, hard, motionless, does not eat**

Describe the adult grain beetle. **hard outer covering, dark, 6 legs, 3 body parts**

How did the adult grain beetle respond to the light bulb, ice cube, and ammonia or vinegar? **The grain beetle responded in the same manner as the mealworm.**

How can these observations be helpful to man?

Grain storage businesses might need to have moisture and temperature controls to discourage the presence of mealworms and grain beetles.

Use the questions in the Science Process Skills to discuss observing.

Activity Manual

Activity, pages 79–80

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Objectives

- Identify fish as cold-blooded animals that breathe through gills
- Identify amphibians as cold-blooded animals that live part of their lives in water and part on land
- Describe the life cycle of most amphibians

Materials

- Vertebrate Characteristics (IA), for display

Vocabulary

cold-blooded
cartilage
amphibian

Introduction

Discuss fish that the student has either had as pets or perhaps noticed in a pet store or doctor's office.

Have you ever had a fish as a pet?

Did you have only one kind of fish or many different kinds?

Did the fish have bright colors or dull colors?

Why do you think fish would be either brightly colored or dull? Possible answer: For some fish in their natural environment, their coloring helps camouflage them from predators or helps them be unnoticeable to their prey. Some fish that have bright colors are poisonous or dangerous to others. The color serves as a warning.

Teach for Understanding**Purpose for reading**

What is one way scientists group fish?

How are frogs and toads different?

Discussion

Which phylum in the animal kingdom is made up of vertebrates? **Chordata**

Why can a vertebrate grow larger than an invertebrate? **A vertebrate has a backbone that supports its weight.**

What are classes? **the smaller groups of animals within a phylum**

What are some classes of vertebrates? **fish, amphibians, reptiles, birds, mammals**

Vertebrates

Most phyla of the animal kingdom are invertebrates. Only one phylum, *Chordata*, is made up of vertebrates. Vertebrates are usually larger in size than invertebrates. Their backbones give support for their greater weight. If vertebrates did not have this support, they would collapse under their own weight.

Animals in phylum Chordata are quite different from each other. Scientists classify the animals within a phylum into smaller groups called classes. For vertebrates, these classes include fish, amphibians, reptiles, birds, and mammals.

Fish

Fish come in many different shapes and sizes. Certain characteristics, however, identify an animal as a fish. All fish breathe through gills and are **cold-blooded**. Cold-blooded animals must find warmth or coolness from their environments. Their blood does not maintain a constant temperature.

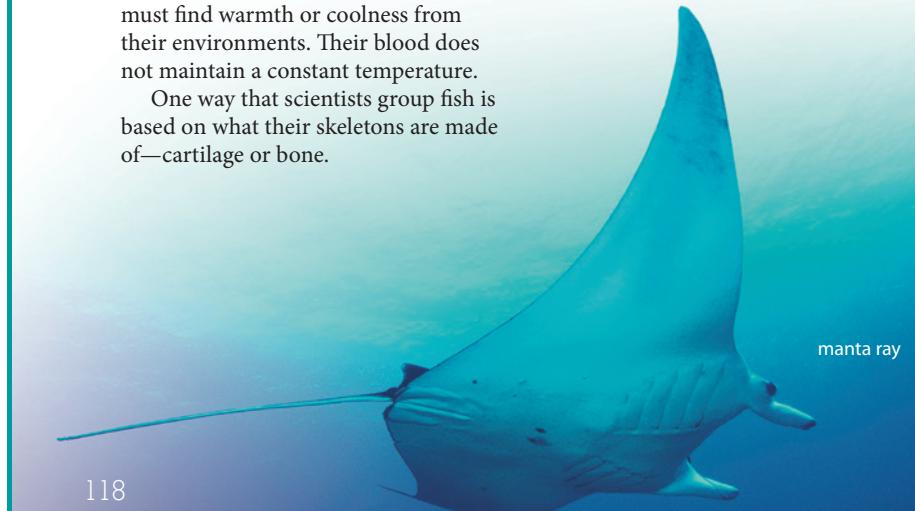
One way that scientists group fish is based on what their skeletons are made of—cartilage or bone.

Cartilage fish

Sharks, rays, and skates have skeletons made completely of cartilage. **Cartilage** (KAHR tl ij) is a bonelike substance, but it is softer and more bendable than bone. Your nose and the outside of your ear are made out of cartilage rather than bone.

Rays and skates look very similar. Both have “wings” of skin that make them look a little like stealth bombers. But rays have whiplike tails that may have painful stingers, while skates are harmless. Rays and skates, as well as sharks, have mouths on the bottoms of their bodies, so whatever they eat must be below them.

Sharks have a reputation for being human killers. Although some humans are bitten by sharks every year, a person is more likely to be struck by lightning than to be bitten by a shark. Sharks that eat sea lions and small whales may be big



118

manta ray

**Characteristics comparison**

Vertebrate Characteristics (IA) from the Teacher's Toolkit CD could be used in various ways.

You may want to prepare a blank copy for display and complete the chart with the student as you teach Lessons 63–66. You could also use the chart already filled in and uncover each section of characteristics as you finish discussing each class of animals.

SCIENCE BACKGROUND**Buoyancy**

Buoyancy is the upward thrust of a liquid, such as water. The swim bladder of a fish acts much like a balloon. A fish increases in size as its bladder fills with air. As a result, the water molecules under the fish

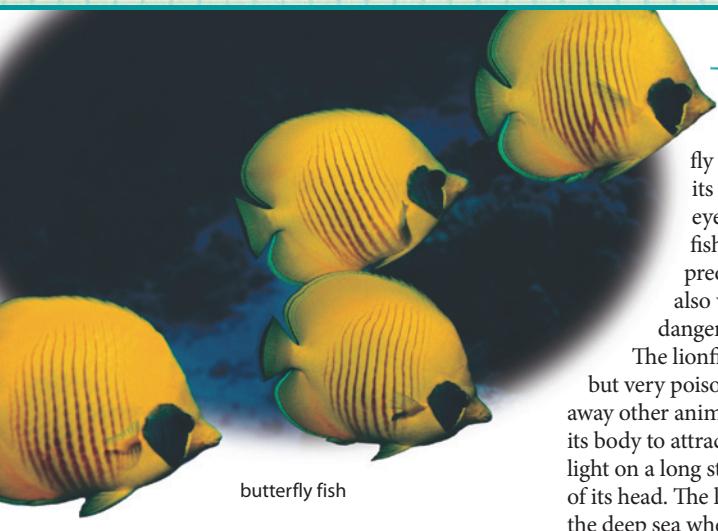
have a greater surface area to push the fish upward.

Fish classification

In addition to cartilaginous and bony fish, there is a small group of fish without jaws that is classified separately because of the unique characteristics of its fish. This group includes fish such as lampreys.

Fish eyes

Fish never close their eyes because they have no eyelids. Some fish, such as halibut and flounder, lie on the same side all the time. Their eyes are both on the same side of their heads. Usually these flat fish live on the ocean bottom. God designed this position of their eyes to give them the ability to see greater areas.



butterfly fish

enough to bite people, but they usually shy away from humans. Most sharks eat only small fish and plankton. Many of the largest sharks, such as the whale shark and the basking shark, are filter feeders, filtering food through their gills.

Bony fish

Most fish are bony fish. Bony fish have skeletons that are stronger and harder than those of cartilage fish. Bony fish live in both fresh water and salt water. Freshwater bony fish, such as bluegill, bass, and trout, are usually brown or gray, so they can blend in with the mud and water in their freshwater habitats. Most fish have scales, but some, like catfish, have only skin to cover their bodies.

Saltwater fish are often brightly colored. They use their unique coloring for camouflage, for warning, and sometimes for attracting food. The flounder changes its color while it lies on the sea

floor in order to avoid detection. The butterfly fish has a huge spot on its side that looks like an eye. This “eye” makes the fish appear larger and scares predators away. Colors also warn predators of the danger of eating certain fish.

