

GRADE 2 LIFE SCIENCE: ANIMAL FAMILIES

A year of read-aloud visits with the great families of animals God made, from Dürer's armored rhinoceros and the platypus skin that puzzled the scholars of London to Audubon's eagles, the hummingbird at the feeder, the salmon leaping home up the river, the dancing bees of the hive, Maria Merian's caterpillars and the bones of the dinosaurs, each one looked at closely, sorted, counted, measured and then tried at the kitchen table with a child's own hands.

First edition

"And God made the beast of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind: and God saw that it was good." (Genesis 1:25, KJV)

COURSE GUIDE

This course takes a young child through the great families of animals, one family at a time: the **mammals**, the **birds**, the **reptiles**, the **amphibians**, the **fish** and the **insects**, then the **dinosaurs** and, last of all, the **life cycles** that carry each family from egg or seed to grown-up. Along the way your child meets a bat that sees with its ears, a whale that comes up for air, a platypus that lays eggs, a bald eagle on its great nest, a snake that smells with its tongue, a tadpole that grows legs, a shark with rows of teeth, a monarch that flies a long way south, and an armored dinosaur with a club on its tail.

Every lesson follows the same path. First comes **a story or a real animal**, read aloud by a parent: the rhinoceros that Albrecht Dürer drew without ever seeing one, the platypus skin that scholars first thought was a joke, Karl von Frisch watching his bees dance. Then the child **looks closely**: at a painting, a plate from an old nature book, a feather, a fish at the market or a beetle under a magnifying glass. Then the child **counts and measures**: how many legs, which is bigger, how many hands long. Last, the child **makes and does**: tests a “fur coat” in cold water, builds a bird-bone tube, raises tadpoles, builds a bug hotel or lays out a dinosaur to scale on the driveway.

The thread of the year is simple: **God made each animal after its kind, and every kind belongs to a family we can know by looking**. Fur and milk make a mammal. Feathers and hollow bones make a bird. Dry scales make a reptile; damp skin and two lives make an amphibian; gills and fins make a fish; six legs and three body parts make an insect. Week by week the child learns to ask three questions about any creature: What is it covered with? How does it breathe? How does it begin its life?

The faith thread runs through the whole year. On the sixth day, “**And God made the beast of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind: and God saw that it was good.**” (Genesis 1:25). Children hear that they that wait upon the Lord shall mount up with wings as eagles (Isaiah 40:31), and they sit in the boat with Peter when the nets break with fish at the word of Jesus (Luke 5). The course teaches a child to sort and name the creatures, as Adam did, and to thank the One who made them.

WHO IT IS FOR

Written for children in grade 2 (about ages 7–8), and easy to use with ages 5–8, with every lesson read aloud by a parent or older sibling. No reading or writing is required of the child, though a second grader may label drawings and write a word or two: everything is said, pointed to, sorted, matched, counted, built, measured or drawn. Counting stays under 100. Nothing needs to be bought beyond ordinary household things: crayons, paper, a ruler, a magnifying glass, a few jars and bowls, some clay or play dough, and whatever feathers, shells and bugs you find outside.

HOW TO USE THIS COURSE

The weekly rhythm. The year has 32 lessons, one a week, in eight units of four, plus the optional Nature Lab. Each lesson takes two sessions of 30–40 minutes. Session 1 is the warm-up, the read-aloud, the words to know and the picture study. Session 2 is the make-and-do project, the simple practice and a page in the nature notebook. Short and happy is better than long and tired; stop while your child still wants more.

The ★ quarter path. Ten lessons are marked with ★: one or two from every unit. If you want a one-quarter course, or a lighter year alongside other science, teach just those ten. Together they cover what makes each animal family, the dinosaurs and the butterfly's life cycle.

The nature notebook. Use one plain sketchbook or a stack of paper in a folder for the whole year. After every lesson the child draws one thing: an animal with its family marks labeled, a feather, a fish's gills, an insect's six legs, a tadpole on the day it grew legs. The parent writes the date and one sentence the child says about the drawing. By spring the notebook is a field guide of the child's own.

Experiments and safety. The projects are gentle and use household things, but a grown-up is always close by. Wash hands after touching soil, pond water, feathers, fish, frogs, turtles or anything found outdoors. Look at wild animals but do not chase, pick up or feed them, and never touch a nest, an egg or a baby animal. Leave bees, wasps and snakes alone. If you raise tadpoles, follow your state's rules, take only a few, and return the young frogs to the same pond they came from.

Worked examples and practice. Each lesson has one very simple worked example, such as counting an insect's legs, telling which animal is bigger, reading a picture chart or measuring with hands or a ruler, and five short practice items. Most are done aloud, by pointing, drawing, sorting, matching or counting. The answers are given for the parent, so you never have to guess.

Unit reviews and unit projects. The last week of each unit adds a short oral review: six to eight questions a parent asks aloud, worth 20 points in all, answered by telling back (narration), pointing or drawing. Each unit also ends with a unit project that gathers the unit's work, such as My Mammal Book, My Bird Book, My Fish Aquarium or My Insect Field Guide. Keep them together; they make a fine show-and-tell at the end of the year.

A word about time. This course is written from a Christian view of creation (Genesis 1:1) and the Flood (Genesis 6–9). Children will see deep-time names such as “Jurassic” or “Ice Age” on museum signs, in picture books and on toy boxes, so the course teaches them as museum words, so that a child can read any sign or book with understanding. Wherever they come up, a 🕒 Thinking About Time box sets out, in very simple sentences, what the sign says, what we can see with our own eyes, and how Christians read it.

SCOPE AND SEQUENCE

Unit 1: Mammals (1–4)

Fur and milk, the marks of every mammal; bats that fly and find their way by sound; whales that live in the sea but breathe air; and the platypus, the egg-laying puzzle that surprised the scholars.

Unit 2: Birds (5–8)

Feathers and hollow bones made for flight; eagles that mount up with wings (Isaiah 40:31); the tiny hummingbird; and the bald eagle's comeback along America's rivers.

Unit 3: Reptiles (9–12)

Dry scales and warming up in the sun; snakes that smell with their tongues; crocodiles and alligators and how to tell them apart; and turtles that carry their homes on their backs.

Unit 4: Amphibians (13–16)

Animals with damp skin and two lives, one in the water and one on land; the tadpole that becomes a frog; salamanders under the log; and a tadpole nursery to raise and watch.

Unit 5: Fish (17–20)

Gills that breathe underwater; sharks and their rows of teeth; salmon that swim back up the river to the stream where they hatched; and Peter's great catch at the word of Jesus (Luke 5).

Unit 6: Insects (21–24)

Six legs and three body parts; the monarch's long journey south; Karl von Frisch and the dance that tells bees where the flowers are; and a bug hotel built for the backyard.

Unit 7: Dinosaur Kinds (25–28)

Sorting dinosaurs by their hips, lizard-hipped and bird-hipped; armored dinosaurs with plates and tail clubs; horned dinosaurs with frills; and a dinosaur laid out to scale, with  Thinking About Time boxes for the museum words.

Unit 8: Life Cycles (29–32)

How living things begin and grow up: the butterfly from egg to caterpillar to chrysalis to wing, the chicken from egg to hen, the frog from egg to tadpole to frog, and a bean plant from seed to pod.

Unit 9: Nature Lab (optional) (Any time)

Four outdoor lessons to use whenever the weather is fine: a nature journal walk, a backyard survey of every animal family you can find, a visit to a zoo, farm or museum, and a small

specimen collection.

MATERIALS

- **Nature notebook (a plain sketchbook, or paper in a folder):** One for the whole year. The child draws; the parent writes the date and one sentence the child says.
- **Crayons, colored pencils, a glue stick, child scissors and tape:** Used in nearly every lesson for drawing, cutting and building the unit books.
- **A ruler, a measuring tape, a yardstick and a magnifying glass:** For measuring animals, eggs and dinosaur models and for looking closely at feathers, scales, gills and insects.
- **Clear jars, bowls, cups and zip-top bags:** For the fur coat test, the tadpole nursery, looking at bugs and sorting found things.
- **Play dough or clay, paper tubes, paper plates and an egg carton:** For hollow-bone tubes, clay salamanders, egg carton insects, paper bowl turtles and armored dinosaurs.
- **A large clear jar or tub, pond or dechlorinated water and a few water plants:** For raising tadpoles in Unit 4. Follow your state's rules, or watch a frog life cycle at a nature center instead.
- **Dry beans, a clear cup and paper towels:** For sprouting a bean plant in Unit 8. Start a few weeks before the lesson so there is something to see.
- **Sticks, pinecones, hollow stems, bark and a small box or tin can:** For the bug hotel in Unit 6.
- **Sidewalk chalk and a ball of string or yarn:** For laying out life-size alligators and dinosaurs to scale on the driveway.
- **Optional: a picture field guide to birds, insects or animals:** Never required. Any library picture guide helps with the Nature Lab walks and the backyard survey.

GRADING

There are no letter grades in this course. Young children learn science by looking, telling back and doing, so the parent keeps a simple checklist instead: Did the child narrate the lesson, take part in the make-and-do, draw a notebook page and answer the oral review? The weights below are a guide for families who must report something to a school or state.

- Oral narration (tells the story or lesson back in his or her own words): 40%
- Make and do (takes part, follows steps, counts, sorts or measures): 25%
- Nature notebook (one dated drawing each lesson): 20%
- Unit reviews (oral, 20 points each): 15%

No letter grades. Mark each checklist item: Got it ✓, Growing ~, or Try again later. If a report is needed, use Satisfactory, Needs time, or Excellent.

- Narration is the heart of the checklist. A child who can name an animal's family and tell one or two marks that put it there (fur, feathers, scales, gills, six legs) has learned the lesson.

- Unit reviews are always oral. Ask the questions aloud and let the child answer by telling, pointing, sorting or drawing. The parent writes down the answers.
- A notebook page earns its check when it has the date, a drawing and one sentence the child said. Neatness is not graded.
- If a lesson did not take, try it again another day or skip ahead and return later. Many children understand an idea weeks after it was first taught.
- Keep the unit projects and the notebook together as the record of the year.

A NOTE TO PARENTS

You do not need to be a scientist to teach this course. Read the lesson aloud, look at the picture together, and then get down on the floor and do the project with your child. Ask “What do you see?”, “Which family does it belong to?” and “Why do you think God made it that way?” Those three questions are most of what a good first science teacher does.

Go outside as often as you can. A robin on the lawn, a lizard on a warm wall, a fish at the market counter, a beetle under a stone or a butterfly on the clover will teach more than a page ever could. Bring the nature notebook, sit still, and let your child look for a long time. By the end of the year your child will sort every creature in the yard into its family without being asked.

Above all, the course hopes to raise a child who notices the world, cares gently for living things and gives thanks to the One who made them. “But ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee” (Job 12:7).

CONTENTS

Unit 1: Mammals

- 1.1 Fur and Milk ★
- 1.2 Bats Fly
- 1.3 Whales Breathe Air
- 1.4 The Platypus Puzzle

Unit 2: Birds

- 2.1 Hollow Bones ★
- 2.2 Eagles Mount Up with Wings
- 2.3 Hummingbirds
- 2.4 The Bald Eagle's Comeback

Unit 3: Reptiles

- 3.1 Scales and Cold Blood ★
- 3.2 Snakes ★
- 3.3 Crocodiles and Alligators
- 3.4 Turtles

Unit 4: Amphibians

- 4.1 Two Lives ★
- 4.2 Tadpole to Frog
- 4.3 Salamanders
- 4.4 Raise Tadpoles

Unit 5: Fish

- 5.1 Gills ★
- 5.2 Sharks ★
- 5.3 Salmon Run Home
- 5.4 Peter's Great Catch (Luke 5)

Unit 6: Insects

- 6.1 Six Legs ★
- 6.2 Monarch Migration
- 6.3 The Bees' Dance
- 6.4 Bug Hotel

Unit 7: Dinosaur Kinds

- 7.1 Lizard-hipped and bird-hipped ★
- 7.2 Armored dinosaurs
- 7.3 Horned dinosaurs
- 7.4 Build a dinosaur model to scale

Unit 8: Life Cycles

- 8.1 The Butterfly's Life Cycle ★
- 8.2 The Chicken's Life Cycle
- 8.3 The Frog's Life Cycle
- 8.4 The Bean Plant's Life Cycle

Unit 9: Bonus: Nature Lab (optional)

9.1 Nature Journal Walk

9.2 Backyard Survey

9.3 Zoo, Farm or Museum Visit

9.4 Specimen Collection

★ quarter path ·  Thinking About Time box

MAMMALS

“And God made the beast of the earth after his kind, and cattle after their kind” (Genesis 1:25). This year your child meets the great animal families God made, and the first family is the one we know best: the **mammals**. Dogs, cats, cows, horses, squirrels and rabbits are all mammals. Your child will learn the two big clues that mark a mammal, fur or hair and milk for the babies, and will sort animals the way Carl Linnaeus did in 1758.

Then come three surprises. Bats fly, yet they are mammals, and they find bugs in the dark by listening to echoes. Whales live in the sea like fish, yet they breathe air through a blowhole and feed their calves milk. And the platypus, with its duck-like bill, lays eggs, yet it has fur and makes milk too. Each surprise teaches the same lesson: a good scientist looks closely before deciding.

Everything in this unit is told, pointed to, sorted, counted, built or drawn. Keep the drawings, the hand-wing bat and the play-dough platypus in a box. At the end of the unit your child will put them together into a Mammal Book.

BEFORE YOU BEGIN

- Can add and subtract numbers to 30
- Can count by twos and threes
- Can sort objects into two groups by one clue
- Can listen to a short story and tell it back

MASTERY CHECKLIST

- I can name the two big clues of a mammal: fur or hair, and milk for the babies.
- I can sort animals into mammals and animals that are not mammals.
- I can show how a bat’s wing is like a hand and tell how bats use echoes.
- I can tell how a whale breathes and how blubber keeps it warm.
- I can explain why the platypus is a mammal even though it lays eggs.
- I can say that God made each kind of animal and made it just right for its life.

OPTIONAL BOOKS AND RESOURCES

- **Smithsonian’s National Zoo and Conservation Biology Institute** (<https://nationalzoo.si.edu/>): Free. Animal pages and live animal cams. Look up bats and other mammals together, and watch the animals move, eat and care for their young.
- **NOAA Fisheries** (<https://www.fisheries.noaa.gov/>): Free. Search the species pages for the humpback whale and the blue whale to see photos of whales blowing, diving and swimming with their calves (Lesson 1.3).

- ***The Burgess Animal Book for Children* by Thornton W. Burgess (free at Project Gutenberg)** (<https://www.gutenberg.org/ebooks/search/?query=Burgess+Animal+Book>): Free. A classic read-aloud in which Peter Rabbit meets the mammals of North America, including the bats. Read a chapter or two each week alongside this unit.

1.1 FUR AND MILK ★

OBJECTIVES

- Name the two big clues that tell us an animal is a mammal: fur or hair, and milk for its babies.
- Sort animals into mammals and animals that are not mammals.
- Tell how Carl Linnaeus put the mammals together in one group and gave them their name.

Warm-up. Set out a wool sock or sweater and a glass of milk. Let your child feel the wool and take a sip of the milk. Ask: Which animal gave us this wool? (A sheep.) Which animal gave us this milk? (A cow.) Now pat a pet, or pat your own head. What do a sheep, a cow, a dog and you all have? Hair! Today we will learn what that clue means.

Video. Coming soon. Mammals for kids: what makes a mammal (fur or hair, milk for babies, breathing air), farm animal mothers nursing their young; search Smithsonian's National Zoo, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and gentle farm or zoo nature footage.

KEY TERMS

mammal

An animal with fur or hair whose mother makes milk to feed her babies. Dogs, cows, mice and whales are mammals.

fur

A thick coat of soft hair that covers an animal's body and keeps it warm.

milk

The first food a mammal mother makes in her own body to feed her babies.

warm-blooded

Able to keep the body warm inside all the time, even on a cold day. Mammals and birds are warm-blooded.