The lionfish has brightly colored but very poisonous spines that warn away other animals. The anglerfish uses its body to attract food. This fish has a light on a long string of skin on the front of its head. The light attracts other fish in the deep sea where the anglerfish lives. When a fish comes and tries to bite the light, the anglerfish bites the fish instead.

Some fish do not look like fish at all. The seahorse is a fish that uses its shape to blend in with seaweed. The eel looks more like a snake, but it is a bony fish. Some fish, like the appropriately named rockfish, look like rocks.

Whatever the color, shape, or size of the fish, God has given each species exactly what it needs to survive in its habitat.



119

Fish tall tales

 WRITING Provide pictures of some distinctive and unusual fish. Allow the student to choose a picture and write a tall tale explaining the fish's distinctive features.

Discussion

Display the Fish column of *Vertebrate Characteristics* during the discussion.

What characteristics identify an animal as a fish? All fish breathe with gills and are cold-blooded.

What does cold-blooded mean? A cold-blooded animal does not maintain a consistent body temperature. Its body temperature depends on its environment.

💡 List two other groups of vertebrates that are cold-blooded. amphibians and reptiles

What is one way scientists group fish? by whether the fish has a skeleton made of cartilage or bone

What is cartilage? a material similar to bone but is able to bend and is not as hard as bone

Which parts of the human body are made of cartilage? the nose, the outside of the ear

What are some examples of cartilage fish? Possible answers: rays, skates, sharks

Rays and skates look similar. What is one way they are different? Rays have stingers on their tails, but skates are harmless.

💡 Some sharks are filter feeders. What other animals are filter feeders? Possible answers: echinoderms, clams, some whales, sponges

💡 Why do you think sharks have such a bad reputation? Possible answers: They look scary. Some have attacked humans. Movies and books often portray sharks as vicious.

Are most fish cartilage or bony fish? bony

Where do bony fish live? in salt water and fresh water

Why do freshwater fish usually have dull colors? to blend in with surroundings

💡 What word means “to blend in”? camouflage

Why are many saltwater fish brightly colored? for camouflage, for warning, to attract food

💡 How could being brightly colored provide camouflage? Answers may vary, but elicit that many sea animals, such as coral, are brightly colored, and brightly colored fish blend in well with them.

What are some fish that do not look like fish at all? Possible answers: seahorse, eel, rockfish



Discussion

Display the Amphibians column of *Vertebrate Characteristics* during the discussion.

What does *amphibian* mean? double life

Why is amphibian a good name for this group of animals? Amphibians lead double lives, living part of their lives in the water and the other part on land.

What characteristic do amphibians have in common with fish? They are cold-blooded.

How do adult amphibians breathe? with lungs, and through their thin skin

How do young amphibians breathe? with gills

What are some examples of amphibians? frogs, toads, salamanders, newts

Describe the life cycle of most amphibians. Most amphibians lay eggs in the water. The eggs hatch into the larval stage, or tadpoles. Most tadpoles then lose their gills, gain legs, and move onto land as adults.

💡 What other animals have a larval stage? insects that go through complete metamorphosis

Why do many tadpoles never reach adulthood? They are eaten by other aquatic creatures.

Which three types of amphibians look similar but are actually in different subgroups? frogs, toads, and tree frogs

How are toads and frogs different? Frogs have smooth skin and live near water. They have powerful jumping legs. Frogs lay their eggs in clusters. Toads have nubby skin and short legs. They lay eggs in long chains.

Amphibians

Perhaps you have been on a camping trip to a lake and the quietness of the night was interrupted by a huge blast of sound. You may have been scared until someone laughingly told you that a male bullfrog made the sound. The background chirping you heard might have been tree frogs. Frogs, along with toads and salamanders, are amphibians. The term **amphibian** means “double life.” And amphibians do lead double lives—part in the water and part on land. They are cold-blooded like fish. As adults, amphibians have lungs, but they also use their thin skin to help them breathe.

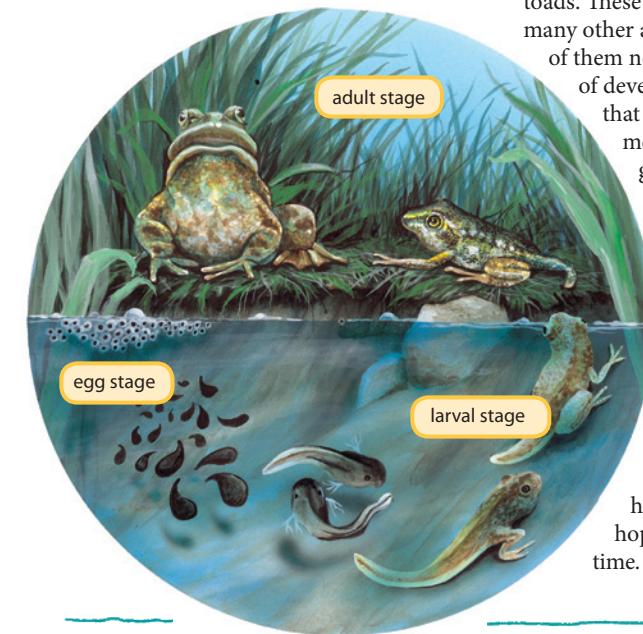
Not all amphibians have the same



life cycle. But most of them lay eggs in the water. Some eggs hatch into tadpoles, the larval stage of frogs and toads. These tadpoles are easy meals for many other aquatic creatures, so many

of them never reach the next stage of development. The tadpoles that survive go through metamorphosis, losing their gills, growing legs, and moving onto land.

Frogs, toads, and tree frogs all look very similar, but scientists classify them in different subgroups of amphibians. Frogs have smooth skin and always live near the water. They have large, powerful hind legs for jumping. Toads have short legs because they hop only short distances at a time. They have nubby skin that



120

SCIENCE BACKGROUND

Marbled salamander

Unlike most salamanders who lay their eggs in water in the springtime, marbled salamanders breed and lay eggs in the fall in dried up ditches and ponds. When the autumn rains come, the eggs hatch into aquatic larvae. This salamander moves slowly rather than quickly like most salamanders.

Red-spotted newt

The red-spotted newt is usually green with red spots, but during its immature stage, called an eft stage, it is bright reddish-orange with red spots. The one pictured in the Student Text is in its eft stage.



makes them look like they have warts. Toads lay their eggs in long chains, but frogs lay theirs in clusters.

Although they look like regular frogs, tree frogs belong to a different group of amphibians. Most tree frogs are brown, gray, or green in order to blend in with their environments. But some, like the poison dart frogs of South and Central America, come in an array of beautiful color patterns. Like those of some fish, these bright colors warn predators that the frogs are poisonous. Many of these frogs skip the tadpole stage of life and hatch as immature adults.

Frogs and toads are not the only amphibians. Salamanders and newts are amphibians with tails. They are often brightly colored and live in moist areas under rocks and logs.

red-spotted newt



Amphibious vehicles

Amphibious vehicles can operate in the water and on land.

The military has special ships that have well decks for transporting amphibious vehicles.



marbled salamander

Amphibians are useful to humans because they eat insects, such as flies and mosquitoes, that humans consider pests. But that is not the only way amphibians are useful to humans. Scientists are studying the poisons found in some species of frogs and are finding ways to use some of the poisonous substances in medicine. Also, because amphibians have such thin skin, they are very sensitive to changes in their environments. They often provide a living alert to problems such as air or water pollution.



QUICK CHECK

- How are fish and amphibians alike?
- Why is *amphibian* an appropriate name for this class of animals?
- Describe the life cycle of many amphibians.

121

Discussion

Why are most tree frogs colored green or gray? to blend in with the trees they live on

💡 Why do you think many poisonous frogs have *dart* as part of their names? Their poison is often used to coat the tips of blow darts or other weapons.