CORE IDEAS

The story. Put your hand on a dog, a cat or your own head. What do you feel? Hair! Now think of a baby calf on a farm. What does it drink? Its mother's milk. In 1758 a Swedish scientist named Carl Linnaeus was sorting all the animals he knew into groups. He put together the animals with hair whose mothers feed their babies milk. He named the group from a Latin word about a mother nursing her baby. We call these animals **mammals**.

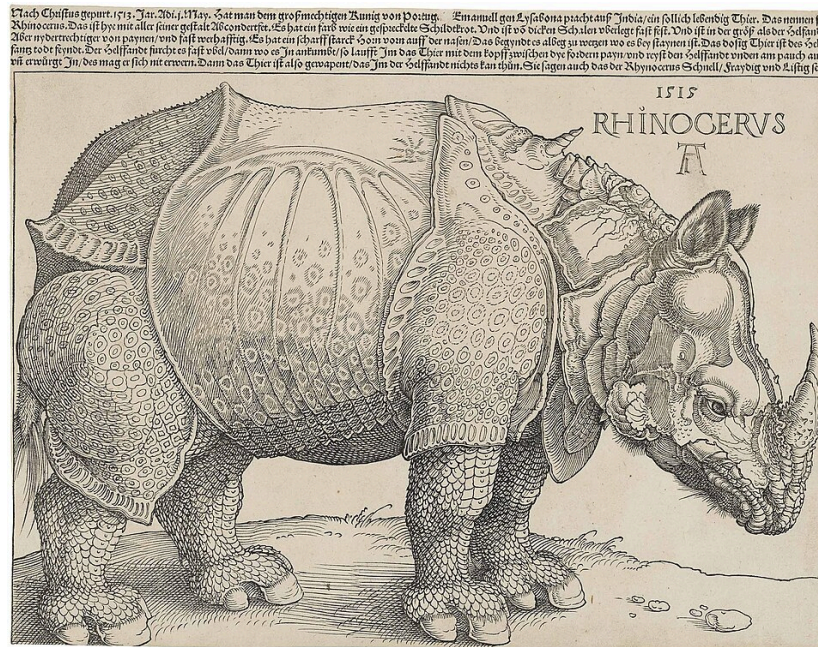
How they figured it out. Linnaeus did not sort animals only by where they live. He looked closely at their bodies and at how they care for their babies. A whale swims in the sea like a fish. But Linnaeus knew that a whale mother feeds her baby milk, so he put whales with the

mammals, not with the fish. Scientists still sort animals this way. They ask, “What is its body like? How does it feed its babies?”

The big idea. Mammals have **fur** or hair. Mammal mothers make **milk** for their babies. Mammals breathe air with lungs, and they are **warm-blooded**: they keep their bodies warm inside, even in the snow. Dogs, cats, cows, horses, mice, rabbits, bears and elephants are all mammals. Some mammals have thick fur, like a sheep. Some have only a little hair, like a rhinoceros, which has hair on its ears and the tip of its tail. A little hair still counts!

God’s handiwork. God made “the beast of the earth after his kind, and cattle after their kind” (Genesis 1:25). He gave each kind the coat it needs. A polar bear has thick fur for the ice. A horse grows a fuzzy winter coat and sheds it in spring. Your body has hair, and babies drink milk too. But God made people special, in His own image (Genesis 1:27), to name the animals and care for them.

PICTURE STUDY



Rhinoceros, Albrecht Dürer, 1515 · Woodcut print · Prints are kept in many museums, including the British Museum, London, and the National Gallery of Art, Washington

Albrecht Dürer was a great German artist who lived in the city of Nuremberg. In 1515 a real rhinoceros came by ship from India to Lisbon, Portugal, as a gift for the king. No one in Europe had seen one in a very long time. Dürer never saw it himself. He had only a letter and a quick sketch from someone who did. From these he carved this picture into a block of wood and printed it.

People all over Europe bought copies, and for a long time many thought a rhinoceros really looked like this. Dürer did his best, but a real rhinoceros does not wear plates of armor. Its thick, folded skin only looks a little like armor.

Look closely

- Find the big horn on the nose. Now find the small twisty horn on its back. A real rhinoceros does not have that one!
- Look at the skin. What does Dürer make it look like? Find the bumps and the plates.
- Find the ears and the tail. On a real rhinoceros, that is where some of its hair grows.
- Find the word RHINOCERVS and the year 1515 at the top of the print.

Talk about it

1. Dürer never saw a real rhinoceros. Why is it important for a scientist to look at the real thing?
2. Is a rhinoceros a mammal? What two clues would you look for to find out?

Safety first. Use warm water from the tap, not hot water from the stove or kettle. A grown-up should pour the water.

MAKE AND DO: THE FUR COAT TEST

Does a furry coat really keep an animal warm? You will dress one jar of warm water in a “fur coat” and leave the other jar bare. Then you will feel which one stays warm longer, just like a scientist.

You will need

- Two jars or mugs that are the same size
- Warm tap water
- A wool sock, a fuzzy scarf or a piece of fake fur
- A rubber band
- A kitchen thermometer, if you have one (not needed)
- Paper and crayons

Steps

1. Ask: Which jar will stay warm longer, the one with a fur coat or the bare one? Say your guess out loud.
2. A grown-up fills both jars with the same amount of warm tap water. Touch both jars. They should feel the same.
3. Pull the wool sock over one jar like a coat and hold it with a rubber band. Leave the other jar bare.
4. Set both jars side by side on the table and wait about 30 minutes. While you wait, look at a pet or a picture of a furry animal.
5. Take off the sock. Put a finger in the water of each jar. Which is warmer? If you have a thermometer, read both jars.
6. Draw the two jars. Color the warmer one red and the cooler one blue. Write or tell: “The fur coat kept the water warm.”

Tips

- Fur works by holding a layer of still air close to the body. The air keeps the warmth from escaping.
- Try it again with a cotton dish towel or a paper towel as the “coat.” Which coat works best?

Check your work

- I can tell which jar stayed warmer and why.
- I can say how fur helps a mammal stay warm.
- I can name the two clues that tell me an animal is a mammal.

NATURE NOTEBOOK

1. Draw a mammal that lives near you, such as a dog, cat, squirrel or cow. Draw an arrow to its fur and write the word “fur.”
2. Draw a mother animal feeding her baby milk, such as a cow and calf or a cat and kittens. Label the mother and the baby.
3. Make a page called “Mammals I Have Seen.” Each time you see a mammal this week, draw it small and make a tally mark.

From history. Linnaeus wrote a book called *Systema Naturae*, which means “The System of Nature.” In the edition printed in 1758 he gave each kind of animal a two-part Latin name, a little like a first and last name. The house cat became *Felis catus*. Scientists still use many of his names today. Linnaeus loved God’s creation and believed that studying nature was a way to honor its Maker.

WORKED EXAMPLES

Example 1. Look at the sorting chart. Eight animals are sorted by one clue: does it have fur? How many have fur? How many do not? Which ones are mammals?

Has fur	No fur
dog	robin
cow	goldfish
horse	frog
rabbit	snake

Sorting animals by one clue: fur.

1. Point to each animal in the “Has fur” side and count: dog, cow, horse, rabbit. That is 4.
2. Point to each animal in the “No fur” side and count: robin, goldfish, frog, snake. That is 4.
3. Check: $4 + 4 = 8$, and there are 8 animals in all.
4. The animals with fur are the mammals. Their mothers also feed their babies milk.

Answer: 4 animals have fur and 4 do not. The dog, cow, horse and rabbit are the mammals.

PRACTICE

1. **EASY** Tell two clues that show an animal is a mammal.
2. **EASY** Point to the mammals in this list as your parent reads it: cat, duck, cow, goldfish, mouse.
3. **MEDIUM** A farm has 6 cows, 4 horses and 5 chickens. How many mammals live on the farm?
4. **MEDIUM** Draw a mammal you saw this week. Draw an arrow to its fur or hair.
5. **HARD** A rhinoceros has very little hair. Is it still a mammal? Tell why.

COMMON MISTAKES

- Thinking only furry pets are mammals. Elephants, rhinoceroses, bats and whales are mammals too.
- Thinking every animal with four legs is a mammal. Frogs, lizards and turtles have four legs, but they have no fur and do not make milk.
- Thinking every animal that lives in the water is a fish. Whales and dolphins live in the sea, but they are mammals.

Make it a game · Mammal or Not? Your parent names an animal. If it is a mammal, pat your head (hair!) and say “Mammal!” If it is not, flap your arms, wiggle like a fish or slither like a snake. Try: cow, robin, mouse, goldfish, horse, frog, bear, snake, rabbit, duck. Score a point for each right answer. Then switch: you name the animals, and your parent pats or flaps.

Scripture. “And God said, Let the earth bring forth the living creature after his kind, cattle, and creeping thing, and beast of the earth after his kind: and it was so.” (Genesis 1:24, KJV)

God made the cattle and the beasts of the earth, each after its own kind. When we sort animals into groups like mammals, we are noticing the order God put into His world.

Practice answers

1. It has fur or hair, and the mother makes milk to feed her babies.
2. Cat, cow and mouse. The duck is a bird and the goldfish is a fish.
3. $6 + 4 = 10$ mammals. The chickens are birds, so they do not count.
4. Any real mammal, such as a dog, cat, squirrel, rabbit or horse, with an arrow pointing to its fur or hair.
5. Yes. It has some hair on its ears and the tip of its tail, and a mother rhinoceros feeds her baby milk.

1.2 BATS FLY

OBJECTIVES

- Tell why a bat is a mammal and not a bird.
- Show how a bat's wing is made like a hand, with a thumb and four long fingers.
- Explain how bats use echoes to find their way and catch bugs in the dark.

Warm-up. Stand in a hallway or a big empty room and clap once, hard. Listen. Then try it outside in an open yard. Where did the clap seem to bounce back to you? Now spread your fingers as wide as you can and imagine thin skin stretched between them, like a kite. You have just made a bat's wing!

Video. Coming soon. Bats for kids: bats flying in slow motion, bat wings with long finger bones, echolocation explained, bats leaving a cave or bridge at dusk; search Smithsonian's National Zoo, Bat Conservation International, SciShow Kids, Homeschool Pop (Alternate) and nature footage.

KEY TERMS

bat

The only mammal that can really fly. It has fur, and the mother feeds her baby, called a pup, with milk.

wing

A body part for flying. A bat's wing is thin skin stretched over very long finger bones.

echo

A sound that bounces off something and comes back to your ears.

echolocation

Finding things by making sounds and listening for the echoes. Bats use it to fly and hunt in the dark.

CORE IDEAS

The story. In the 1790s, in Italy, a priest and scientist named Lazzaro Spallanzani had a question. He knew that owls cannot fly in a room that is totally dark. So how do bats zip through the black night without bumping into things? He let bats fly in dark rooms, and they flew safely. But when their ears were plugged, they bumped into things! Bats were finding their way with their ears.

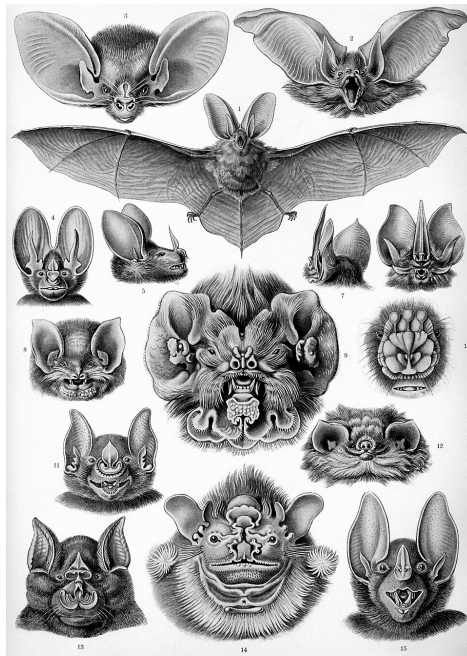
How they figured it out. For many years no one knew what the bats were hearing. Then, in 1938, a college student named Donald Griffin brought bats to a special machine that could pick up very high sounds. The machine showed that the bats were calling all the time! Their calls are so high that our ears cannot hear them. Each call bounces off a moth or a tree and

comes back as an **echo**. The bat listens and knows where things are. Griffin named this **echolocation**.

The big idea. A bat is not a bird. It has fur, not feathers. A mother bat feeds her baby, called a pup, with milk. Bats are the only mammals that can truly fly. Look closely at a bat's **wing** and you will find a hand! It has a small thumb with a claw and four very long fingers. Thin skin stretches between the fingers and down to the legs. When a bat rests, it hangs upside down by its feet.

God's handiwork. Bats are good helpers. Many bats eat night-flying bugs, such as moths and mosquitoes. In warm lands, some bats sip nectar from flowers and carry pollen, the way bees do. Others eat fruit and drop the seeds, and new trees grow. The Bible says that God makes the darkness, and then the creatures of the forest come out (Psalm 104:20). God made the bats to do their work while we sleep.

PICTURE STUDY



*Chiroptera (Bats), Plate 67 of Art Forms in Nature, Ernst Haeckel, 1899–1904 (the book came out in parts) · Printed plate from the book *Kunstformen der Natur* · Published in Leipzig, Germany; copies are kept in many libraries*

Ernst Haeckel was a German scientist who loved to draw living things. He made a big book of 100 pictures called *Art Forms in Nature*. On this page he drew the faces of many different kinds of bats, up close, so we can see things that are hard to see when a bat flies by at night.

Some bats have huge ears for catching echoes. Some have strange flaps of skin on their noses, called nose leaves. Bats with nose leaves send out their calls through their noses, and the leaf helps aim the sound.

Look closely

- Count the bat faces you can find on the page.
- Find the bat with the biggest ears. Why might it need such big ears?
- Find a nose with a leaf-shaped flap on it.
- Find some tiny sharp teeth. What do you think those teeth are good for?

Talk about it

1. How are these faces different from a bird's face? (Look for fur, ears and teeth.)
2. Which bat face do you like best? Tell why.

Safety first. Never touch a bat, even one lying on the ground. Some bats carry a sickness called rabies. If you find a bat, stay back and tell a grown-up. Use child-safe scissors for the project, with a grown-up nearby.

MAKE AND DO: HAND-WING BAT

A bat's wing is really a hand with very long fingers. You will trace your own hand and turn it into a bat wing, so you can see the thumb and fingers inside it. Then you will hang your bat upside down, just like a real bat at rest.

You will need

- Black, brown or gray paper (two sheets)
- A pencil and a white crayon or chalk
- Child-safe scissors
- Crayons or markers
- A piece of string and tape

Steps

1. Lay your hand on the paper with your fingers spread wide. Trace around it with a pencil.
2. Now make the fingers much longer. Draw a long line out from the tip of each of your four fingers, almost to the edge of the paper. Leave the thumb short.
3. Draw a curvy line from fingertip to fingertip, and from the last finger down toward the bottom of the paper. This is the skin of the wing.
4. Trace the finger lines with white crayon so they show, like bones. Draw a tiny claw on the thumb.
5. Cut out the wing. Make a second wing the same way with your other hand.
6. Draw a small furry body with big ears on another piece of paper, cut it out and tape a wing to each side.
7. Tape a string to the bat's feet and hang it upside down from a doorknob or a shelf. Point to the thumb and count the long fingers.

Tips

- If tracing the second hand is hard, fold the paper in half and cut both wings at once.
- Go outside near a wall or a building and clap. Can you hear the echo? That is the kind of sound a bat listens for.

Check your work

- I can point to the thumb and the four long fingers in a bat's wing.
- I can tell why a bat is a mammal and not a bird.
- I can explain how a bat uses echoes to find a moth.

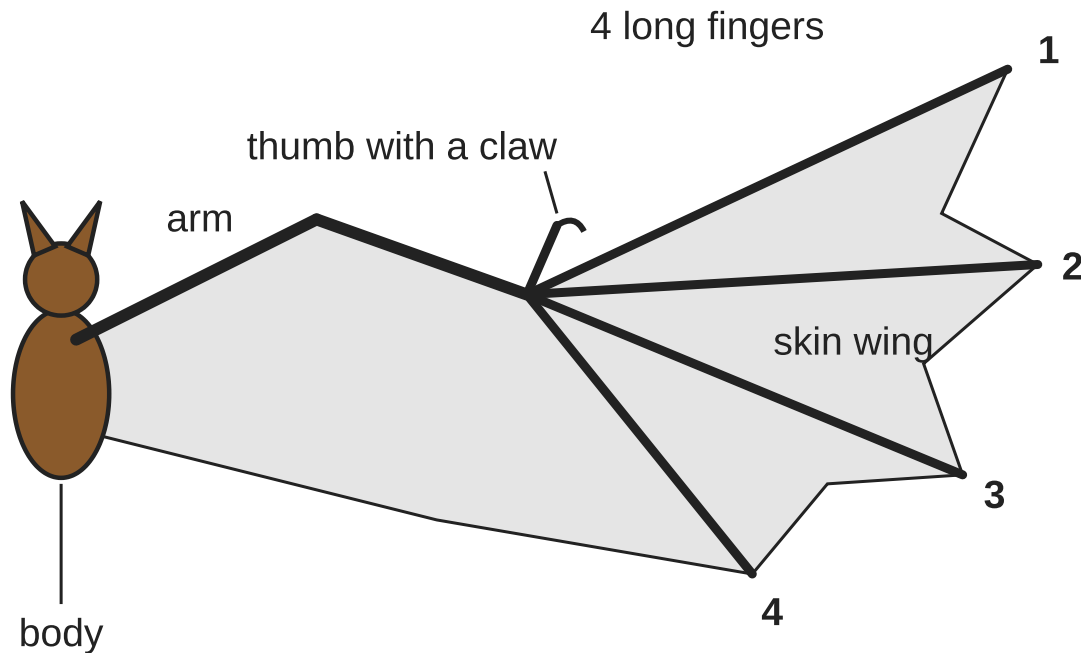
NATURE NOTEBOOK

1. Draw a bat hanging upside down. Label its fur, its ears, its thumb and its wing.
2. Draw a bat and a bird side by side. Under each, write one clue: "fur" under the bat and "feathers" under the bird.
3. Go outside at dusk with a grown-up on a summer evening and watch the sky. If you see bats darting after bugs, draw what you saw and write the date.

From history. In Austin, Texas, a huge colony of Mexican free-tailed bats lives in the cracks under the Congress Avenue Bridge. On summer evenings people gather on the bridge and along the river to watch the bats pour out at dusk in a long, dark ribbon across the sky. The bats fly off to hunt night-flying bugs over the fields and come home before morning. It is one of the largest city bat colonies in the world.

WORKED EXAMPLES

Example 1. Look at the bat wing picture. How many long fingers hold up the skin of the wing? Add the thumb. How many in all? Compare with your own hand.



A bat's wing is a hand: a thumb with a claw and four long fingers, with skin stretched between them.

1. Find the long finger bones. They are numbered 1, 2, 3 and 4. That is 4 long fingers.
2. Find the short thumb with a claw near the top. That is 1 more.
3. Add: $4 + 1 = 5$.
4. Now count your own hand: 4 fingers and 1 thumb make 5. The bat's hand has the same number, but its fingers are much longer.

Answer: 5: a thumb and 4 long fingers, the same number as on your hand.

PRACTICE

1. **EASY** Does a bat have feathers or fur?
2. **EASY** What is a baby bat called, and what does it drink?
3. **MEDIUM** Three bats hang upside down in a barn. Each one holds on with 2 feet. How many feet are holding on?
4. **MEDIUM** Clap near a wall and then clap in the middle of an open field. Where do you hear an echo better? Why?
5. **HARD** Tell in your own words how a bat catches a moth in the dark.

COMMON MISTAKES

- Thinking bats are birds. Bats have fur, not feathers, and the mothers feed their pups milk, so bats are mammals.
- Thinking bats are blind. All bats can see. Many fruit bats see very well, and bats that hunt bugs use their ears and their eyes together.
- Thinking bats try to fly into people's hair. Bats use echoes to steer around things, and they are hunting bugs, not people.

Make it a game · Bat and Moth. Play in a clear room or yard with nothing to trip over. One player is the bat and wears a blindfold or keeps eyes shut. The other players are moths. The bat calls "Bat!" and every moth must answer "Moth!" right away. The bat follows the sounds and tries to gently tag a moth. A tagged moth becomes the next bat. Afterward, talk about it: how is this like a real bat listening for echoes?

Scripture. "Thou makest darkness, and it is night: wherein all the beasts of the forest do creep forth." (Psalm 104:20, KJV)

God made the night as well as the day, and He made creatures to live and work in each. When the sun goes down, the bats come out to hunt, all part of God's good plan.

Practice answers

1. Fur. Birds have feathers; bats have fur.
2. A pup. It drinks its mother's milk.
3. $2 + 2 + 2 = 6$ feet.
4. Near the wall. The sound bounces off the wall and comes back to your ears. In an open field there is nothing close by for the sound to bounce off.
5. The bat makes very high calls as it flies. The sound bounces off the moth and comes back as an echo. The bat hears the echo, knows where the moth is, and flies to catch it.

1.3 WHALES BREATHE AIR

OBJECTIVES

- Explain why a whale is a mammal and not a fish.
- Tell how a whale breathes through a blowhole and what its “blow” is.
- Read a bar chart to compare the lengths of a dolphin, a humpback whale and a blue whale.

Warm-up. Take a deep breath and hold it while your parent counts slowly. Let it out when you need to. Then breathe out a big “haaa” onto a cold window or a mirror. What do you see? A little cloud! When a whale comes up from the deep sea, it breathes out a big cloud like that, only much bigger.

Video. Coming soon. Whales for kids: humpback and blue whales surfacing and blowing, a close look at a blowhole, mother whales swimming with their calves, whale tails moving up and down; search NOAA Fisheries, Smithsonian Ocean, SciShow Kids, Homeschool Pop (Alternate) and ocean nature footage.

KEY TERMS

blowhole

The nose hole on the top of a whale’s head. The whale breathes in and out through it.

blubber

A thick layer of fat under a whale’s skin that keeps it warm in cold water.

calf

A baby whale. (A baby cow is also called a calf.)

lungs

The parts inside your chest that fill with air when you breathe. Whales have lungs, just like you.

CORE IDEAS

The story. Long ago, sailors on whaling ships climbed high up the mast to watch the sea. When they saw a puff of white mist shoot up from the water, they shouted, “There she blows!” That puff was a whale breathing out. In 1851 a Navy officer named Matthew Fontaine Maury gathered the logbooks of many whaling ships. He marked where whales had been seen and made a chart of the oceans to show sailors where to find them.

How they figured it out. A whale swims like a fish, so long ago many people called whales fish. But careful watchers saw that a whale must come up to the top of the water to breathe. A fish breathes under water with gills. A whale has **lungs**, like you. It breathes through a **blowhole** on top of its head. The “blow” is its warm, wet breath making a cloud in the air. Watch the tail, too. A fish’s tail swishes side to side. A whale’s tail goes up and down.

The big idea. A whale is a mammal. A mother whale gives birth to her baby, called a **calf**, in the water. The calf swims up for its first breath, often with a nudge from its mother. Then it drinks her rich milk. Many whales even have a few stiff hairs, like whiskers, on their heads. Under the skin, a thick layer of **blubber** keeps them warm in icy seas. The blue whale is the biggest animal we know of. It can grow longer than two school buses.

God's handiwork. On the fifth day of creation God filled the seas with living things, and the Bible says, "God created great whales" (Genesis 1:21). Think of how wisely the whale is made. Because the blowhole is on top of its head, a whale can take a breath while almost all of its body stays under the water. It does not even have to lift its face out of the sea.

PICTURE STUDY



Whalers, Joseph Mallord William Turner, about 1845 · Oil on canvas · The Metropolitan Museum of Art, New York

J. M. W. Turner was an English painter who loved to paint the sea, the sky and the light. In his time, ships sailed far out on the ocean to hunt whales. Whale oil was burned in lamps to light homes and streets at night.

Turner did not paint every little detail. He painted the feeling of being out on a wild sea, with spray, mist and clouds all swirling together. You have to look carefully to find everything that is happening.

Look closely

- Find the whale. Where is it in the picture?
- Find the small boats. How close are they to the whale?
- Find the white spray and mist. Some comes from the waves. What else near a whale might make a cloud of mist?

- Where do the sea and the sky seem to blend together?

Talk about it

1. How would the sailors in the boats know where a whale was, even when it was under the water?
2. Does this painting feel calm or exciting? What did Turner do to make it feel that way?

Safety first. Stay with a grown-up when using the bowl of ice water. Take your hand out as soon as it feels too cold, and never keep a bare hand in ice water for more than half a minute.

MAKE AND DO: BLUBBER GLOVE AND WHALE BREATH

How does a whale stay warm in icy water? You will make a “blubber glove” and test it in ice water. Then you will make your own whale blow on a cold mirror.

You will need

- A large bowl of cold water with plenty of ice
- Two zip-top sandwich bags
- About 1 cup of solid vegetable shortening
- A spoon
- A small hand mirror chilled in the refrigerator for about 10 minutes
- A towel

Steps

1. Ask: Will a finger in a blubber glove feel the cold water more or less than a bare finger? Say your guess.
2. Spoon the shortening into one bag. Put your hand into the empty bag, then push it, bag and all, into the bag of shortening. A grown-up squishes the shortening all around your hand. This is your blubber glove.
3. Put your bare other hand into the ice water for a few seconds. How does it feel? Take it out and dry it.
4. Now put the hand with the blubber glove into the ice water. Keep the top of the bags above the water. How does it feel?
5. Tell which hand felt warmer. The fat kept the cold away, just like a whale’s blubber.
6. Now take the cold mirror and breathe a big warm “haaa” onto it. Look at the cloud your breath makes. Your warm, wet breath turned to a mist on the cold glass. A whale’s blow is warm, wet breath that makes a cloud in the cool air over the sea.

Tips

- If you do not have shortening, a thick wool sock under a plastic bag works too, but the fat works best.

- Count slowly while each hand is in the water, and compare: which hand could stay in longer before it felt cold?

Check your work

- I can tell how blubber keeps a whale warm.
- I can explain that a whale's blow is its breath, not a fountain of seawater.
- I can name three clues that show a whale is a mammal.

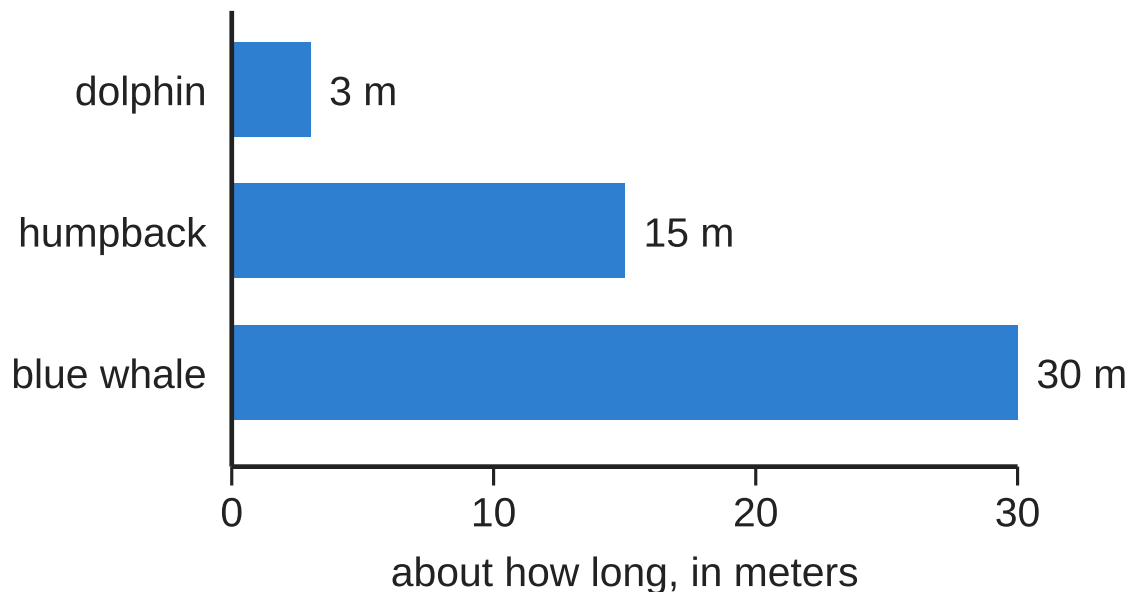
NATURE NOTEBOOK

1. Draw a whale at the top of the water, breathing out. Label the blowhole, the blow and the tail.
2. Draw a fish tail swishing side to side and a whale tail moving up and down. Add arrows to show the way each one moves.
3. Draw a mother whale and her calf swimming together. Label the calf and write one thing the calf needs from its mother.

From history. In the 1800s many lamps in America burned whale oil. Then, in 1859, Edwin Drake drilled an oil well in Titusville, Pennsylvania. Soon kerosene made from rock oil was cheaper and easier to get than whale oil, and families began to fill their lamps with it instead. Today laws protect whales, and humpback whales have come back in large numbers in many seas.

WORKED EXAMPLES

Example 1. The bar chart shows about how long three sea mammals can grow. Which one is longest? How much longer is the blue whale than the humpback whale?



About how long a bottlenose dolphin, a humpback whale and a blue whale can grow, in meters.

1. Put your finger at the end of each bar and read the number under it. The dolphin is about 3 meters. The humpback whale is about 15 meters. The blue whale is about 30 meters.
2. The longest bar is the blue whale's, so the blue whale is the longest.
3. Take away to compare: $30 - 15 = 15$. The blue whale is about 15 meters longer than the humpback.
4. A meter is about one big step for a grown-up. So a blue whale is about 30 big steps long!

Answer: The blue whale is the longest. It is about 15 meters longer than the humpback whale, or about twice as long.

PRACTICE

1. **EASY** Where is a whale's blowhole? Point to the same place on your own head.
2. **EASY** What is a baby whale called? What does it drink?
3. **MEDIUM** A whale comes up and blows 4 times. It dives, then comes up again and blows 5 more times. How many blows did you see in all?
4. **MEDIUM** Use the bar chart. A dolphin is about 3 meters long. About how many dolphins, lined up nose to tail, would be as long as one humpback whale?

(Use the map or drawing “Use the chart to compare the dolphin and the humpback whale.” shown earlier in this lesson.)

5. **HARD** A shark and a whale both swim in the sea. Tell two ways a whale is different from a shark.

COMMON MISTAKES

- Thinking whales are fish because they live in the sea. Whales breathe air with lungs and feed their babies milk, so they are mammals.
- Thinking the whale’s spout is a fountain of seawater squirted out of its mouth. The blow is the whale breathing out warm, wet air through its blowhole.
- Thinking whales can breathe under water. A whale can hold its breath a long time, but it must always come back up to the top to breathe.

Make it a game • There She Blows!. Your child “swims” around the room. Your parent names a sea animal. If it is a mammal (whale, dolphin, seal, manatee, sea otter), the child surfaces: stands tall, throws both arms up like a spout and shouts “There she blows!” If it is a fish (shark, tuna, goldfish, salmon), the child wiggles a fish tail side to side. Score a point for each right answer. Then switch places.

Scripture. “And God created great whales, and every living creature that moveth, which the waters brought forth abundantly, after their kind, and every winged fowl after his kind: and God saw that it was good.” (Genesis 1:21, KJV)

The great whales are among the very first animals the Bible names. God made them, and He saw that they were good.