Why are some tree frogs in Central and South America brightly colored? The colors serve as a warning to predators.

Where do most salamanders and newts live? in moist areas under rocks and logs

💡 Why do people find some amphibians useful? Amphibians eat pesky insects like flies and mosquitoes. Some amphibians' poisons can be used in medicine. Amphibians are also a living alert to pollution problems.

💡 How can amphibians be a living alert to pollution problems? Their thin skin makes them sensitive to environmental changes, so increased amounts of pollution may sicken or kill many amphibians at once. Pollution can also cause genetic mutations causing birth defects.

Answers

- Fish and amphibians are cold-blooded, and most amphibians breathe with gills until they become adults.
- Amphibian* means “double life.” Most amphibians live part of their lives in the water and part of their lives on land.
- Most amphibians hatch from eggs in the water, develop into the larval stage, and mature into an adult. Usually they lose their gills and gain legs before leaving the larval stage and moving to land.

Activity Manual

Reinforcement, page 81

Objectives

- Identify two characteristics of reptiles
- Identify two characteristics of birds
- Compare similarities and differences of birds and reptiles

Materials

- world map
- Vertebrate Characteristics* from Lesson 63

Vocabulary

omnivore
herbivore
carnivore
warm-blooded

Introduction

As I read the poem “A Narrow Fellow in the Grass” by Emily Dickinson, listen for the phrases that describe a snake.

The poem is in the Language link.

Listen to the first verse of the poem. What might make you suddenly notice a snake? Possible answers: a rattle, a hiss, a sudden swish into the bushes or grass

Listen to the next two verses. What other characteristics of a snake do you notice? Possible answers: likes cool places, lays in the sun, “wrinkles” or slithers

Listen to the last two verses. What emotion do you think the author is feeling when she says she has “tighter breathing and Zero at the Bone”? fear

What other words might you use for “Zero at the Bone”? Possible answers: frozen, chilled to the bone, scared stiff

Teach for Understanding**Purpose for reading**

What are two characteristics of reptiles?

What are two characteristics of birds?

Discussion

Display the Reptile column of *Vertebrate Characteristics* during the discussion.

What are three characteristics of reptiles? cold-blooded, lay eggs, have scaly skin

What characteristics do reptiles have in common with fish and amphibians? Possible answers: They are cold-blooded. They lay eggs.

Reptiles

Reptiles exhibit some characteristics similar to amphibians; however, they are a different group. Like fish and amphibians, reptiles are cold-blooded. Most reptiles lay eggs, but unlike amphibians, they lay them on the land instead of in water. Reptiles have scaly skin that allows them to live in areas away from water. Scientists have divided reptiles into three major groups: turtles, lizards and snakes, and crocodilians.



The Galápagos tortoise is the largest known land turtle. It weighs about 225 kg (500 lb).

Turtles

The unique skeletal structure of a turtle clearly identifies this reptile. Most turtles have a layer of hard, bony plates on their backs that provide protection. Some turtles, such as the common box turtle, can completely enclose their heads and legs inside their shells.

Turtles live in a wide variety of locations, including deserts and oceans. Turtles that live in or around water usually have streamlined shells and webbed feet for better swimming. Many of these turtles are **omnivores** (AHM

122

nuh vorz), eating both plants and animals. Some turtles are called *tortoises*. Tortoises are usually land-dwellers with high, domed shells. These land tortoises often have thick legs and feet that can support their heavy shells. Tortoises are often **herbivores** (HUR buh vorz), eating only plants. Some small turtles are called *terrapins*.

Several large turtles, such as the leatherback turtle and the Galápagos tortoise, are endangered species. The leatherback is a marine turtle. The Galápagos tortoise lives in the Galápagos Islands near South America. Known not only for their weight but also for their age, Galápagos tortoises can live for about 150 years.

Lizards and snakes

Some lizards look much like salamanders, which are amphibians. Lizards, though, belong to the reptile group. Lizards have scaly skins and can live almost anywhere. There is such a variety of lizards that even a small ecosystem can support many different kinds.

Most lizards are small and harmless. Only a few, such as the Gila monsters of the American Southwest, are poisonous. One lizard, however, is neither small nor harmless. Komodo dragons grow to enormous sizes and are very fierce when disturbed.

Like lizards, snakes live in almost every

Komodo dragons can grow to 3 m (10 ft) and can weigh up to 165 kg (364 lb).

**A Narrow Fellow in the Grass**
by Emily Dickinson

A narrow Fellow in the Grass
Occasionally rides—
You may have met Him—did you not
His notice sudden is—

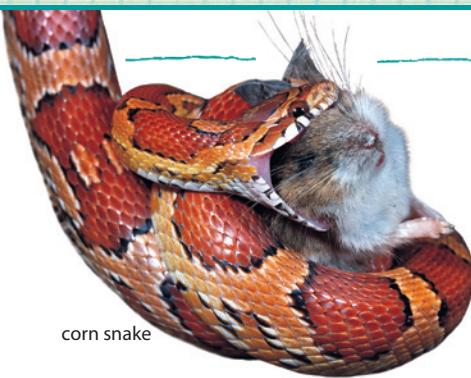
The Grass divides as with a Comb—
A spotted shaft is seen—
And then it closes at your feet
And opens further on—

He likes a Boggy Acre
A Floor too cool for Corn—
Yet when a Boy, and Barefoot—
I more than once at Noon
Have passed, I thought, a Whip lash
Unbraiding in the Sun
When stooping to secure it
It wrinkled, and was gone—

Several of Nature’s People
I know, and they know me—
I feel for them a transport
Of cordiality—

But never met this Fellow
Attended, or alone
Without a tighter breathing
And Zero at the Bone—

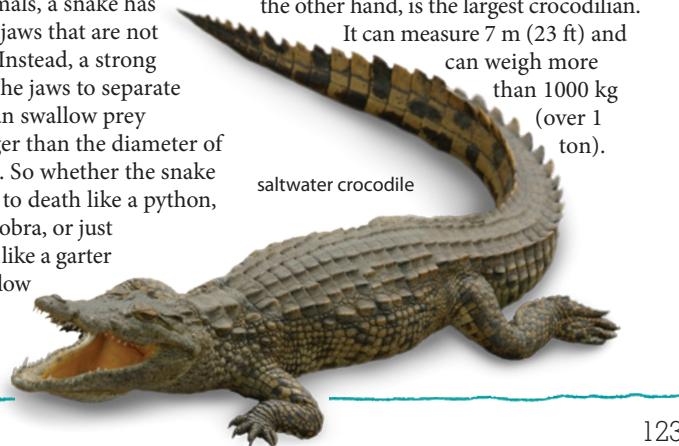
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corn snake

area of the world. A snake's most obvious feature is its long, legless body. Without legs, the snake must slither along on its belly. Snakes have other characteristic traits as well. One of these is a clear scale that covers each eye. Snakes do not have moveable eyelids. They live their entire lives without blinking even once!

All snakes are **carnivores** (KAHR nuh vorz), meaning they eat only animals. However, they cannot tear or chew their prey, so they must be able to swallow their meals whole. God has specially designed their jaws and bodies to accommodate this need. Unlike most animals, a snake has upper and lower jaws that are not tightly attached. Instead, a strong ligament allows the jaws to separate widely. Snakes can swallow prey considerably larger than the diameter of their own bodies. So whether the snake squeezes its prey to death like a python, poisons it like a cobra, or just quickly catches it like a garter snake, it can swallow its prey.



saltwater crocodile

123

SCIENCE BACKGROUND

Eating habits

Alligators and crocodiles swallow their food whole. In addition to food, they also swallow stones. These stones remain in their stomachs to help grind the food they swallow. A snake can separate its upper and lower jaws so that it can swallow its prey whole.

Turtle names

The common names *turtle*, *tortoise*, and *terrapin* usually indicate differences in habitat and body structure. Turtles have streamlined shells and webbed feet. They spend most of the time in water. Tortoises live on land and eat plants. They have round, stumpy feet for walking. Terrapins live on land and in water and are often found in swampy areas.