Practice answers

1. On the top of its head. The child points to the top of their own head.
2. A calf. It drinks its mother’s milk.
3. $4 + 5 = 9$ blows.
4. Count by threes to 15: 3, 6, 9, 12, 15. That is 5 dolphins.
5. Any two: a whale breathes air with lungs through a blowhole, but a shark breathes water with gills; a whale mother feeds her calf milk; a whale’s tail moves up and down, but a shark’s tail moves side to side; a whale has blubber and a few hairs.

1.4 THE PLATYPUS PUZZLE

OBJECTIVES

- Describe the platypus: its fur, bill, webbed feet, eggs and milk.
- Explain why the platypus is still a mammal even though it lays eggs.
- Use a chart to compare the platypus with a dog and a duck.

Warm-up. Play “Mixed-Up Animal.” One person names a head (a duck’s), the next names a body (an otter’s), and the next names a tail (a beaver’s). Draw the silly animal together, fast, and laugh. Then ask: Could a real animal look a little like that? Today you will meet one.

Video. Coming soon. Platypus for kids: a platypus swimming and hunting under water with its eyes shut, its bill and webbed feet up close, and the spiny echidna, the other egg-laying mammal; search Zoos Victoria, Taronga Zoo, Smithsonian’s National Zoo, SciShow Kids and nature footage.

KEY TERMS

platypus

A furry mammal from Australia with a flat bill, webbed feet and a wide tail. The mother lays eggs and feeds her babies milk.

bill

A flat mouth that sticks out like a duck’s. A platypus bill is soft and rubbery, not hard.

webbed feet

Feet with skin between the toes, like paddles, for swimming.

egg-laying mammal

A mammal whose babies hatch from eggs. Only the platypus and the spiny echidnas are mammals like this.

CORE IDEAS

The story. Around 1799 a strange dried skin reached London from Australia, far across the sea. It had soft brown fur, a flat bill like a duck’s and webbed feet. A scientist named George Shaw studied it and wrote about it. He could hardly believe his eyes. Some people thought a trickster had sewn a duck’s bill onto a furry body as a joke! The story is told that Shaw even looked for stitches. There were none. The animal was real. It was the **platypus**.

How they figured it out. The puzzle was not finished. Scientists could see the fur, and later they learned that platypus mothers make milk. But did the mother lay eggs like a duck, or have live babies like a dog? People argued about it for years. In 1884 a young Scottish scientist named William Caldwell went to Australia to find out. With help from Aboriginal

hunters who knew the animals well, he found a platypus mother with eggs. He sent the news across the world by telegram: the platypus lays eggs!

The big idea. The platypus is a mammal, because it has fur and the mother feeds her babies milk. But it is an **egg-laying mammal**, and only it and the spiny echidnas are like that. The mother lays one to three tiny eggs, usually two, and curls around them in her burrow to keep them warm. When the babies hatch, they lap up milk that comes out onto her belly fur. Under water a platypus shuts its eyes and ears tight. It finds worms, shrimp and bugs with its soft **bill**, which can sense the tiny movements of its prey.

God's handiwork. The platypus reminds us that God does not have to fit our boxes. He made each kind just right for its life: **webbed feet** for paddling, a bill for hunting in the mud, and a wide flat tail that stores fat for hard times. The scientists did not throw the puzzle away. They kept looking until they understood. That is what good scientists do. As Job said, "ask now the beasts, and they shall teach thee" (Job 12:7).

PICTURE STUDY



The Duck-billed Platypus, Frederick Polydore Nodder, for George Shaw's *The Naturalist's Miscellany*, 1799 · Hand-colored engraving · Published in London; copies are kept in many libraries, and the book can be viewed free online

This is one of the very first pictures of a platypus ever printed. George Shaw wrote about the strange new animal in a book called *The Naturalist's Miscellany*, and the artist Frederick Nodder drew and engraved the picture. Each copy was colored by hand.

Nodder had probably never seen a living platypus. He worked from the dried skin that had come all the way from Australia. Look closely and think about what a scientist could and could not learn from a skin.

Look closely

- Find the bill. Does it look soft or hard? (A real platypus bill is soft and rubbery.)
- Look at the feet. Can you see the skin between the toes?
- Look at the tail. What other animal has a tail like that?
- What color is the fur? Does the animal look like it is swimming, walking or standing still?

Talk about it

1. If you had only this picture and a dried skin, what would you think about this animal?
2. What would you want to see with your own eyes to be sure the platypus was real?

Safety first. Never touch a wild platypus. A male platypus has a sharp spur on each back ankle that can give a very painful sting. For the bill hunt, keep small pasta shells away from babies and toddlers.

MAKE AND DO: HUNT LIKE A PLATYPUS

A platypus hunts with its eyes and ears shut tight. It finds its food by feeling with its bill. You will hunt the same way, with your eyes closed, using only your fingertips. Then you will build a play-dough platypus with all its puzzle pieces.

You will need

- A shallow tub or baking pan filled with dry rice or dry beans
- About 15 small pasta shells (these are the “shrimp”)
- A timer or a clock
- Brown and black play dough, plus a little white
- Paper and crayons for a tally chart

Steps

1. A grown-up hides the pasta shells in the rice and mixes them in.
2. Close your eyes tight, like a platypus under water. Your fingertips are your bill.
3. When the grown-up says “Go,” feel through the rice and pull out as many shells as you can in 1 minute.
4. Count your shells and make tally marks on your paper. Take two more turns. Did you get better with practice?
5. Now build a platypus from play dough: a brown body with fur lines pressed in with a fingernail, a flat black bill, a wide flat tail and four short legs with flat webbed feet.
6. Make two tiny white eggs and set them beside your platypus. Point to each part and tell whether it is a mammal clue, a duck-like clue or both.

Tips

- Try the hunt once with your eyes open and once with them shut. Which way was harder? A platypus does it with its eyes shut every time!

- Keep your play-dough platypus for your Mammal Book display at the end of the unit.

Check your work

- I can find things by touch, the way a platypus hunts with its bill.
- I can name the two clues that make the platypus a mammal.
- I can tell what makes the platypus so unusual.

NATURE NOTEBOOK

1. Draw a platypus swimming. Label its bill, its fur, its webbed feet and its tail.
2. Draw a platypus mother curled around her two eggs in her burrow.
3. Draw a platypus and a duck side by side. Circle the parts that look alike. Put a star on the parts that are different.

From history. Platypuses are shy and hard to keep in a zoo. In 1943, at Healesville Sanctuary near Melbourne, Australia, a naturalist named David Fleay became the first person to have a baby platypus hatch and grow up in a zoo. Today the platypus is a favorite animal in Australia, and it is pictured on the back of the Australian twenty-cent coin.

WORKED EXAMPLES

Example 1. Read the puzzle chart. How many “yes” boxes does the platypus have? Which clues does it share with the dog? Which does it share with the duck?

clue	dog	duck	platypus
fur	yes	no	yes
makes milk	yes	no	yes
lays eggs	no	yes	yes
has a bill	no	yes	yes
webbed feet	no	yes	yes

The platypus puzzle: which clues does it share with a dog, and which with a duck?

1. Run your finger down the platypus column: fur, yes; makes milk, yes; lays eggs, yes; has a bill, yes; webbed feet, yes. That is 5 yes boxes.
2. Find the yes boxes in the dog column: fur and makes milk. The platypus shares 2 clues with the dog.
3. Find the yes boxes in the duck column: lays eggs, has a bill and webbed feet. The platypus shares 3 clues with the duck.
4. Check: $2 + 3 = 5$. Fur and milk are the mammal clues, so the platypus is a mammal.

Answer: The platypus has 5 yes boxes. It shares fur and milk with the dog, and eggs, a bill and webbed feet with the duck. Because it has fur and makes milk, it is a mammal.

PRACTICE

1. **EASY** Name two ways a platypus is like a duck.
2. **EASY** Name the two clues that make a platypus a mammal.
3. **MEDIUM** One platypus mother laid 2 eggs. Another laid 3 eggs. How many eggs in all?
4. **MEDIUM** Sort these animals two ways: dog, platypus, duck, cow, chicken, echidna. First, which ones lay eggs? Then, which ones are mammals?
5. **HARD** Why did some people think the first platypus skin was a trick? What did the scientists do about it?

COMMON MISTAKES

- Thinking all mammals have live babies. The platypus and the echidnas lay eggs, but they are mammals because they have fur and make milk.
- Thinking the platypus is part duck and part beaver. It is its own kind of animal, made just right for its life in the rivers.
- Thinking the platypus bill is a hard beak like a duck's. It is soft and rubbery, and it can feel the tiny movements of bugs and worms.

Make it a game · Puzzle Animal Riddles. Your parent gives clues one at a time, and you guess the animal as fast as you can. Example: "I have fur. I lay eggs. I have a soft bill. Who am I?" (A platypus.) Other riddles: "I have fur and I fly at night." (A bat.) "I breathe through a blowhole and drink my mother's milk." (A whale.) "I have feathers, a bill and webbed feet." (A duck.) Guess after one clue for 3 points, two clues for 2 points, three clues for 1 point. Then make up a riddle for your parent.

Scripture. "But ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee:" (Job 12:7, KJV)

When we watch animals closely and ask good questions, they teach us about the wisdom of the God who made them. The platypus taught scientists to look carefully before deciding what is true.

Practice answers

1. Any two: it has a bill, it has webbed feet, and it lays eggs.
2. It has fur, and the mother feeds her babies milk.
3. $2 + 3 = 5$ eggs.
4. Lay eggs: platypus, duck, chicken, echidna. Mammals: dog, platypus, cow, echidna. The platypus and the echidna are in both groups.
5. It looked like a duck's bill sewn onto a furry animal, and no one in England had seen anything like it. The scientists looked closely, checked for stitches, and kept studying until they learned it was a real animal that has fur, makes milk and lays eggs.

UNIT 1 REVIEW

This is an oral review. Read each question aloud and let your child answer by telling, pointing, sorting or showing. Have the Mammal Book drawings, the hand-wing bat and the play-dough platypus nearby. Give full points for a clear answer in your child's own words. The review is worth 20 points.

1. (3 pts) What two big clues tell you that an animal is a mammal?
2. (3 pts) Sort these animals as I say them: dog, robin, cow, frog, mouse, goldfish. Which are mammals? How many are mammals?
3. (3 pts) Is a bat a bird? Tell why or why not. Then show me where the thumb and fingers are on your hand-wing bat.
4. (3 pts) How does a bat find a moth in the dark?
5. (3 pts) How does a whale breathe? What is the "blow" that sailors see?
6. (2 pts) What keeps a whale warm in icy water?
7. (3 pts) Tell me the platypus puzzle. What is strange about it, and why is it still a mammal?

UNIT PROJECT: MY MAMMAL BOOK

Make a small book of mammals by folding and stapling sheets of paper. Make one page for each lesson: a furry farm or pet mammal with a mother feeding her baby, a bat with its hand-wing labeled, a whale breathing out at the top of the water, and a platypus with its eggs. On the cover, draw your favorite mammal. On the last page, glue your "Has fur / No fur" sorting chart. Then set out the book with your hand-wing bat and play-dough platypus and give your family a short "zoo tour," telling what makes each animal a mammal.

- **Accuracy:** Each page shows the right clues: fur, milk, the bat's thumb and fingers, the whale's blowhole and the platypus's eggs.
- **Observation:** Drawings show real details the child noticed in pictures, at the zoo or around home, with simple labels.
- **Telling:** On the zoo tour the child explains in their own words why bats, whales and the platypus are all mammals.
- **Care:** The book is neat and colorful, and the bat and platypus models are complete and kept safe.

Answer key

1. It has fur or hair, and the mother makes milk to feed her babies.
2. Dog, cow and mouse are mammals. That is 3 mammals. The robin is a bird, the frog is an amphibian and the goldfish is a fish.
3. No. A bat has fur, not feathers, and the mother feeds her pup milk, so it is a mammal. The child points to the short thumb with a claw and the four long fingers in the wing.
4. It makes very high calls. The sound bounces off the moth and comes back as an echo. The bat hears the echo and knows where the moth is. This is called echolocation.

5. A whale breathes air with lungs. It comes up to the top of the water and breathes through the blowhole on top of its head. The blow is its warm, wet breath making a cloud in the air.
6. Blubber, a thick layer of fat under its skin.
7. The platypus has a bill and webbed feet like a duck, and the mother lays eggs. But it has fur, and the mother feeds her babies milk, so it is a mammal.

BIRDS

On the fifth day God made the birds to “fly above the earth in the open firmament of heaven” (Genesis 1:20). In this unit your child will find out what makes a bird a bird: feathers, a beak, two wings, two legs and eggs with hard shells. You will hold a real chicken bone, see that it is a light, hollow tube with braces inside, and test how strong a paper tube can be.

Then you will meet three wonderful birds. You will watch eagles soar on rising warm air, just as Isaiah wrote, “they shall mount up with wings as eagles.” You will count how fast a hummingbird’s wings beat and make a feeder to invite one to your yard. Last, you will hear the true story of how bald eagles almost disappeared and how a man named Charles Broley, along with scientists, wildlife workers and many neighbors, helped them make a great comeback.

Each lesson has a picture study (an old painting or one of Audubon’s life-size bird plates), a make-or-do activity and short oral practice. Keep your child’s drawings together. They become the unit’s capstone, a hand-made bird book.

BEFORE YOU BEGIN

- Can count to 100 and add small numbers
- Knows from Unit 1 that mammals have fur and feed their babies milk
- Can use a ruler or tape measure with a grown-up’s help
- Can listen to a short story and tell it back in order

MASTERY CHECKLIST

- I can name the things every bird has and sort birds from other animals.
- I can tell why many bird bones are hollow and why they are still strong.
- I can tell how an eagle soars on rising warm air and say Isaiah 40:31.
- I can tell three amazing things about hummingbirds and how they help flowers.
- I can tell the story of the bald eagle’s comeback and name ways to care for wild birds.

OPTIONAL BOOKS AND RESOURCES

- **All About Birds, from the Cornell Lab of Ornithology** (<https://www.allaboutbirds.org/>): Free. Look up any bird to see photos and hear its song. Search “Bald Eagle” and “Ruby-throated Hummingbird” for Lessons 2.2 to 2.4.
- **Cornell Lab Bird Cams** (<https://www.allaboutbirds.org/cams/>): Free live cameras at real bird nests and feeders. In late winter and spring, look for a bald eagle nest cam and watch the parents care for their eggs and eaglets.
- **Audubon’s *The Birds of America* online, from the National Audubon Society** (<https://www.audubon.org/birds-of-america>): Free. Browse Audubon’s life-size bird

plates, including the Golden Eagle, Ruby-throated Hummingbird and White-headed (Bald) Eagle used in this unit's picture studies.

2.1 HOLLOW BONES ★

OBJECTIVES

- Name the things that make a bird a bird: feathers, a beak, two wings, two legs and eggs with hard shells.
- Explain that many bird bones are hollow, with little braces inside, so they are light and strong.
- Sort animals into birds and not-birds and tell why.

Warm-up. Hold an empty paper towel tube in one hand and a wooden spoon or a short stick in the other. Which one feels lighter? Peek inside the tube. What is in there? (Only air!) Now press gently on the ends of the tube. It is light, but it does not crumple easily. Today we will find out why God gave many birds bones a little like this tube.

Video. Coming soon. Bird skeletons and hollow bones for kids: search SciShow Kids, Smithsonian National Museum of Natural History, Cornell Lab of Ornithology (All About Birds) and nature footage of birds taking off in slow motion.

KEY TERMS

bird

An animal with feathers, a beak, two wings and two legs that lays eggs with hard shells.

feather

The soft, light covering that only birds have. Feathers keep a bird warm and help it fly.

hollow bone

A bone with an air space inside instead of being solid all the way through.

brace

A thin piece inside a hollow bone that crosses from side to side and makes the bone strong.