Snakes and the Garden of Eden

In the Garden of Eden, snakes may have had legs, but God cursed them to crawl on their bellies. The anatomy of the snake is a reminder of God's triumph over Satan (Gen. 3:14–15).



Endangered species lists

Before an organism can receive protection under the Endangered Species Act, it must have met the specific criteria needed to be placed on the list of endangered and threatened wildlife and plants.

Endangered Species Act

The US Congress passed the Endangered Species Act in 1973. Its purpose is to protect and preserve endangered species and their habitats.

People often fear snakes and other reptiles without real cause. Snakes are actually beneficial to humans. Many snakes are predators of mice and rats. Others eat insects and slugs that can destroy gardens. God created snakes to serve an important role in helping humans.

Crocodilians

Crocodilians, such as alligators, caimans, and crocodiles, are often thought of as fierce predators. These animals are excellent hunters, especially in the water. Their primary food is fish, but anything that comes near their water habitat, including humans, may become prey.

All crocodilians look similar. They have scaly skin, large bodies, and short legs. The biggest difference in their appearance is the width of their snouts. The crocodilians are the largest reptiles, but they vary greatly in size. Caimans are the smallest crocodilians, approximately 2–3 m (about 7 ft) in length. The Indo-Pacific crocodile, on the other hand, is the largest crocodilian.

It can measure 7 m (23 ft) and can weigh more than 1000 kg (over 1 ton).

Discussion

What are some differences between a reptile and an amphibian? Reptiles have scaly skin, can live away from the water, and lay eggs on land. Amphibians have smooth skin, live in or near water, and lay eggs in water.

Into what three major groups do scientists divide reptiles? turtles, lizards and snakes, crocodilians

What unique feature identifies a turtle? the hard, bony plates on its back (the shell)

Why would having a streamlined shell and webbed feet help turtles that live near the water? They make swimming easier.

What does *streamlined* mean? Answers will vary, but elicit that it means smooth and straight.

Explain the difference between omnivores and herbivores. Omnivores eat plants and animals. Herbivores eat plants only.

What does *endangered species* mean? The species exists in limited numbers in its natural habitat and is dangerously close to extinction.

Point out the Galápagos Islands on the world map. Allow the student to share his ideas of how the wildlife may have arrived on these isolated islands after the Flood.

Most lizards are small and harmless. What are some examples of lizards that are dangerous? the Gila monster of the southwestern United States and the Komodo dragon

What are two characteristics of snakes? Possible answers: legless bodies, clear scales over each eye, no moveable eyelids

What is a carnivore? an animal whose main food is other animals

How do snakes swallow prey larger than the diameter of their bodies? Snakes' jaws are not attached, but they have strong ligaments that allow the jaws to open widely.

Why do snakes need such jaws? They cannot tear or chew their prey.

How are snakes useful to man? They are predators of mice, rats, insects, and slugs.

Which group of reptiles is usually largest in size? the crocodilians

What body characteristics do all crocodilians have in common? scaly skin, large bodies, and short legs

Which kind of crocodilian is the largest? the Indo-Pacific crocodile

What is the primary food of crocodilians? fish

God has also given each bird the perfect beak for the food it eats. A bird that eats seeds has a strong, thick beak to crack seeds and nuts and to pull the meat out of the seed's outer covering. But a bird that eats other animals has a sharp hook to tear flesh off the bones. A hummingbird has a thin, needlelike beak that can fit down inside flowers.

A hummingbird's beak can also bend, allowing it to catch insects while flying.

Birds are **warm-blooded**, having body temperatures that stay basically the same, regardless of where the birds are. Reptiles, fish, and amphibians are cold-blooded.

All birds lay their eggs in nests. The variety of nest styles is just as amazing as the variety of birds. Some birds take a long time to build their nests, and they make them very elaborate. Others, like the cowbird and the European

male redstart feeding a baby common cuckoo

cuckoo, lay their eggs in other birds' nests. The Great Spotted Cuckoo often lays one of her eggs in a magpie's nest. The magpie usually takes care of the cuckoo egg and then the baby bird as if it were her own.



QUICK CHECK

1. What is the difference between an omnivore and a herbivore?
2. What is unique about a snake's jaw?
3. What do birds have that other animals do not have?
4. How do the beaks of different birds reflect God's perfect design?



macaw



eagle



hummingbird

125



Arm span and wingspan

Measure outstretched arms of several students. Average the measurements. Determine how much longer the wingspan of an albatross is than the average arm span of a sixth grader.



Discussion

Discuss the pictures of the birds' beaks.

Looking at the beaks, which of these birds is a seed eater? **the macaw** Which bird gets its food from flowers? **the hummingbird** Which bird preys on other animals? **the eagle**

💡 What do we call animals that eat other animals? **carnivores**

💡 What kinds of birds are carnivores? **Possible answers: eagles, hawks, falcons**

Fish, amphibians, and reptiles are cold-blooded. Birds are not. What does it mean to be warm-blooded? **The body temperature of the animal stays basically the same no matter where the animal is.**

Where might cowbirds and the European cuckoo lay their eggs? **in other birds' nests**

What happens when a cuckoo's egg hatches in a magpie's nest? **The magpie takes care of the baby bird as if it were her own.**

💡 What features of birds has man copied in his inventions? **Possible answers: how their wings work; their lightweight skeletons; the waterproofing of their feathers**

💡 Man can learn from God's creation. Our gracious God has provided many examples and patterns from which man can learn.

Answers

1. An omnivore eats both plants and animals. A herbivore eats plants only.
2. The upper and lower jaws of a snake are not tightly attached. A strong ligament allows the jaws to separate widely. The snake can then swallow its prey whole.
3. feathers
4. The shape of a bird's beak matches the kind of food it eats.

Objectives

- Identify four characteristics of mammals
- Explain how marsupials and monotremes are different from other mammals
- Explain how humans are different from mammals

Materials

- pictures of a whale, rhinoceros, and porcupine
- world map
- Vertebrate Characteristics* from Lesson 63
- Mammal Orders* (IA), for display (optional)

Vocabulary

insectivore	pride
nocturnal	blubber
echolocation	pod

Introduction

Two lesson days have been allotted for you to discuss and explore the wide variety of mammals.

Show the pictures of the whale, rhinoceros, and porcupine.

All mammals have hair. Describe the hair on each of the animals pictured. *Answers will vary.*

Hair does not always look like a lion's mane or like the hair on our heads. A whale has very little hair. The horns of a rhinoceros are actually made of hair packed together tightly. The quills of a porcupine are thick hairs.

Teach for Understanding**Purpose for reading**

Which characteristics do all mammals have in common?

Why do the platypus and the echidna belong to two groups, separate from all other mammals?

Discussion

Display the Mammals column from *Vertebrate Characteristics* during the discussion.

What characteristics do all mammals have? Possible answers: have hair or fur; are warm-blooded; feed young with milk from the mother's body; have a four-chambered heart; have three middle ear bones; breathe with lungs

Display *Mammal Orders* while teaching the lesson to help the student see the organization of the mammal orders (referred to as groups in the Student Text). Two of the orders are not discussed in the Student Text.

How are monotremes different from other mammals? They lay eggs.

Mammals

Though fewer in number, mammals probably have the widest diversity of any group of animals. These vertebrates range in size from a tiny mouse to an enormous blue whale. Scientists have determined certain characteristics that categorize an animal as a mammal, regardless of its size or uniqueness. All mammals, even the aquatic mammals, have hair or fur. Mammals are warm-blooded, and the fur or hair helps land mammals maintain their internal body temperatures. Most mammals bear live young, and all mammals, including the egg-layers, feed their young with milk from the mother's body.

Other characteristics of mammals are less obvious. Unlike most other animals, every mammal has a four-chambered heart. Mammals also have three ear bones. Even whales, which have no outer ears, have middle ears with bones very similar to the ones in your ear. The whale receives sound vibrations through the tissues in its head.

Take a deep breath. You should be able to feel the muscle in your abdomen move. Most mammals use this muscle, the diaphragm, for moving air in and out of the lungs. All mammals breathe using lungs. The class of mammals is divided into smaller groups called orders.

Monotremes

Monotremes are a unique kind of mammal. The Australian platypus (PLAT ih pus) and echidna (ih KID nuh) both lay eggs. No



echidna

other mammal does that. But once the eggs hatch, the babies drink milk and have hair, just like other mammals. The platypus has a ducklike bill, and males have poisonous spurs on their back legs. Though these features may look like those of reptiles or birds, the platypus still has all the characteristics of mammals. Some mammals, such as echidnas, do not have teeth. An echidna sticks out its tongue on top of an anthill or termite mound and waits for the insects to crawl onto it.



platypus

126

SCIENCE BACKGROUND**Marsupials**

The majority of marsupials live in Australia. Some of these marsupials are the Tasmanian devil, numbat, bandicoot, wombat, mouse opossum, and cuscus.

North American marsupial

The only marsupial native to North America is the Virginia, or common, opossum. This opossum is known for "playing possum," or pretending to be dead when frightened or attacked.

South American marsupials

South America has two other marsupials. Each is in a separate family of marsupial. The *shrew opossum* is not an opossum except in name. It lives in western South America. The *monito del monte* is another

South American marsupial that lives in the Andes mountains.

Monotremes

Australia is the home to the platypus. Echidnas can be found in Australia, New Guinea, and Tasmania. The echidna is also known as the spiny anteater.



kangaroos

Marsupials

These unusual mammals have pouches outside their bodies. In these pouches their developing babies grow big enough to function. When the baby comes out of the pouch, it is like other mammal babies. Many marsupials, such as kangaroos, koalas, and wallabies, live in Australia. Most species of marsupials living in North and South America are called opossums.



capybaras

127

SCIENCE BACKGROUND

Mammal orders

The class of mammals is further subdivided into orders. The largest order of mammals is Rodentia, or rodents. Rabbits belong to the order Lagomorpha. Moles and shrews are in the order Insectivora.

Rodents, rabbits, and moles

Forty percent of all mammals are rodents. Mice, rats, and squirrels are common rodents, but beavers and porcupines also belong to this group. Rodents have large front teeth that never stop growing. The largest rodent, the capybara (KAP uh BAHR uh), lives in South America and averages 50 kg (110 lb) in weight. Rodents are found on every continent except Antarctica. They are often considered pests because they eat crops and gardens and get into people's houses. But some rodents are beneficial to humans because they eat harmful insects.

Rabbits share some characteristics with rodents, but a rabbit's teeth form differently than the teeth of a rodent. Moles and shrews are also similar to rodents, but they are **insectivores** (in SEK tuh vorz). They eat insects as their primary food.

Discussion

Give two examples of monotremes. **echidna, platypus**

Where do these animals live? **Australia**

Why are platypuses and echidnas not classified as reptiles or birds? **They have all the requirements to be mammals. They do not have scales or feathers.**

What distinctive feature do marsupials have? **They have pouches outside their bodies, where their babies finish developing.**

What are some examples of marsupials? **Possible answers: kangaroos, koalas, wallabies, opossums**

What is the largest group of mammals? **rodents**

What is a distinctive feature of rodents? **Rodents have large front teeth that never stop growing.**

What are some examples of rodents? **mice, rats, squirrels, beavers, porcupines, capybaras**

💡 Beavers are rodents. Why would having continuously growing teeth be useful to a beaver? **Possible answer: Beavers wear down their teeth as they gnaw trees, but the teeth continue to grow, so the teeth do not wear down.**

What is the largest rodent? **capybara**

How do some rodents help man? **by eating insects**

What other groups of mammals are similar to rodents? **rabbits, moles, and shrews**

What is an insectivore? **an animal that eats insects only**



Discussion

What are the only flying mammals? **bats**

What does *nocturnal* mean? **active at night**

What is echolocation? **a technique used by some animals to determine the location of objects; The animal produces high-frequency clicking sounds that bounce off objects. The length of time it takes for the sound to bounce back off an object and reach the animal tells the animal how far away the object is.**

Can humans hear the sounds made during echolocation? **no**

What manmade technology uses the technique of echolocation? **sonar**

How do scientists group hoofed mammals? **by the number of toes on each hoof—an odd number or an even number**

What are some common odd-toed mammals? **Possible answers: horses, zebras, burros, and mules**

What is another name for an even-toed animal? **cloven hoof**

💡 Give an example of an even-toed animal that lives in each of these places. Possible answers given. In the plains of Africa? giraffe In the forest? deer In the desert? camel On a farm? cow, sheep, pig



Bats

The next largest group of mammals after rodents is bats. Bats are the only mammals that can fly. They are usually **nocturnal**, meaning they are active at night. Bats can see, but just like you, they cannot see well in the dark. In order for them to know where they are flying, bats use a technique called **echolocation**. They make high-frequency clicks that bounce off objects. The bats judge the distance to the object by the time it takes the sound to return. Bats hear and use sounds that are too high for humans to hear. Humans use an artificial form of echolocation. We call it sonar.

Sometimes thousands of bats live in a single place. Many bats, especially the small types, eat insects. Some larger tropical types eat fruit, and other bats drink nectar from flowers. Bats can also help pollinate trees as they search for food.

Hoofed mammals

Scientists divide hoofed mammals into two groups: those with an odd number of toes on each hoof and those

with an even number.

Odd-toed animals

include horses, zebras, burros, and mules. Tapirs and rhinoceroses are also odd-toed hoofed mammals.

Even-toed mammals are also called “cloven hoof.” Deer, giraffes, camels, cattle, and sheep are all examples of this group of mammals. Some even-toed mammals live on the plains, some in forests, and others on farms. Antelopes, some of the fastest mammals, and hippopotamuses, some of the slowest, belong to this group.

even-toed—
camel



128

SCIENCE BACKGROUND

Tapir

A tapir looks like a large pig with a short trunk instead of a snout. It lives in Central America, South America, and Southeast Asia.

Vampire bats

Most bats eat insects, but the vampire bat eats the blood of large birds and animals. Vampire bats do not suck blood, but rather lick the blood after making a small bite. The bat can lick up as much blood as its own body weighs. Much like the leech, the vampire bat's saliva contains chemicals that numb the victim's skin and keep the blood from clotting.

SCIENCE MISCONCEPTIONS

Blind bats

Bats are not blind. They just have poor night vision.

Flying squirrels

Students may suggest that a flying squirrel is another mammal that flies. Flying squirrels do not really fly. Flaps of skin between their front and back legs help them glide from high to low points.

Carnivores

Many kinds of mammals are omnivores, but only a few are exclusively carnivores, or meat-eaters. Cats are carnivorous mammals. Although many people have domestic cats as pets, most of the cats in the world would not make good pets. They need space to roam. Most cats have *retractable claws*. A cat can make its claws disappear into its paw when it does not need them for hunting or climbing. This ability enables cats to move quickly and quietly, thus allowing them to stalk their prey.

Cats can live nearly anywhere and are native to every continent except Australia and Antarctica. With the exception of lions, most cats are solitary. Lions live in groups called **prides**. The prides establish very clear territory. Solitary cats also establish territories. Lions, cougars, tigers, and jaguars

are just a few of the cats that roam the earth.

Dogs are also carnivores, but they have been domesticated since Bible times to herd sheep, guard houses, and do other things. However, wolves, jackals, and dingoes are also dogs. Many kinds of untamed dogs hunt in packs. Every pack has a leader, and the other dogs obey him. Dogs



African
wild dog

have a very good sense of smell that helps them locate prey, and they can pursue prey a long distance. Dogs communicate by barks and howls. One of the eeriest nighttime sounds is the mournful howl of the coyote “talking” to his pack.