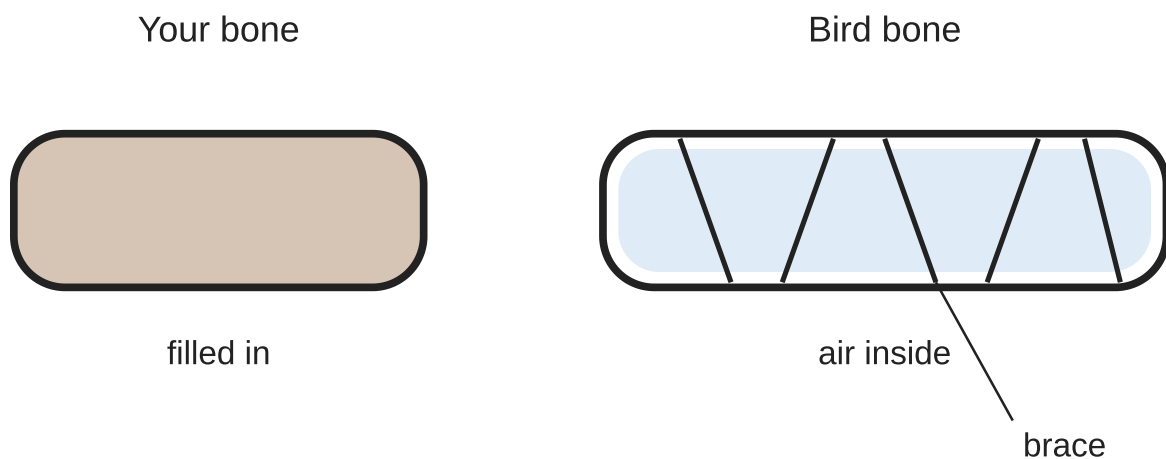
CORE IDEAS

The story. After a chicken dinner, ask a grown-up to save a cooked wing bone and wash it clean. Hold it up to a window. Feel how light it is. Then look at a broken end. You will see that the bone is not solid like a stick. It is a thin tube! The bones of your own arm are much heavier and are filled with soft marrow. A chicken is a bird, and many birds have bones like this.

How they figured it out. People who studied birds looked very closely at their skeletons. When they cut bird bones open, they found that many of them were hollow. Inside were thin little **braces** crossing from wall to wall, like the beams in a bridge. They also found that a bird's lungs connect to air sacs in its body, and in many birds air from those sacs goes right into some of the bones. A flying bird is full of air in places where we are full of bone!

The big idea. A **bird** is an animal with **feathers**, a beak with no teeth, two wings and two legs. Every bird hatches from an egg with a hard shell, and a bird keeps its body warm all the time. Only birds have feathers. Bats fly, but bats have fur, so they are not birds. Hollow bones help a flying bird be light enough to lift into the air, and the braces keep those light bones strong. Not every bird flies. An ostrich runs, and a penguin swims. Penguins have heavier, more solid bones that help them dive deep under the water.

God's handiwork. On the fifth day God made the birds "that may fly above the earth." He did not just give them wings. He built them from the inside out to fly: light bones, strong braces, warm feathers and a body full of air. When you watch a robin hop and then lift into the sky, remember that you are seeing a little flying machine that God designed long before anyone built an airplane.



A bone cut open: your bone is filled in, but a flying bird's bone is a light tube with braces inside.

PICTURE STUDY



Wing of a European Roller, Albrecht Dürer, 1512 · Watercolor and gouache on vellum · Albertina, Vienna, Austria

Albrecht Dürer was a German artist who loved to look closely at God's creatures. One day he painted just one wing of a bird called a roller. He painted every feather, one by one, with a very fine brush. Scientists today still admire how true his painting is.

A wing is made of feathers lying on top of bones. The long feathers at the end of the wing are the flight feathers that push against the air.

Look closely

- Find the long feathers at the end of the wing. These are the flight feathers.
- Find the small feathers near the top of the wing. How are they different from the long ones?
- Point to all the colors you can see. Which color is the brightest?
- Look at how the feathers overlap, like shingles on a roof.

Talk about it

1. Why do you think the feathers overlap instead of having gaps between them?
2. If you could paint just one part of an animal very carefully, which part would you choose?

Safety first. Use only cooked bones that a grown-up has washed. Broken bird bones can have sharp edges, so hold them gently and do not put them in your mouth. Never give cooked chicken bones to a dog. Wash your hands after touching bones.

MAKE AND DO: STRONG TUBES TEST

Is a hollow tube weak? Let's test it! You will see how a light paper tube can hold up books, just as a bird's hollow bones hold up the bird.

You will need

- 3 sheets of plain printer paper
- Tape
- A stack of small, light books or board books
- A cooked, washed chicken wing or leg bone (optional)
- A magnifying glass (optional)

Steps

1. Lay one sheet of paper flat across two books with a gap between them, like a bridge. Set one small book on top. What happens? (It sags or falls.)
2. Now roll each of the 3 sheets into a tube about as wide as a toilet paper roll. Tape each one closed.
3. Stand the 3 tubes up on the table, close together.
4. Gently set one book on top of the tubes. Then add another, and another. Count how many books the tubes hold before they bend.
5. If you have a chicken bone, look at its broken end with a magnifying glass. Can you see the tube shape? Can you see any tiny braces inside?
6. Draw your tubes holding up the books, and write the number of books they held.

Tips

- Add books slowly and set them down gently, right in the middle.
- Try it again with a crumpled ball of paper instead of tubes. Which holds more?

Check your work

- I can tell how many books my paper tubes held.
- I can say why a hollow bone can be light and still strong.

NATURE NOTEBOOK

1. Draw a bird and label five parts: feathers, beak, wing, leg and eye.
2. Draw a bone cut in half the way it looks in the picture, with braces inside. Write "light and strong" beside it.
3. Look out the window for one real bird. Draw it and write one thing you saw it do.

From history. About five hundred years ago, the Italian artist and inventor Leonardo da Vinci watched birds for hours and filled a small notebook with drawings of how they flap, glide and turn. We call it his *Codex on the Flight of Birds*. He dreamed of building a flying

machine. People did not fly until many years later, but they kept learning from the birds, just as Leonardo did.

WORKED EXAMPLES

Example 1. Look at the picture of the bird bone cut open. How many braces cross the inside of the bone?

(Use the map or drawing “Count the braces inside the bird bone.” shown earlier in this lesson.)

1. Find the bird bone. It is the one on the right with air inside.
2. Put your finger on the first brace at the left end of the bone and say “one.”
3. Slide your finger along and count each brace: one, two, three, four, five.

Answer: There are 5 braces inside the bird bone.

PRACTICE

1. **EASY** Say three things that every bird has.
2. **EASY** Sort these animals into birds and not-birds: robin, cat, penguin, bat, ostrich, eagle.
3. **MEDIUM** A robin has 2 legs. How many legs do 6 robins have?
4. **MEDIUM** Draw a bone cut open the way a flying bird’s bone looks inside. Point to the air space and to a brace.
5. **HARD** Tell in your own words why hollow bones help a bird fly. Why don’t they break easily?

COMMON MISTAKES

- Thinking anything that flies is a bird. Bats and butterflies fly too. Only birds have feathers.
- Thinking every bird bone is hollow. Many are, but not all, and penguins have heavier, more solid bones that help them dive.
- Thinking hollow means weak. The braces inside make a hollow bone strong for its weight.

Make it a game • Bird or Not a Bird?. A parent names an animal. If it is a bird, flap your arms like wings and say “Feathers!” If it is not a bird, stand still like a statue. Try tricky ones like bat, penguin, butterfly, ostrich and chicken. Score a point for each right answer and say why. Play to ten points.

Scripture. “And God said, Let the waters bring forth abundantly the moving creature that hath life, and fowl that may fly above the earth in the open firmament of heaven.” (Genesis 1:20, KJV)

“Fowl” is the old word for birds. God made birds to fly in the open sky, and He gave them light, strong bodies to do it.

Practice answers

1. Any three of these: feathers, a beak, two wings, two legs, eggs with hard shells, a warm body.
2. Birds: robin, penguin, ostrich, eagle. Not birds: cat and bat (they have fur, not feathers).
3. 12 legs (2, 4, 6, 8, 10, 12).
4. The drawing shows a thin tube with an empty space inside and little lines crossing from wall to wall. The child points to the empty space (air) and to one crossing line (a brace).
5. Hollow bones are light, so the bird is light enough to lift into the air. They don't break easily because thin braces inside make them strong, like beams in a bridge.

2.2 EAGLES MOUNT UP WITH WINGS

OBJECTIVES

- Tell how an eagle soars high on rising warm air without flapping its wings much.
- Name three things that make an eagle a strong hunter: sharp eyes, a hooked beak and talons.
- Say Isaiah 40:31 and tell what it means to “mount up with wings as eagles.”

Warm-up. Stand up and hold your arms out wide like wings. Flap hard for a count of ten. Are your arms tired? Now hold them out wide and still, and lean and tip gently from side to side like a bird gliding. Which way would be easier to keep doing all day long? An eagle knows the answer!

Video. Coming soon. Eagles soaring on thermals and hunting for kids: search Cornell Lab Bird Cams, Smithsonian, U.S. Fish and Wildlife Service, Hawk Mountain Sanctuary, SciShow Kids and slow-motion nature footage of bald and golden eagles.

KEY TERMS

soar

To fly high and float on the air with wings held wide and almost still.

thermal

A column of warm air rising up from the ground on a sunny day. Eagles ride it upward.

talons

The long, sharp, curved claws on an eagle’s feet, used to grab food.

bird of prey

A bird that hunts other animals for food, like an eagle, hawk or owl.

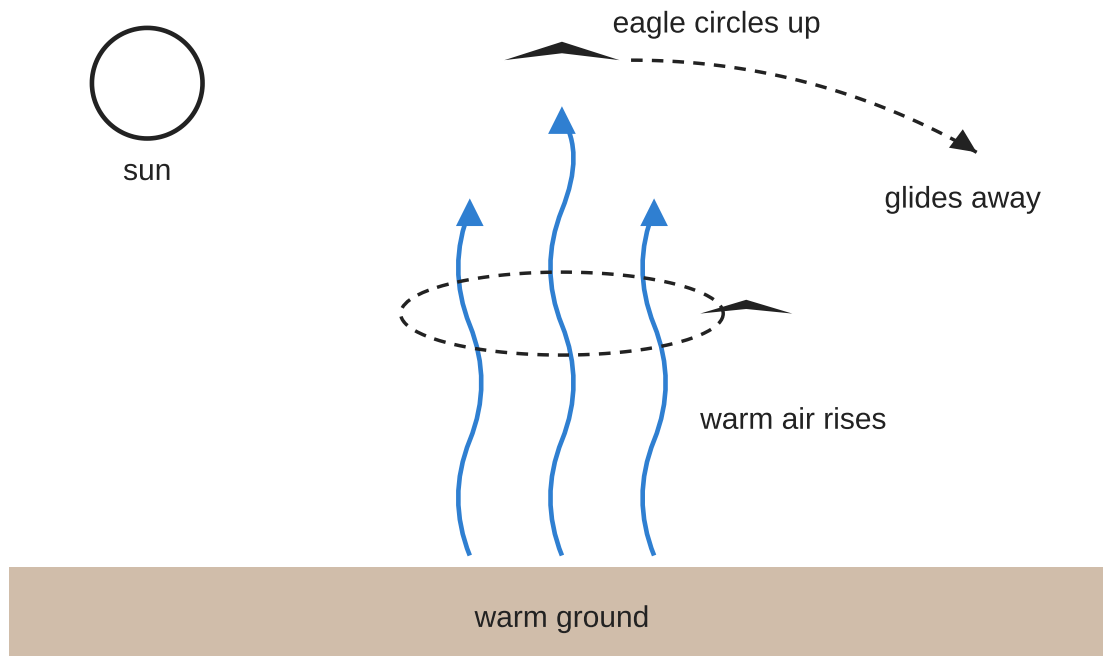
CORE IDEAS

The story. On Hawk Mountain in Pennsylvania there is a high, rocky lookout. Every fall, people climb up and sit on the rocks with binoculars. They are watching for hawks and eagles flying south. People have counted the birds there every fall since 1934. On a good day the watchers see eagles sail past, high in the sky, with their wings held wide and almost still. How can such a big bird fly so far without flapping?

How they figured it out. People who watched closely saw that eagles circle round and round as they go up, like a slow spinning top. On a sunny day the ground gets warm. The warm ground warms the air above it, and warm air rises in a tall, invisible column called a **thermal**. An eagle finds a thermal, spreads its great wings and circles inside it. The rising air lifts it higher and higher. Then it glides off to find the next one. Wind blowing up the side of a mountain lifts eagles too. That is why Hawk Mountain is such a good place to watch.

The big idea. An eagle is a **bird of prey**. It hunts other animals for food. A bald eagle's wings stretch about as wide as a tall man is tall. Its eyes are so sharp that it can spot a fish from high in the air. It dives down and grabs the fish with its **talons**, then tears its food with its strong, hooked beak. Eagle pairs build huge nests of sticks high in tall trees or on cliffs and add more sticks each year.

God's handiwork. Long ago, the prophet Isaiah watched eagles too. He wrote that people who wait upon the LORD "shall mount up with wings as eagles." An eagle does not soar by working harder. It soars by resting its wings on the air that lifts it. In the same way, when we trust God, He gives us strength we do not have on our own.



The sun warms the ground, warm air rises, and the eagle circles up inside it without flapping.

PICTURE STUDY



Golden Eagle (Plate 181 of The Birds of America), John James Audubon (engraved by Robert Havell), painted 1833 · Hand-colored engraving and aquatint, after Audubon's watercolor · The Birds of America; Audubon's original watercolor is at the New-York Historical Society, New York

John James Audubon spent his life painting the birds of America life-size. He painted this golden eagle in Boston in 1833, from a real eagle. He made the eagle look huge and wild, flying high above the mountains with its food.

Look very closely near the bottom of the picture. Audubon painted a tiny man crossing a log over a deep valley. Many people think he painted himself there, climbing after the eagle.

Look closely

- Find the eagle's talons. What are they holding?
- Look at the eagle's beak. Is it straight or hooked?
- Find the mountains. How did Audubon show that the eagle is very high up?
- Search for the tiny man near the bottom. What is he doing?

Talk about it

1. How do the wings in this picture look different from wings that are soaring still on the air?
2. Why do you think Audubon made the eagle so big and the man so small?

Safety first. A grown-up should hold the paper spiral over a warm heater vent, radiator or warm (not hot) lamp. Never hold paper over a stove, candle, fireplace or bare bulb, because paper can catch fire. Always watch eagles and their nests from far away with binoculars.

MAKE AND DO: SPINNING SPIRAL: SEE RISING AIR

You cannot see a thermal, but you can see what it does! Make a paper spiral and watch warm air lift and spin it, the same way warm air lifts an eagle.

You will need

- A paper plate or a circle of paper about the size of a dinner plate
- Crayons or markers
- Child-safe scissors
- A piece of thread about as long as your arm
- Tape
- A warm heater vent, radiator or warm lamp shade, with a grown-up

Steps

1. Draw a spiral on the paper circle, starting at the edge and curling in to the middle like a snail shell.
2. Color a little eagle at the outside end of the spiral.
3. Cut along the spiral line with a grown-up's help.
4. Tape the thread to the middle of the spiral. Hold the thread up so the spiral hangs down like a spring.
5. Hold it still in a room with no breeze. Does it spin?
6. Now have a grown-up hold it above the warm heater vent or radiator. Watch what happens. The rising warm air pushes on the spiral and makes it turn.
7. Circle around the room with your arms out wide, "riding" up the thermal like the eagle.

Tips

- If it does not spin, hold it a little higher and keep your hand very still.
- Turn the heater off and try again after it cools. What changes?

Check your work

- I can show which way warm air moves: up!
- I can tell how an eagle uses rising air to soar.

NATURE NOTEBOOK

1. Draw an eagle soaring in a circle inside a thermal. Draw the sun and arrows to show warm air rising.
2. Draw an eagle's foot with its talons. Count the toes and write the number.
3. Copy the words "they shall mount up with wings as eagles" under a picture of an eagle.

From history. In 1782, the leaders of the young United States chose a bald eagle for the Great Seal of the United States. On the seal, the eagle holds an olive branch for peace in

one set of talons and arrows for strength in the other. You can still see this eagle on the back of a one-dollar bill. Ask a grown-up to help you find it.

WORKED EXAMPLES

Example 1. A bald eagle's wings stretch about 6 feet from tip to tip. Lie down on the floor with your arms out wide while a grown-up puts a piece of tape at each fingertip. Measure your arm span with a tape measure. Is the eagle's wingspan bigger or smaller than yours?

1. Stretch your arms out wide on the floor. A grown-up marks the tip of each middle finger with tape.
2. Measure from one piece of tape to the other. Many children measure about 4 feet.
3. Now measure 6 feet along the floor and put two more pieces of tape there. That is the eagle.
4. Compare: 6 feet is more than 4 feet. Take away: $6 - 4 = 2$.

Answer: The eagle's wings are bigger. If your arm span is 4 feet, the eagle's wingspan is about 2 feet wider than yours.

PRACTICE

1. **EASY** Point to your eyes, your mouth and your feet. Now say the eagle part that matches each: eyes, beak, talons. What does the eagle use each one for?
2. **EASY** Does an eagle soar by flapping hard or by holding its wings out wide on rising air?
3. **MEDIUM** An eagle has 4 toes on each foot. How many toes does it have on both feet? How many talons?
4. **MEDIUM** Sort these into birds of prey and not birds of prey: eagle, duck, owl, hawk, chicken, robin.
5. **HARD** Say Isaiah 40:31. Then tell in your own words how an eagle riding a thermal is like a person who trusts God.

COMMON MISTAKES

- Thinking big birds must flap all the time to stay up. Eagles save their strength by soaring on rising air.
- Thinking warm air sinks. Warm air rises, and cool air sinks.
- Thinking eagles grab food with their beaks. They catch it with their talons and use the beak to tear it.

Make it a game • Eagle Eyes. A parent hides five small paper "fish" around a room. You are the eagle! Stand on a step or a stool (with a grown-up nearby) and look carefully without moving your feet. Point to each fish you spot and call "Eagle eyes!" Then "soar"

down with your arms wide and grab each fish with your hand like talons. Switch and let the parent be the eagle.

Scripture. “But they that wait upon the LORD shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; and they shall walk, and not faint.” (Isaiah 40:31, KJV)

An eagle rises by resting on the air God sends. People who wait on the LORD are lifted by His strength, not their own.

Practice answers

1. Sharp eyes to spot food from high up, a hooked beak to tear food, and talons to grab food.
2. By holding its wings out wide and riding the rising warm air (a thermal).
3. 8 toes (4 + 4), and 8 talons, one on each toe.
4. Birds of prey: eagle, owl, hawk. Not birds of prey: duck, chicken, robin.
5. “But they that wait upon the LORD shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; and they shall walk, and not faint.” The eagle does not rise by working harder; it rests its wings on the air that lifts it. A person who trusts God leans on Him, and God gives strength they don’t have on their own.

2.3 HUMMINGBIRDS

OBJECTIVES

- Tell three amazing things about hummingbirds: they hover, they can fly backward, and their wings beat very fast.
- Explain how hummingbirds drink nectar and carry pollen from flower to flower.
- Compare the size of a hummingbird egg with a chicken egg.

Warm-up. Hold your arms out and flap them as fast as you can while a grown-up counts to five. Tired? Now hum with your lips closed: “Mmmmm.” A hummingbird’s wings beat so fast they make a humming sound. That is how it got its name!

Video. Coming soon. Hummingbirds hovering and feeding in slow motion for kids: search Cornell Lab of Ornithology (All About Birds), Smithsonian’s National Zoo, PBS Nature clips, SciShow Kids and high-speed nature footage of ruby-throated hummingbirds.

KEY TERMS

hover

To stay in one spot in the air, like a helicopter.

nectar

Sweet juice inside a flower that hummingbirds and bees drink.

pollen

Yellow dust in a flower. When it is carried to another flower of the same kind, that flower can make seeds.

CORE IDEAS

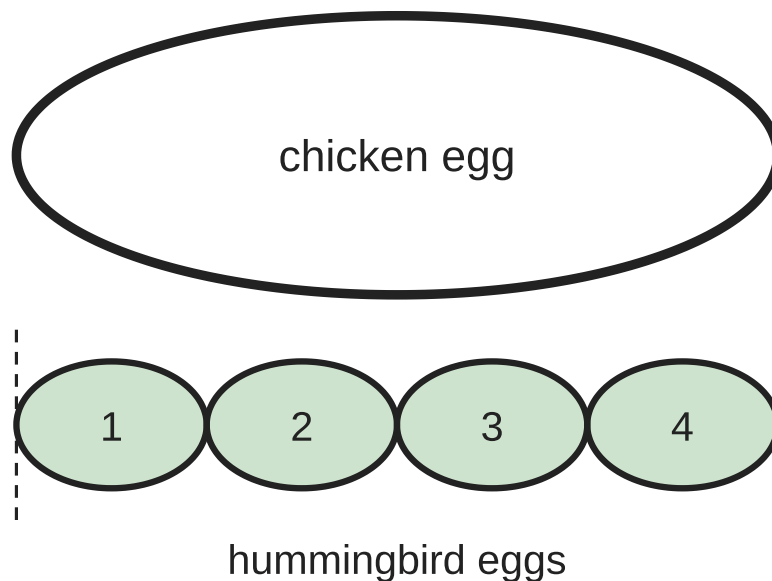
The story. On a summer day, sit very still near a bright red or orange flower. Listen. Do you hear a soft “hmmmm”? A tiny bird zips in. It stops in the air right in front of the flower, as if hanging on a string. It pokes in its long, thin beak, drinks, then zooms backward and darts away. You have just seen a hummingbird! In the eastern United States, the one you will most likely see is the ruby-throated hummingbird. It weighs less than a nickel.

How they figured it out. A hummingbird’s wings move so fast that they look like a blur. Nobody could count the beats just by looking. So people used special cameras with very fast flashes of light to “freeze” the wings in a photograph. Then they could see the wings move in a figure-eight shape and count the beats. A ruby-throated hummingbird beats its wings about 50 times every second! Moving its wings this way lets it **hover** and even fly backward. No other kind of bird can keep flying backward like that.

The big idea. Flying this fast takes a lot of energy, so a hummingbird must eat all day long. It drinks sweet **nectar** from flowers with a long tongue that reaches deep inside. It also

catches tiny insects. As it drinks, yellow **pollen** sticks to its head and beak. At the next flower, some pollen rubs off, and that helps the flower make seeds. The mother builds a nest about the size of half a walnut shell. She glues it together with spider silk and lays 2 tiny eggs, each about the size of a jelly bean. The smallest bird in the whole world is the bee hummingbird of Cuba, only about as long as a grown-up's thumb.

God's handiwork. Jesus said, "Behold the fowls of the air." He told us to look at the birds, because God feeds every one of them. A hummingbird finds hundreds of flowers every day, and God has filled the world with just enough nectar for it. If God takes such good care of a bird smaller than your thumb, He will surely take care of you.



About 4 hummingbird eggs lined up end to end are as long as 1 chicken egg.

PICTURE STUDY



Ruby-throated Humming Bird (Plate 47 of The Birds of America), John James Audubon (engraved by Robert Havell), about 1828 · Hand-colored engraving and aquatint, after Audubon's watercolor · The Birds of America; Audubon's original watercolor is at the New-York Historical Society, New York

John James Audubon loved hummingbirds. He called the ruby-throated hummingbird a “glittering fragment of the rainbow.” In this picture he painted a whole family of ruby-throated hummingbirds around a vine of orange trumpet flowers.

Audubon painted his birds life-size. That means the hummingbirds in his book are just as small as real ones!

Look closely

- Count the hummingbirds. How many can you find?
- Find a bird with a bright red throat. That is a father bird. The mothers have white throats.
- Look at the shape of the flowers. Why is a long, thin beak just right for drinking from them?
- Find a bird that is flying. Find one that is sitting still.

Talk about it

1. Why do you think hummingbirds visit red and orange flowers like these?
2. If you were a hummingbird, which flower in your yard would you visit first?

Safety first. Only a grown-up should boil water and pour hot sugar water. Let it cool completely before you touch it. Never add red food coloring or honey to a hummingbird

feeder. Hang the feeder where you can watch from a window, and do not try to touch or catch a hummingbird.

MAKE AND DO: MAKE A HUMMINGBIRD FEEDER

Invite hummingbirds to your yard! You will make nectar just like flower nectar and fill a feeder, then keep watch like a real bird scientist. If you live where hummingbirds are not around right now, make a paper flower garden on the window instead and try the feeder in late spring.

You will need

- A hummingbird feeder (or a small clean plastic bottle with a red bottle cap that a grown-up pokes a small hole in)
- White table sugar
- Water and a pot (for a grown-up)
- A measuring cup
- Red paper or red tape to decorate

Steps

1. Have a grown-up boil 4 cups of water and stir in 1 cup of white sugar until it disappears. That is 4 parts water to 1 part sugar, about as sweet as flower nectar.
2. Let the sugar water cool all the way.
3. Decorate the feeder with red paper flowers. Hummingbirds are drawn to red.
4. Fill the feeder and hang it outside near a window, in a spot with some shade.
5. Watch every day. Each time you see a hummingbird, make a tally mark on a chart.
6. Every few days, a grown-up should empty the feeder, wash it with hot water and fill it with fresh nectar so it does not spoil.

Tips

- Be patient. It may take days for a hummingbird to find your feeder.
- Extra nectar keeps in the refrigerator for about a week.

Check your work

- I can tell what nectar is and why hummingbirds need it.
- I can keep a tally chart of the hummingbirds I see.

NATURE NOTEBOOK

1. Draw a hummingbird hovering at a flower. Draw lines around its wings to show they are moving fast.
2. Draw a hummingbird nest with 2 eggs inside. Beside it, draw a jelly bean to show the egg size.
3. Keep a tally chart of hummingbirds you see at your feeder or flowers for one week.

From history. Wild hummingbirds live only in North and South America and the islands nearby. When explorers first carried stories of these jewel-like birds back to Europe, people were amazed. In 1851, when crowds came to London for the Great Exhibition, the bird artist John Gould showed his collection of hummingbirds in glass cases at the London Zoo, and Queen Victoria came to see them.

WORKED EXAMPLES

Example 1. A hummingbird egg is about as long as a jelly bean. How many jelly beans lined up end to end are as long as a chicken egg?

(Use the map or drawing “About 4 hummingbird eggs fit along 1 chicken egg.” shown earlier in this lesson.)

1. Lay a chicken egg on its side on a towel so it does not roll.
2. Line up jelly beans end to end beside the egg, starting at one end of the egg.
3. Stop when the line of jelly beans is as long as the egg.
4. Count the jelly beans: one, two, three, four.

Answer: About 4 jelly beans, so a chicken egg is about 4 times as long as a hummingbird egg.

PRACTICE

1. **EASY** Show with your hand how a hummingbird can fly: forward, stop and hover, then backward.
2. **EASY** Match each bird with its food: hummingbird, eagle. Foods: fish, flower nectar.
3. **MEDIUM** Each hummingbird nest has 2 eggs. How many eggs are in 4 nests?
4. **MEDIUM** Flap your arms as fast as you can while a grown-up counts to 10 seconds. Count your flaps. A hummingbird beats its wings about 50 times in just 1 second. Who is faster?
5. **HARD** Tell how a hummingbird helps a flower while it eats.

COMMON MISTAKES

- Thinking hummingbirds drink through their beaks like a straw. They lap up nectar with a long tongue.
- Thinking hummingbirds eat only sugar. They also catch tiny insects for protein.
- Thinking a feeder needs red food coloring. Red on the feeder is enough; the nectar should be clear.

Make it a game • Hummingbird Pollen Relay. Set paper flowers around the room, each with a small bowl. Put a few cotton balls (pollen) in one bowl. You are the hummingbird: hum, hover at the flower, “drink,” pick up one pollen ball and fly to the

next flower to drop it off. Fly backward to the start between flowers! Count how many flowers you help before a grown-up counts to 30.

Scripture. “Behold the fowls of the air: for they sow not, neither do they reap, nor gather into barns; yet your heavenly Father feedeth them. Are ye not much better than they?” (Matthew 6:26, KJV)

Hummingbirds do not plant gardens, yet God fills the flowers with nectar for them. He cares for you even more.

Practice answers

1. The child moves a hand forward, holds it still in the air (hover), then moves it backward.
2. Hummingbird: flower nectar (and tiny insects). Eagle: fish.
3. 8 eggs (2, 4, 6, 8).
4. The hummingbird is much faster. A child may flap about 15 to 30 times in 10 seconds; the hummingbird beats about 50 times in only 1 second.
5. When the hummingbird drinks nectar, pollen sticks to its head and beak. At the next flower some pollen rubs off, and that helps the flower make seeds.

2.4 THE BALD EAGLE’S COMEBACK

OBJECTIVES

- Tell the story of how bald eagles almost disappeared and how people helped them come back.
- Explain in simple words how a bug spray in the fish made eagle eggshells thin.
- Name ways we can care for wild birds today.

Warm-up. Hold a raw egg gently in your palm (over a bowl!). Feel how hard the shell is. Now imagine a shell as thin as tissue paper. What would happen if a big mother bird sat on it? Today you will hear how that really happened to eagles, and how people fixed it.

Video. Coming soon. The bald eagle’s recovery for kids: search U.S. Fish and Wildlife Service, Cornell Lab Bird Cams (eagle nest cams), Smithsonian’s National Zoo, state wildlife agency eagle programs and nature footage of bald eagles on the nest.

KEY TERMS

endangered

So few left that a kind of animal might disappear from the wild unless people help.

comeback

Growing strong again after almost being lost.

band

A tiny metal ring put on a bird’s leg with a number on it, so people can know that bird if they find it again.

stewardship

Taking good care of what God has given us, including His creatures.

CORE IDEAS

The story. In 1939, a man from Canada named Charles Broley began a new hobby in Florida. He had worked at a bank, but now he climbed tall trees on rope ladders, right up to bald eagle nests! There he put a tiny metal **band** on each young eagle’s leg. Year after year he climbed, and he banded hundreds of eaglets. But after some years he found something sad. Fewer and fewer nests had babies. Many nests had eggs that never hatched.

How they figured it out. Scientists looked closely at eagle eggs. The shells were too thin! When the mother sat on her eggs to keep them warm, the eggs cracked. Why? Farmers and towns had sprayed a strong bug spray called DDT. Rain washed it into rivers and lakes. Little fish took it in, and eagles ate the fish. The DDT built up in the eagles’ bodies and made their eggshells thin. In time, so few bald eagles were left that they were called **endangered**.

The big idea. Many people worked together to bring the eagles back. A law protected bald eagles so no one could hunt them or take their nests. In 1972, America stopped almost all use of DDT. Wildlife workers kept people away from nests. In some states they carried young eagles to places with no eagles left. They raised them in tall wooden nest boxes and fed them without being seen, until the young birds could fly. Slowly, the eggshells grew thick again. More eggs hatched. In 2007, bald eagles were taken off the endangered list. That is a real **comeback!**

In the world today. Bald eagles now nest in every one of the lower 48 states. You might see one by a lake or river. A bald eagle is not really bald. An old meaning of “bald” is “white,” and that is its white head. God told the first man to “dress” the garden “and to keep it.” Caring for eagles is part of that good work. We call it **stewardship**.

Eagle nests counted along a river

First count



Second count



Third count



Each nest picture = 1 nest

A picture chart of eagle nests counted along a river (a pretend example). Each nest picture stands for 1 nest.