Another group of carnivores is called *pinnipeds* (PIN uh PEDZ). This group includes seals, walruses, and sea lions. Pinnipeds’ primary food is fish, though they will eat mollusks, crustaceans, and even careless penguins.

sea lion



129

Pinnipeds

The term *pinniped* comes from two Latin words: *pinna* meaning “feather,” and *ped* meaning “foot.” This group includes carnivorous water mammals that use flippers for moving.

Echolocation

Echolocation is a compound word.

What two words do you see in the term *echolocation*? *echo* and *location*

How does knowing this is a compound word help you understand its meaning?

Answers will vary, but elicit that *echo* refers to sound that bounces back and *location* refers to a specific place. The words together define a technique that shows where something is by how sounds bounce back.

Discussion

What group of mammals do cats and dogs belong to? **carnivores**

What is a carnivore? **an animal that eats mainly meat**

What ability do cats have that allows them to move quietly? **retractable claws**

What is a retractable claw? **a claw that disappears into the paw when not needed**

Why are retractable claws important to cats? **They allow cats to move quietly when stalking prey.**

Which cat lives in a group? **lion** What is the group called? **a pride**

What are some examples of wild cats? **Possible answers: lions, cougars, tigers, jaguars**

💡 What does *domesticated* mean? **tamed for man’s use**
How are domesticated dogs used? **Possible answers: to herd sheep; to guard houses**

Name some kinds of nondomesticated dogs. **Possible answers: wolves, jackals, African wild dogs, dingoes**

How do most wild dogs hunt? **in packs**

Why are dogs used to track other animals or to find people? **Dogs have a good sense of smell.**

What is another group of carnivores? **pinnipeds**

Name two examples of pinnipeds. **Possible answers: seals, walruses, sea lions**

What is a pinniped’s primary food? **fish**

💡 Since a pinniped’s primary food is fish, where do you think pinnipeds are usually found? **in or near the water**



Pinnipeds

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Discussion

How are marine mammals different from pinnipeds? Pinnipeds can live on land, but marine mammals live only in the ocean.

Why do scientists identify whales as mammals instead of fish? Possible answers: They have the characteristics of mammals—hair, ear bones, and feeding their young with milk.

💡 Is a marine mammal able to breathe underwater? no Why? because as a mammal it has lungs, which require air.

What fatty substance insulates whales against the cold? blubber

What do baleen whales have instead of teeth? baleen plates

What do baleen whales eat? plankton and tiny crustaceans called krill

💡 What term describes animals like baleen whales that eat organisms they strain out of the water? filter feeders

What is a pod? a group of whales

Why are whales considered social animals? They travel in pods and communicate with each other by making noises.

What are some examples of toothed whales? Possible answers: dolphins, porpoises, orcas, and sperm whales

How are toothed whales similar to bats? They use echolocation to navigate the waters where they travel.

What are some characteristics of primates? good eyesight, "hands" that grasp

What are three groups of primates? lemurs, monkeys, and apes

💡 Find Madagascar on the map. Like Australia, this island nation is home to animals that are found in only a few other places.

Which primates are found in Madagascar? lemurs and related primates

What do you think it means by related primates? primates that are similar to lemurs

Into what two groups do scientists usually divide monkeys? New World monkeys and Old World monkeys

What are some characteristics of New World monkeys? broad noses and long, useful tails

💡 Why are these monkeys called New World monkeys? They are found in the New World.

💡 What part of the world is considered the New World? North, South, and Central America



Marine mammals

Pinnipeds spend much time in the ocean, but they can also live on land. However, some mammals live only in the ocean. Marine mammals may seem to lack the requirements for being mammals, but they too have hair, ear bones, and milk to feed their young. These mammals belong to the whale family. Whales have a fatty substance called **blubber** that insulates them against cold. Blubber is so rich in oil that people used to hunt whales to get this oil.

Some whales, called baleen whales, strain their food out of the water. Instead of teeth, these whales have giant plates, called *baleen plates*, in their mouths. Baleen plates help the whales gather plankton and tiny crustaceans called *krill*. The blue whale, the largest whale, can eat around 3500 kg (about 7,700 lb) of krill per day!

Whales are social creatures. They travel in groups called **pods**. Whales communicate to their pods with sounds. The most famous noise is the male

humpback whale's "song." Scientists do not know exactly why the humpback whale sings, but the song is one of the most interesting sounds of the ocean.

Toothed whales are usually smaller than the baleen whales. The smallest toothed whale is about 1.3 m (4 ft) long, and the largest is about 18 m (59 ft) long. Toothed whales can bite into their food. Dolphins, porpoises, orcas, and sperm whales all belong to this group. Toothed whales use echolocation in a manner similar to that of bats. Dolphins are well known for the clicking sounds that they use to navigate the ocean.



130

SCIENCE BACKGROUND

Old World monkeys

Scientists differ on which families of primates to include in this group.

SCIENCE MISCONCEPTIONS

Students will generally hear mankind referred to as a mammal. In fact, in the classification system, man is classified as a mammal and as a primate. Although man's physical characteristics are similar to those of mammals, students should always be reminded that man is a separate and special creation of God. Only man can have a personal relationship with God, his Creator and Savior.

Primates

Many primates are tree-dwelling mammals. They typically have good eyesight and have “hands” that can grasp. Some of the more familiar groups include lemurs, monkeys, and apes. Most lemurs have long snouts, similar to those of dogs. Many lemurs and related primates live in Madagascar, an island off the east coast of Africa.

Scientists usually divide monkeys into two groups, New World monkeys and Old World monkeys. New World monkeys are found in Central and South America. They have broad noses, and most have tails that can be used almost like arms.

Old World monkeys include baboons, mandrills, and colobus monkeys. Apes are the largest of the primates and have no tails. They include chimpanzees, gorillas, and orangutans. Many of the Old World monkeys and apes live in groups with a clearly defined social order. Old World monkeys are found primarily in Africa and in both South and East Asia.



gorilla

Humans

Humans also have all the physical characteristics necessary to be mammals. But humans are not animals. Some scientists say man is different from animals only because he is rational—he can think. But the real difference is that man was created separately from the rest of creation and was formed in the likeness and image of God.



lemurs



QUICK CHECK

1. Name four characteristics of all mammals.
2. How do bats and toothed whales use echolocation?
3. How are monotremes different from other mammals?

131

DIRECT A DEMONSTRATION

Demonstrate water vapor condensing

Materials: bowl of ice, mirror or window

The water seen spouting from a whale is actually the water vapor of the whale's exhaled air condensing as it hits air of a different temperature. To illustrate this concept, place the bowl of ice against the mirror or against the window. Forcefully exhale over the ice so that the air hits the mirror or window. As the air blows over the cooler ice and hits the mirror or window, it condenses into water droplets. This is also what happens when you see your breath while breathing outside on a cold day.



HISTORY The United States Navy has trained bottle-nosed Atlantic dolphins to search for explosive mines planted by enemy troops. The dolphins use echolocation to find the mines so that the mines can be removed or disarmed safely.

Discussion

Which areas of the New World have monkeys?
Central America and South America

Find Central and South America on the map.

Where are Old World monkeys and apes found?
Africa, South Asia, and East Asia

Find Africa, South Asia, and East Asia on the map.

Give some examples of Old World monkeys.
baboons, mandrills, and colobus monkeys

Give some examples of apes.
chimpanzees, gorillas, and orangutans

Why do some scientists classify man as a mammal?
because man has all the physical characteristics of mammals

Why is a man not a mammal? Man was created separately from the rest of creation and was formed in the likeness and image of God.

Read aloud Genesis 1:24–27 and 2:7.

Is man's special glory the fact that he is rational? no
Was man created as one of the animal groups? no
Explain. God created man separately and unique from all other creation.