PICTURE STUDY



White-headed Eagle (Plate 31 of The Birds of America), John James Audubon (engraved by Robert Havell), about 1828 · Hand-colored engraving and aquatint, after Audubon's watercolor · The Birds of America; Audubon's original watercolor is at the New-York Historical Society, New York

In Audubon's day, many people called the bald eagle the "white-headed eagle." That name tells you just what "bald" means! Audubon painted this grown-up eagle standing on its dinner, a big catfish.

Audubon painted this picture long before the eagles' trouble began. Because people cared for the eagles, you can still see birds like this one today.

Look closely

- Find the white head and the white tail. Is the head really bald, or covered with feathers?
- Look at the beak and the feet. What color are they?
- Find the fish. How is the eagle holding it?
- Look at the eagle's eye. Does it look calm or fierce?

Talk about it

1. Why was "white-headed eagle" a good name for this bird?
2. What does this picture tell you about what bald eagles eat?

Safety first. If you see an eagle or any wild bird's nest, stay far away and watch with binoculars. Never touch a nest, an egg or a baby bird. It is against the law to keep an eagle feather you find, so look at it, draw it and leave it. If you use a real egg in the warm-up, wash your hands afterward.

MAKE AND DO: BUILD AN EAGLE NEST

Bald eagles build the biggest nests of any bird in North America, and they add more sticks every year. Build your own small model nest, and use it to tell the story of the eagles' comeback.

You will need

- A sturdy paper bowl or a shallow box
- Small sticks and twigs from the yard
- Dry grass, moss or shredded paper for a soft lining
- Glue or tape
- Play dough or two plastic eggs
- A small paper eagle you draw and cut out

Steps

1. Gather sticks with a grown-up. Count them as you collect. Try for 30 or more.
2. Lay the bigger sticks around the edge of the bowl in a ring, crossing them like a basket. Glue or tape them in place.
3. Fill the middle with soft grass, moss or shredded paper. Eagles line their nests with soft things too.
4. Make 2 eggs from play dough or use plastic eggs. Most eagle pairs lay 1 to 3 eggs.
5. Set your paper eagle on the nest.
6. Tell the story with your nest: first the eggs crack (squash one play dough egg flat), then people help, and then the eggs hatch (draw a fuzzy eaglet).

Tips

- Real eagle nests can be so big that a grown-up could lie down in one!
- Use only sticks that have fallen on the ground. Do not break branches off living trees.

Check your work

- I can show how an eagle nest is built.
- I can tell the eagle comeback story in order: trouble, help, comeback.

NATURE NOTEBOOK

1. Draw a bald eagle and color its white head and tail, brown body and yellow beak and feet.
2. Draw three boxes in a row. In them, draw: a cracked egg, a person helping, a young eagle flying. Tell the story aloud.
3. Draw one thing your family can do to care for birds, like keeping a bird bath clean or picking up fishing line.

From history. Not everyone liked the choice of the bald eagle for America's seal. In 1784, Benjamin Franklin wrote a letter to his daughter Sarah. He grumbled that the bald eagle steals fish from other birds, and he said the turkey was a more respectable bird. Franklin was teasing a little, but the eagle stayed on the seal, and today it is known all over the world as America's bird.

WORKED EXAMPLES

Example 1. A ranger counts eagle nests along a river. (This is a pretend example.) Read the picture chart. How many nests were there at the first count? At the third count? How many more nests were there at the third count?

(Use the map or drawing "Eagle nests counted along a river (pretend example)." shown earlier in this lesson.)

1. Find the row for the first count. Count the nest pictures: 2.
2. Find the row for the third count. Count the nest pictures: 9.
3. To find how many more, start at 2 and count up to 9: 3, 4, 5, 6, 7, 8, 9. That is 7 more.
4. Check: $2 + 7 = 9$.

Answer: The first count had 2 nests and the third count had 9 nests. There were 7 more nests at the third count. The eagles were coming back!

PRACTICE

1. **EASY** Is a bald eagle really bald? Where does the name come from?
2. **EASY** Look at the picture chart. Which count had the most nests? Which had the fewest?
3. **MEDIUM** Sort these into "helps birds" and "hurts birds": staying far from a nest, climbing up to touch eggs, picking up old fishing line, keeping a clean bird bath, chasing birds.
4. **MEDIUM** Each of 5 eagle nests has 2 eggs. How many eggs are there in all?
5. **HARD** Tell the eagle story in order: what went wrong, how people found out, and how people helped.

COMMON MISTAKES

- Thinking a bald eagle has no feathers on its head. Its head is covered with white feathers.
- Thinking the bug spray hurt the eagles by touching them. It came through the food they ate (fish) and made their eggshells thin.
- Thinking young bald eagles have white heads. Young eagles are mostly brown and get their white heads and tails only when they are grown.

Make it a game • Eagle Comeback Count. Hide 10 paper eaglets around the house. Set a timer for one minute and find as many as you can. Each one you find, “band” it with a sticker and set it in your model nest. Count how many eagles came back! Then hide them again and try to beat your number.

Scripture. “And the LORD God took the man, and put him into the garden of Eden to dress it and to keep it.” (Genesis 2:15, KJV)

God gave people the job of caring for His world. When people protected the bald eagle, they were doing this good work.

Practice answers

1. No. Its head is covered with white feathers. An old meaning of “bald” is “white,” so the name means white-headed.
2. The third count had the most (9). The first count had the fewest (2).
3. Helps: staying far from a nest, picking up old fishing line, keeping a clean bird bath. Hurts: climbing up to touch eggs, chasing birds.
4. 10 eggs (2, 4, 6, 8, 10).
5. A bug spray called DDT got into rivers, then fish, then eagles, and made their eggshells thin, so the eggs cracked. Charles Broley noticed fewer baby eagles, and scientists found the thin shells. People protected eagles by law, stopped using DDT, kept nests safe and raised young eagles in new places. The eagles came back and were taken off the endangered list.

UNIT 2 REVIEW

Oral review. Read each question aloud and let your child answer in their own words, point or draw. Give full points for a clear answer with the main idea. The review is worth 20 points.

1. (3 pts) Name three things that every bird has. What do only birds have?
2. (3 pts) Why are many bird bones hollow? What keeps them from breaking?
3. (3 pts) How can an eagle fly high without flapping much?
4. (3 pts) Say Isaiah 40:31, or tell what it says about eagles.
5. (3 pts) Tell two things a hummingbird can do that most birds cannot.
6. (2 pts) Each hummingbird nest has 2 eggs. How many eggs are in 3 nests?
7. (3 pts) Tell the bald eagle's comeback story: what went wrong and how people helped.

UNIT PROJECT: MY BIRD BOOK

Make a hand-made book about birds with at least five pages: (1) a bird with its parts labeled and a hollow bone drawn cut open; (2) an eagle soaring in a thermal with Isaiah 40:31 copied underneath; (3) a hummingbird at a flower with its nest and 2 tiny eggs; (4) the bald eagle comeback told in three pictures: trouble, help, comeback; and (5) a page about one real bird your child watched outside, with a drawing and one sentence. Add the cover title "My Bird Book" and your child's name, then have your child read or tell the book aloud to the family.

- **Science:** Bird parts, the hollow bone with braces, the thermal and the hummingbird facts are shown and labeled correctly.
- **Story:** The eagle comeback pages tell what went wrong, how people helped and how the eagles came back, in the right order.
- **Observation:** The real-bird page shows a bird the child actually watched, with at least one true detail about how it looked or what it did.
- **Care:** Drawings are colored with care, words are neat, and the child can tell about each page aloud.

Answer key

1. Any three: feathers, a beak, two wings, two legs, eggs with hard shells, a warm body. Only birds have feathers.
2. Hollow bones are light, which helps a bird fly. Thin braces inside make them strong.
3. It soars on rising warm air called a thermal. It circles inside the rising air with its wings held wide, and the air lifts it up.
4. "But they that wait upon the LORD shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; and they shall walk, and not faint." (Telling the main idea counts: those who trust God get strength and rise up like eagles.)
5. Any two: hover in one spot, fly backward, beat its wings about 50 times a second (so fast they hum).
6. 6 eggs.

7. A bug spray called DDT got into fish, eagles ate the fish, and their eggshells got thin and cracked, so few babies hatched. People protected eagles by law, stopped using DDT, kept nests safe and raised young eagles in new places. The eagles came back.

REPTILES

God made “every thing that creepeth upon the earth after his kind” (Genesis 1:25). In this unit your child meets the creeping things with scales: the **reptiles**. Lizards, snakes, turtles, and crocodiles with their cousins the alligators all have dry, scaly skin, breathe air with lungs, and get their warmth from the sun and the world around them. Your child will feel a sunny rock and a shady rock to learn why a lizard basks, just as Mark Catesby watched green lizards on the fences of Carolina.

Then come the reptile families one by one. Snakes move with no legs, smell with their tongues and slip out of their old skins. William Bartram heard alligators roar like thunder on a Florida river. Alligators hide with only their eyes and nostrils above the water, and the mother carries her babies gently in her mouth. Turtles carry a shell that is part of their own skeleton, and Archie Carr’s tagged sea turtles came home to the same beach to nest.

Everything in this unit is told, pointed to, counted, measured, built or drawn. Keep the paper snake, the chalk-alligator drawing, the paper bowl turtle and the notebook pages together. At the end of the unit your child will use them to make a Reptile Book. A word on safety runs through the whole unit: we watch wild reptiles from a safe place, we never touch a wild snake, and we wash our hands after touching any reptile.

BEFORE YOU BEGIN

- Knows the clues of a mammal (fur or hair, milk) and a bird (feathers) from Units 1 and 2
- Can add and subtract numbers to 50
- Can read the numbers on a ruler and a thermometer with help
- Can listen to a short story and tell it back

MASTERY CHECKLIST

- I can name the clues of a reptile: dry scales, lungs for breathing air, and warmth from the sun.
- I can name the four reptile groups: lizards, snakes, turtles, and crocodiles and alligators.
- I can tell how a snake moves, smells and sheds its skin, and I know to stay back from a wild snake.
- I can tell an alligator from a crocodile by its snout and tell how a mother alligator cares for her babies.
- I can explain why a turtle cannot crawl out of its shell and count the scutes on its back.
- I can say that God made each kind of reptile and gave people the job of caring for His creatures.

OPTIONAL BOOKS AND RESOURCES

- **Smithsonian's National Zoo and Conservation Biology Institute** (<https://nationalzoo.si.edu/>): Free. Animal pages and photos of lizards, snakes, turtles, alligators and crocodiles. Look up the animal from each lesson together and compare its scales, feet and snout.
- **Everglades National Park (National Park Service)** (<https://www.nps.gov/ever/>): Free. Photos and short pages about the American alligator and the American crocodile, which both live in the Everglades (Lesson 3.3).
- **Biodiversity Heritage Library** (<https://www.biodiversitylibrary.org/>): Free. A parent can search for Catesby, Seba and Merian to page through the old natural-history books used in this unit's picture studies.

3.1 SCALES AND COLD BLOOD ★

OBJECTIVES

- Name the clues that tell us an animal is a reptile: dry scales, lungs for breathing air, and a body that gets its warmth from the world around it.
- Name the four big reptile groups: lizards, snakes, turtles, and crocodiles with their cousins the alligators.
- Show how a lizard warms up by sitting in the sun, and read two thermometers to find which is warmer.

Warm-up. Set one spoon in a sunny window and one spoon in a shady spot for 10 minutes. Then let your child hold one in each hand. Which one is warmer? Ask: If you were a little lizard on a cool morning, where would you go to get warm? Today we meet the animals that warm up just like the spoon.

Video. Coming soon. Reptiles for kids: what makes a reptile (scales, lungs, eggs, basking in the sun to warm up), lizards sunning on rocks, green anoles changing color; search Smithsonian’s National Zoo, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and gentle nature footage of lizards basking.

KEY TERMS

reptile

An animal with dry scales on its skin that breathes air with lungs. Lizards, snakes, turtles and crocodiles are reptiles.

scales

Small, hard, dry plates that cover a reptile’s skin like a suit of armor. They are made of the same stuff as your fingernails.

cold-blooded

Getting body warmth from the sun and the world outside, not from inside. A reptile is warm on a hot day and cool on a cold day.

bask

To lie in the sun to soak up its warmth. Lizards and turtles bask on rocks and logs.

CORE IDEAS

The story. In 1722 an English naturalist named Mark Catesby sailed across the ocean to Carolina. He walked through woods and swamps with his paints and paper. On fences and tree trunks he saw small green lizards with long, thin tails. In the warm sun they were bright green and quick. On cool mornings they sat still, and some turned brown. Catesby painted them carefully, and later he etched his paintings onto copper plates and printed them in a big book.

How they figured it out. Naturalists like Catesby noticed something about lizards. In the morning a lizard climbs onto a sunny rock and lies very still. This is called **basking**. After a while it warms up and darts away to hunt bugs. When the day gets too hot, it hides in the shade. A lizard cannot shiver or grow fur to keep warm. It gets its warmth from the sun, the rocks and the air. We call animals like this **cold-blooded**. Their blood is not really cold. It is just as warm or as cool as the place they are in.

The big idea. Lizards belong to a big animal family called the **reptiles**. Reptiles have dry **scales** on their skin. The scales overlap like shingles on a roof and keep the reptile from drying out. Reptiles breathe air with lungs, even the ones that swim. Most reptile mothers lay eggs with tough or leathery shells on land. There are four big reptile groups: lizards, snakes, turtles, and crocodiles with their cousins the alligators.

God's handiwork. God made "every thing that creepeth upon the earth after his kind" (Genesis 1:25). A reptile does not need to eat as much food as a mammal or a bird, because it does not have to make its own warmth. A lizard can live on a few bugs and a lot of sunshine. God fitted each kind for its life, and He saw that it was good.

PICTURE STUDY



The Green Lizard of Carolina, from *The Natural History of Carolina, Florida and the Bahama Islands*, Mark Catesby, published between 1731 and 1743 · Hand-colored etching · Catesby's original watercolors are in the Royal Collection at Windsor Castle; printed copies are kept in many libraries

Photo: rawpixel.com (digitally enhanced) · CC BY-SA 4.0 (<https://creativecommons.org/licenses/by-sa/4.0>) · via Wikimedia

Commons

Mark Catesby was an English naturalist who lived in Carolina for several years and painted the birds, fish, snakes, lizards and plants he found there. He learned to etch his own copper printing plates so his pictures would be printed just as he drew them. He liked to show each animal with a plant from the same place.

The lizard in this picture is the one we now call the green anole. It still lives in the southern United States. You might see one on a fence or a porch rail, basking in the sun.

Look closely

- Find the lizard's long tail. Is the tail longer or shorter than its body?
- Look at its toes. How do you think they help it climb?
- Find the plant. Why do you think Catesby painted the lizard with a plant?
- What color is the lizard? What color might it turn on a cool morning?

Talk about it

1. Is this lizard a reptile? What clues would you look for to find out?
2. Catesby watched lizards for a long time before he painted them. Why is watching closely important for a scientist?

Safety first. Rocks and jars in the sun can get warm, so touch them gently. Never look straight at the sun. If you see a wild lizard, watch it but do not grab it, and wash your hands after touching any reptile.

MAKE AND DO: SUNNY ROCK, SHADY ROCK

Why does a lizard climb onto a sunny rock in the morning? You will set out two rocks, one in the sun and one in the shade, and feel which one a lizard would choose.

You will need

- Two dark rocks about the same size (or two dark mugs of water)
- A sunny spot and a shady spot
- A thermometer, if you have one (not needed)
- A toy lizard or a lizard cut from paper
- Paper and crayons

Steps

1. Ask: Which rock will be warmer after a while, the sunny one or the shady one? Say your guess out loud.
2. Feel both rocks first. They should feel the same.
3. Set one rock in a sunny window or outside in the sun. Set the other rock in the shade.
4. Wait about 30 minutes. While you wait, cut out a paper lizard or find a toy one.
5. Feel both rocks. Which one is warmer? If you have a thermometer, lay it on each rock for a minute and read it.
6. Put your lizard on the rock it would pick on a cool morning. Then move it to the rock it would pick on a very hot afternoon.
7. Draw both rocks with a sun over one. Draw your lizard basking. Write or tell: "The sun warms the lizard."