How was man made? in the likeness (image) of God

Discuss what it means to be made in the image of God. Include that man has a relationship with God and other people, that man is the head of creation on Earth, and that man lives forever.

Answers

1. Possible answers: have hair or fur; are warm-blooded; bear live young; feed young with milk from the mother's body; have a four-chambered heart; have three middle ear bones; breathe with lungs
2. They bounce sounds off objects. The length of time needed for the sound to return tells them their distance from the objects.
3. Monotremes are the only mammals that lay eggs.

Activity Manual

Reinforcement, page 82

Review, pages 83–84

These pages review Lessons 63–66.

Assessment

Quiz 5-C

The quiz may be given any time after completion of this lesson.

Objectives

- Formulate a hypothesis
- Model the insulating properties of animal blubber
- Experiment to test each model as an insulator
- Record temperatures and observations

Materials

- See Student Text page
- buckets or large containers to transport and dispose of the water and ice

Introduction

Review the usefulness of blubber in whales.

What is blubber? a fatty substance

How is blubber helpful to whales? Blubber insulates their bodies against the arctic cold.

What other animals have blubber to help keep them warm? Possible answers: polar bears, seals

Teach for Understanding**Purpose for reading**

Display shortening, batting, and plastic bags.

How do you think these materials could be used to show how walrus blubber insulates the animals from cold temperatures and keeps body heat from escaping? Answers will vary.

The student should read all the pages before beginning the activity.

**Blubber Mitts**

Walruses live in arctic conditions. They rest and bear their young on snow-covered moving ice called *ice floes*, where the air temperature may be as low as -50°C (-58°F). Walruses can dive deep in the icy arctic waters. To survive the frigid conditions, walruses have thick, tough skin, much like that of a rhinoceros. Under the skin is a thick yellow layer of blubber. Why has God given walruses this layer of blubber? Experiment to find out how effective different materials are at insulating against the cold.

Problem

What materials best insulate against cold?

Preparation

1. Make the **non-insulated mitt** with two plastic bags. Carefully turn one plastic bag inside out. Place your hand inside this bag and push it into the bag that is right-side-out. Zip together the two bags so you can still insert your hand.
2. Make the **batting-insulated mitt** with two plastic bags and the piece of quilt batting. Repeat step 1, but fold the batting in half and insert it into the right-side-out bag before inserting the inside-out bag.
3. Make the **blubber-insulated mitt** with two plastic bags and the shortening or lard. Repeat step 1, but place 500 mL of shortening in the right-side-out bag before inserting the inside-out bag. Tape the top edge as needed for a better seal. Squish the shortening until it makes a layer about as thick as the batting in the batting-insulated mitt.

Materials

- 6 resealable bags
- 15 cm \times 30 cm piece of quilt batting, 1 cm thick
- 500 mL solid shortening or lard
- metric measuring cup
- rubber spatula
- masking tape (optional)
- deep dishpan
- ice cubes
- water
- 4 thermometers
- clock or timer
- Activity Manual



132

**Duration of activity**

This activity may be done in one or two days. If continuing the activity a second day, allow the students to bring other insulating materials to test.

Dishpan and ice

A dishpan is listed in the materials, but any container deep enough to hold the mitts, ice, and water will work.

Prepare ice cubes the day before. Keep them in an ice chest. You need enough ice to fill the dishpan half full.

Resealable bags

Self-sealing plastic bags with sliding zipper closures will not work for this activity.

Measuring

To reduce the mess when measuring the shortening, place the plastic bag inside the measuring cup and flatten the sides of the

bag around the edges of the measuring cup. Measure the correct amount of shortening directly into the bag.

If you would rather not have the student measure the shortening, prepare the bags ahead of time.

SCIENCE BACKGROUND**Desert mammals**

Camels, alpacas, and llamas have fur, which helps to insulate their bodies from the desert heat.

Body insulators

Insulators such as blubber not only protect the body from the cold temperatures on the outside, but they also decrease the loss of body heat. The thick skin of the walrus protects it against the cold, and the food eaten by the walrus provides energy that is transformed into heat. As an animal eats, it replenishes lost heat.

- Process Skills**
- Predicting
 - Measuring
 - Experimenting
 - Observing
 - Inferring
 - Recording data

Procedure

1. Write your hypothesis in the Activity Manual, stating which mitt you think will insulate the best against the cold.
2. Fill the dishpan half full with ice. Add water, filling to about 5 cm from the top of the dishpan.
3. In column A on the chart, record the temperature of each thermometer at room temperature.
4. Two or three people are needed. Insert a hand and a thermometer into each mitt. Keep the hands inside the mitts until step 8 is finished. Hold the fourth thermometer in the water. (Do not place the mitts into the water yet.)
5. After 2 minutes, check and record in column B the temperatures of each mitt and the water. Then replace each thermometer.
6. Place each mitt into the ice water. Keep the fourth thermometer in the water.
7. After 2 minutes, check and record in column C the temperatures of each mitt and the water.
8. Return the thermometers. After 2 more minutes check and record in column D the temperatures of each mitt and the water. Repeat again after 2 more minutes, recording your temperatures in column E.

Conclusions

- Which mitt provided the best insulation against the cold?
- How can you apply what you have learned to other areas, such as special clothing for arctic explorations and mountain rescue teams?

Follow-up

- Try the activity using warm water instead of ice water. Will the results be the same?



133

SCIENCE PROCESS SKILLS

Collecting and Recording Data

Why is it necessary to record the temperature before putting the mitts in the ice water? To know how much the temperature changes, you must know what the starting temperature is.

Why is the data gathered at two-minute intervals rather than at five-minute intervals? Elicit that at five-minute intervals you may not be able to see the progression of temperature changes.

Gathering data at shorter intervals of time enables the observer to see the progression of changes in the experiment. If the observer gathered data at longer intervals of time, he would see the end result but not the progression.

Why is recording the data important?

With four different temperatures to check each time, it would be easy to forget or mix up the temperatures.

Procedure

Guide the students in preparing the different mitts. Make sure the narrow edges of the insulated bags have as much insulation as the flat sides.

Review how to read a thermometer accurately.

After making the mitts, direct the students to write their hypotheses in their Activity Manuals. Point out the location of the ice and assist the students as needed in setting up the dishpan and thermometers. Remind them to record the room temperature for each thermometer before placing them.

Conclusions

Which material was the best insulator against the cold water? shortening or lard

What do you think would happen if you decreased the amount of shortening in the blubber mitt? The mitt probably would not have insulated as well.

💡 What other materials would make good insulators? Possible answers: feathers, foam bits, wool, fake or real fur, sawdust, scrap fabric

How do your results help you understand the way blubber helps insulate a walrus? Answers will vary, but elicit the idea that a walrus's blubber works similarly to how the shortening provided insulation against the ice water.

How can you apply what you learned about insulation and put it to practical use? Answers will vary but may include a discussion of clothing and building materials.

Use the questions in Science Process Skills to discuss collecting and recording data.

Activity Manual

Activity, pages 85–86

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Objectives

- Associate animal parts with mechanical tools
- Research to design a robotic animal
- Create a drawing and description of a robotic animal

Materials

- picture of a hang glider
- resources, such as encyclopedias and trade books about animals
- unlined paper or poster board
- colored pencils, felt-tip pens, or crayons

Introduction

Two lesson days are allotted for this exploration. On the first day, introduce the exploration, set guidelines and a due date for the drawings and reports to be completed, and begin planning. The second lesson day may occur later after the drawings and reports are finished.

Which manmade system models a bat's or dolphin's echolocation? sonar

We can learn and apply many concepts of movement and operation by watching the world around us.

Display the picture of the hang glider.

Of what animal does the hang glider remind you?

Possible answers: any large soaring bird, such as an eagle, a hawk, or an albatross

How does a hang glider remind you of the wing-span of an eagle? The shape and support rods on the glider are like the shape and bone structure of an eagle's wings.

Teach for Understanding**Purpose for reading**

How does the mantis shrimp use its hard "elbow" to get food?

How are the mantis shrimp's eyes shaped?

The student should read all the pages before beginning the exploration.

Discussion

 God has made man to have dominion over the earth. Part of that dominion is man's curiosity and creativity in producing new things. Often God's creation provides the inspiration and pattern for these new things.

**Animal Robotics**

Many of the tools and machines that man designs are based on the superior design of God's creation. For example, man designed sonar, but many of God's creatures, such as bats and dolphins, have built-in sonar. Man uses scuba flippers to move around underwater, but God has equipped His aquatic creatures with ready-made flippers. God has created many complex creatures with bodies perfectly suited to their needs.

machines or tools would you use? Of course, what you use would depend on the animal you are making. Let's use a mantis shrimp as an example.

Mantis shrimp are crustaceans that pack a powerful punch for their size. The front appendages of a mantis shrimp fold under its head like those of a praying mantis. When it sees prey, the shrimp unfolds its appendages with the speed of a bullet. Some mantis shrimp are called spearers because the appendages have sharp spines on them that stab the victim. Others are called smashers because each appendage has a hard "elbow" that the shrimp uses to smash mollusks and other crustaceans. The mantis shrimp has been known to break divers' fingers and aquarium glass.

Good vision is also important for catching prey with lightning speed. The mantis shrimp has compound eyes that can see in every direction. These eyes rest on the top of short stalks. Each compound eye is radar-dish-shaped and has three pupils. Divers often see only the eyes of the mantis shrimp peering out from a sand burrow.

Use the picture of the robotic mantis shrimp in the Activity Manual to help you design your own robotic animal.



Perhaps you have seen someone with a mechanical part to replace a joint or missing limb. That mechanical part is designed to function as closely as possible to what it replaces. Suppose you were to replace some parts of an animal with mechanical parts. What

134

**Possible animals**

Other possible animals include a pelican, armadillo, rhinoceros beetle, and hog-nose snake.

Grouping students

Students may work in groups to research and design the robotic animal. Each student should write his own description.

Make models

You may choose to have the students make models of their animals.

SCIENCE MISCONCEPTIONS**Classifying mantis shrimp**

The mantis shrimp is neither a mantis (insect) nor a shrimp. Like shrimp, it is a crustacean, but it is a member of the order Stomatopoda. Shrimp belong to the order Decapoda.

What to do

1. Choose an animal to use as your robotic animal. Pay close attention to unusual body parts that might be replaced by mechanical devices. You may use one of the following animals or choose one of your own: hummingbird, beaver, bombardier beetle, Komodo dragon, spade-foot toad, stalk-eyed mud crab.
2. Gather information about the animal you selected. How does your animal use its body parts? What parts remind you of tools or equipment that are used around us? Where does this animal live, and how does its environment affect the way it looks and uses its body?
3. Write a brief description of where the actual animal lives, what it eats, and any other information that you would like to include.
4. Draw a picture of your robotic animal. Label each tool, machine part, or piece of equipment that is used to replace an animal body part. Explain its function and how it would be useful. In parentheses, label the actual name of the animal's body part. For example, the paddles on the mantis shrimp are used for movement. These paddles are called swimmerets.
5. Display and explain your drawing. Read the description about your animal.



135

DIRECT AN ACTIVITY

Choose several animal parts. Discuss what function each part has. Allow a student to draw a mechanical device that corresponds to an animal part.

Suggestions:

swan's or duck's feet—paddles

woodpecker beak—drill

gecko frill or flying squirrel—hang glider

mole's front paws—shovel

Discussion

Stimulate student interest and imagination by discussing the features of the mantis shrimp. Relate each part of the shrimp to a mechanical device or tool. Direct attention to the picture on Activity Manual page 87.

What is an appendage? Answers may vary. Elicit that it is a claw- or arm-like body part.

💡 Why can a small appendage pack such a powerful punch? Answers may vary, but elicit that the speed increases the force the appendage produces. The leverage arrangement of the limb yields a mechanical advantage.

What does the shrimp use to smash mollusks and other crustaceans? its hard “elbow”

💡 Do you think the shrimp actually moves as fast as a bullet or as fast as lightning? no Why do we use these phrases? Accept any answer, but elicit that those descriptive phrases help us visualize that the shrimp is very fast.

How would periscope-mounted eyes be helpful to the mantis shrimp waiting in a sand burrow or crevice in a rock? Answers will vary but may include that the shrimp can see prey from all angles and can be ready to attack without leaving the security of its hiding place. It can also remain hidden from larger predators while it waits for food.

How could designing robotic animals help you glorify God? Possible answers: The design could allow it to perform tasks that are aspects of man's job described in Genesis 1:28 and Matthew 22:37. Possible tasks include fixing a problem, increasing efficiency or productivity, or spreading the gospel.

What to do

Explain your guidelines for the project (size, due date, materials to use, etc.). Guide the student in choosing and researching his robotic animal, making the drawing, and writing the description. You may choose to have the student include a Bible application to the description. Provide time for the student to present his drawing and information about the animal.

Activity Manual
Explorations, page 87

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Objectives

- Recall concepts and terms from Chapter 5
- Apply knowledge to everyday situations

Introduction

Material for the Chapter 5 Test will be taken from Student Text page 136 and Activity Manual pages 75, 77–78, 83–84, and 88. You may review any or all of the material during this lesson. Questions similar to Solve the Problem or the ones in Thinking It Through, Activity Manual page 88, may appear on the test.

You may choose to review Chapter 5 by playing “Vertebrate vs. Invertebrate” or a game from the Game Bank on the Teacher’s Toolkit CD.

Diving Deep into Science

Information on this page reflects the concepts the student should know for the test.

Solve the Problem

In order to solve the problem, the student must apply material he has learned. The student should attempt the problem independently. The answer for this Solve the Problem is based on the material on Student Text pages 120–23. Answers will vary and may be discussed.

Activity Manual**Review, page 88**

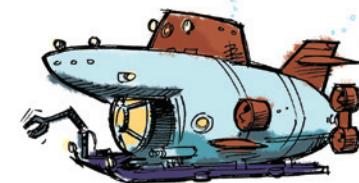
These pages require written responses to application questions.

Lesson 71**Objective**

- Demonstrate knowledge of concepts taught in Chapter 5

Assessment**Tests, Chapter 5****DIVING DEEP INTO SCIENCE****Words to Know**

invertebrate	setae	amphibian
vertebrate	arthropod	warm-blooded
nematocyst	exoskeleton	nocturnal
mollusk	molt	echolocation
spicule	crustacean	pride
radial symmetry	arachnid	blubber
filter feeder	insect	pod
bilateral symmetry	metamorphosis	
parasite	cold-blooded	
free-living	cartilage	

**Key Ideas**

- Characteristics of several phyla
- Identify some animals that belong to each phyla
- Stages of complete and incomplete metamorphosis for insects
- Characteristics of classes of vertebrates
- Stages of metamorphosis for frogs
- Differentiate between herbivores, omnivores, carnivores, and insectivores
- Explain why man is not an animal

Solve the Problem

Your little cousin brings a four-legged animal into the house. Your older brother is positive that it is a lizard and firmly declares it is a reptile. But you are not so sure. You think it might be a salamander. What animal group does a salamander belong to? What could you do to find out whether you or your brother is correctly classifying the animal?

A salamander is an amphibian. Its skin is smoother and moister than a lizard's skin. Usually salamanders are brightly colored. However, it would be best to use an animal classification guide or field guide to determine what the animal really is.

**Review Game****Vertebrate vs. Invertebrate**

Divide the students into two teams. Prepare a tick-tack-toe grid. The team using X as its symbol should receive questions about invertebrates. The team using O as its symbol should receive questions about vertebrates. After each game, or halfway through the review time, switch the question designation so that each team answers questions on all of the material.