Tips

- A dark rock soaks up more of the sun's warmth than a light one. Many lizards that bask are dark, too.
- On a sunny day, go outside and feel a sidewalk, a rock and the grass. Which would a lizard like best in the morning?

Check your work

- I can tell which rock got warmer and why.
- I can explain how a lizard gets warm.
- I can name the four reptile groups.

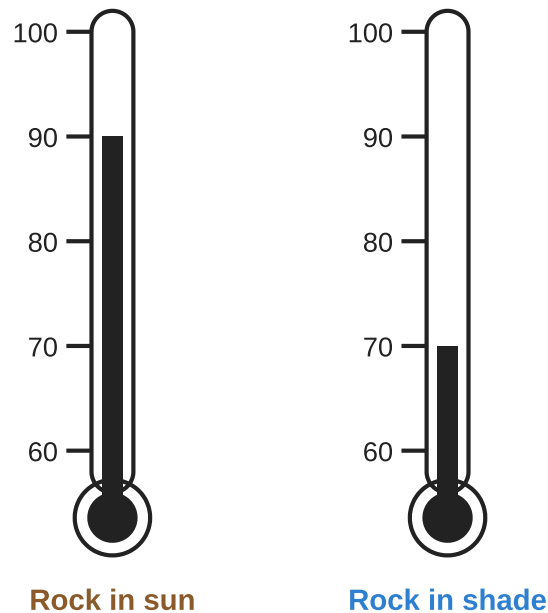
NATURE NOTEBOOK

1. Draw a lizard basking on a rock with the sun above. Draw arrows from the sun to the lizard and write "warmth."
2. Draw a close-up of reptile scales, overlapping like roof shingles. Label the page "Scales."
3. Make a page called "Reptiles I Know" with four boxes: lizard, snake, turtle, crocodile. Draw one animal in each box.

From history. Mark Catesby's big book, *The Natural History of Carolina, Florida and the Bahama Islands*, was one of the first books to show the plants and animals of North America in color. It took him many years to finish. Catesby colored many of the prints himself or watched over the coloring so the animals would look true to life. Later naturalists, such as John James Audubon, followed his idea of painting each animal in its home with the plants around it.

WORKED EXAMPLES

Example 1. A child left one rock in the sun and one rock in the shade. Then she read a thermometer on each rock. Look at the picture. Which rock is warmer? How many degrees warmer is it?



Reading two thermometers: the sunny rock and the shady rock.

1. Find the top of the dark line in the first thermometer. It stops at 90. The rock in the sun is 90 degrees.
2. Find the top of the dark line in the second thermometer. It stops at 70. The rock in the shade is 70 degrees.
3. 90 is more than 70, so the sunny rock is warmer.
4. Count up from 70 to 90 by tens: 80, 90. That is 2 tens, or 20 degrees.

Answer: The rock in the sun is warmer, by 20 degrees. A lizard on a cool morning would choose the sunny rock.

PRACTICE

1. **EASY** Name the four big groups of reptiles.
2. **EASY** Point to the reptiles as your parent says this list: lizard, robin, turtle, cat, snake, frog.
3. **MEDIUM** On a sunny wall, 9 lizards are basking. 4 lizards run into the shade. How many lizards are still in the sun?
4. **MEDIUM** Draw reptile scales that overlap like shingles on a roof. Then touch a real roof shingle, a pinecone or a fish picture and tell how they are alike.

5. **HARD** Why is a lizard slow on a cold morning and fast on a warm afternoon?

COMMON MISTAKES

- Thinking a cold-blooded animal has cold blood. Its blood is as warm as the place it is in. A lizard on a hot rock can be warmer than you!
- Thinking reptiles are slimy. Reptile skin is dry and covered with scales. Frogs and salamanders have smooth, wet skin, and they are amphibians, not reptiles.
- Thinking every animal with four legs and a tail is a lizard. A salamander looks a little like a lizard, but it has no scales.

Make it a game · Sunny Lizard, Chilly Lizard. Your child is a lizard. When the parent calls “Sunny rock!” the lizard darts quickly around the room. When the parent calls “Chilly morning!” the lizard moves very, very slowly. When the parent calls “Too hot!” the lizard runs to hide in the shade under a table. Mix up the calls and try to catch the lizard moving too fast on a chilly morning. Then switch places.

Scripture. “And God made the beast of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind: and God saw that it was good.” (Genesis 1:25, KJV)

Lizards, snakes and turtles creep close to the ground. God made them too, each after its kind, and He called them good.

Practice answers

1. Lizards, snakes, turtles, and crocodiles with their cousins the alligators.
2. Lizard, turtle and snake. The robin is a bird, the cat is a mammal and the frog is an amphibian with smooth, wet skin and no scales.
3. $9 - 4 = 5$ lizards are still in the sun.
4. A drawing of rows of small plates, each one lying a little over the next. The child should say the pieces overlap so they cover the body with no gaps.
5. A lizard is cold-blooded. It gets its warmth from the sun and the world around it. On a cold morning its body is cold, so it moves slowly. After it basks in the sun, it warms up and can move fast.

3.2 SNAKES ★

OBJECTIVES

- Tell how a snake moves without legs, smells with its tongue, and swallows its food whole.
- Explain what it means when a snake sheds its skin.
- Measure and compare two snake shapes with a ruler and know to stay back from any wild snake.

Warm-up. Lie down on your tummy on the floor with your arms at your sides. Try to move across the room without using your hands or feet. Wiggle and push! Now try it on a rug and on a smooth floor. Which was easier? Today we learn how a snake moves with no legs at all.

Video. Coming soon. Snakes for kids: how snakes move without legs, flicking the forked tongue to smell, shedding skin in one piece, swallowing an egg whole, garter and corn snakes; search Smithsonian’s National Zoo, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and calm nature footage of harmless snakes.

KEY TERMS

shed

To slip out of old skin when a new skin has grown underneath. A snake often sheds its skin in one long piece.

forked tongue

A tongue split into two tips at the end. A snake flicks it out to pick up smells from the air and the ground.

belly scales

The wide scales across the bottom of a snake. They grip the ground and help the snake push itself along.

venom

A poison some snakes use to catch their food. Most snakes have no venom, but we stay back from every wild snake.

CORE IDEAS

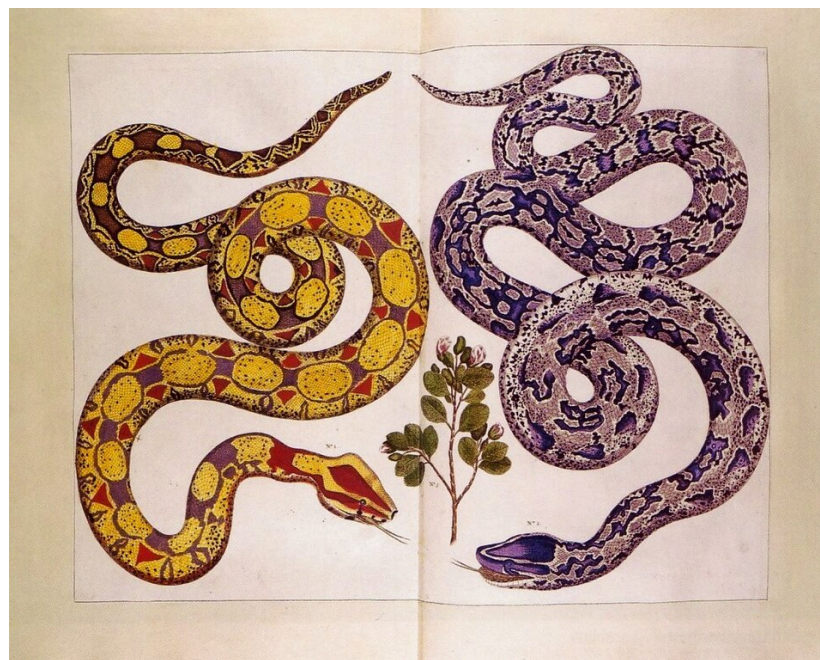
The story. Have you ever found a long, thin, papery tube in the grass or under a bush? Hold it up to the light. You can see the shapes of tiny scales, and even little round caps where the eyes were. It is a snake’s old skin! A snake grows all its life. When its skin gets too tight, a new skin grows underneath. The snake rubs its nose on a rock to start a tear. Then it crawls out, and the old skin peels off, often inside out and in one piece, like pulling off a sock.

How they figured it out. Naturalists watched snakes closely. They saw that a snake flicks its **forked tongue** in and out again and again. The tongue is not for stinging. It gathers smells from the air and the ground and brings them to a special smelling spot in the roof of the mouth. That is how a snake follows a mouse's trail. A snake has no eyelids, so it cannot blink. A clear scale covers each eye like a pair of glasses.

The big idea. A snake is a reptile with no legs. It has dry scales, breathes with lungs and is cold-blooded. Its wide **belly scales** catch on bumps, sticks and rocks, and the snake pushes its body against them in S-shaped waves. A snake does not chew. Its jaws stretch wide, and it swallows its food whole, even an egg bigger than its head. Most snakes lay eggs, but some, like the garter snake, have live babies.

In the world today. Snakes help farmers by eating mice and rats that spoil grain. Most snakes in North America are harmless, like the garter snake and the corn snake. A few have **venom**, such as rattlesnakes and copperheads. A wise scientist never touches a wild snake. Stop, stay back, and tell a grown-up. Watching from a safe place is the best way to study a snake.

PICTURE STUDY



A plate of snakes from Seba's Thesaurus (Volume 2), Albertus Seba (collector) and the artists who drew and engraved his collection, 1735 · Hand-colored engraving · Copies are kept in many libraries; the plates can be seen online

Albertus Seba was a pharmacist in the city of Amsterdam. When ships came home from faraway lands, he asked the sailors to bring him animals, shells and plants. He gathered so many that he filled his house with jars and drawers. Peter the Great, the ruler of Russia, came to see his collection and bought it.

Seba then gathered a second collection and paid artists to draw everything in it for a giant set of books. His second book is full of snakes, more than almost any book before it. The artists showed every scale and pattern as carefully as they could.

Look closely

- Count the snakes on the page. How many can you find?
- Find a snake's head. Can you see its eye? Remember, a snake cannot blink.
- Look at the patterns. Find stripes, spots or bands. Which pattern do you like best?
- Follow one snake from its head all the way to the tip of its tail with your finger.

Talk about it

1. Why do you think the artists drew the snakes curled and twisted instead of lying straight?
2. How could a snake's pattern help it hide in leaves, grass or sand?

Safety first. Never touch or pick up a wild snake, even one you think is harmless. If you see a snake, stop, stay back and tell a grown-up. Use child-safe scissors for the project, and wash your hands after touching a shed skin.

MAKE AND DO: SPIRAL SNAKE AND BELLY SCALE TEST

You will make a paper snake that uncoils like a real one, give it a forked tongue, and measure it. Then you will make a strip of "belly scales" and feel how they grip one way and slide the other.

You will need

- A paper plate
- Crayons or markers
- Child-safe scissors
- A small strip of red paper
- Tape or glue
- A piece of string or yarn
- A ruler
- Six index cards cut in half, and a long strip of cardboard (for the belly scales)

Steps

1. Draw a spiral on the paper plate, starting at the edge and curling in to the middle. Make the middle a little wider for the head.
2. Color a pattern of stripes, spots or bands. Draw small overlapping scales with your crayon.
3. Cut along the spiral line with help. Lift the head and watch your snake uncoil!

4. Cut a small red strip and snip a notch in one end to make a forked tongue. Tape it under the head.
5. Lay a string along your snake from head to tail. Hold the string against a ruler. How many inches long is your snake?
6. Now the belly scale test. Tape the card pieces in a row on the cardboard strip, each one lying over the next like roof shingles, all pointing the same way.
7. Run your finger along the strip one way, then the other way. One way is smooth. The other way catches. A snake's belly scales catch on the ground in the same way, so the snake can push forward.

Tips

- Hang your spiral snake from a string in a doorway. It turns slowly in the moving air.
- If you find a real shed skin, a grown-up can lift it with a stick into a zip-top bag so you can study it with a magnifying glass.

Check your work

- I can tell how a snake moves without legs.
- I can tell what a snake's forked tongue is for.
- I can measure my paper snake with a ruler.

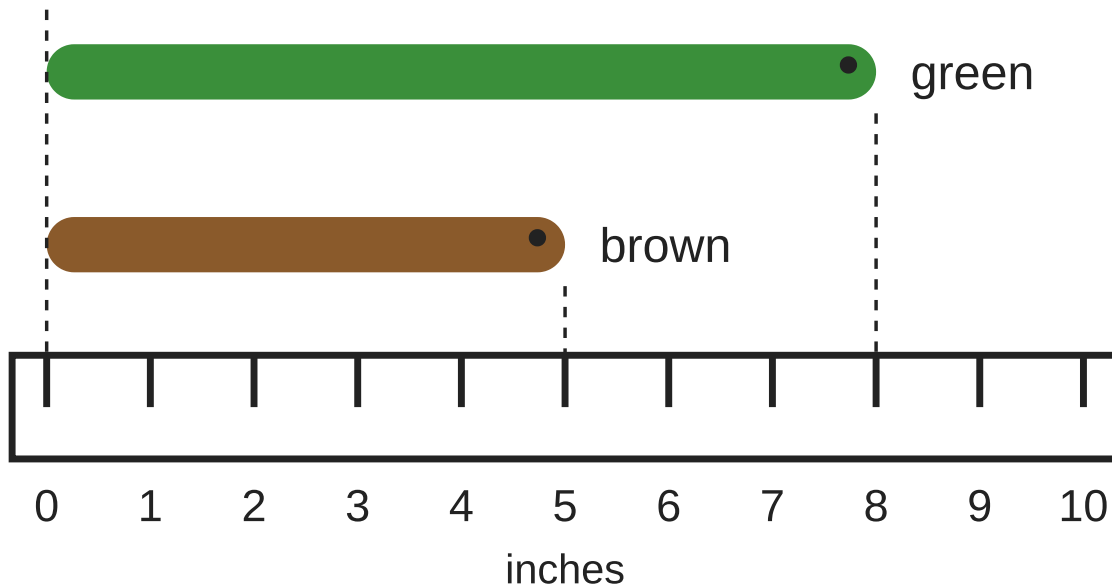
NATURE NOTEBOOK

1. Draw a snake flicking its forked tongue. Draw little dots in the air for smells and label them "smells."
2. Draw a shed snake skin coming off like a sock. Label the new skin and the old skin.
3. Draw a snake in an S shape pushing against three rocks. Draw small arrows where it pushes.

From history. The Bible tells of a snake on the island of Malta. The apostle Paul had been shipwrecked there. On a cold, rainy day he gathered sticks for a fire, and a viper came out of the heat and fastened on his hand. Paul shook it off into the fire and felt no harm, and the people of the island were amazed (Acts 28:1-6).

WORKED EXAMPLES

Example 1. Two yarn snakes lie on a ruler. Look at the picture. How long is each snake? Which snake is longer, and by how many inches?



Measuring two yarn snakes with a ruler.

1. Both snakes start at the 0 on the ruler.
2. The green snake ends at the 8. It is 8 inches long.
3. The brown snake ends at the 5. It is 5 inches long.
4. 8 is more than 5, so the green snake is longer.
5. Count up from 5 to 8: 6, 7, 8. That is 3 more inches.

Answer: The green snake is 8 inches and the brown snake is 5 inches. The green snake is longer by 3 inches.

PRACTICE

1. **EASY** What does a snake use its forked tongue for?
2. **EASY** Your parent will say four things. Hold up a thumb for the ones a snake can do: blink its eyes, smell with its tongue, swallow an egg whole, chew its food.
3. **MEDIUM** A shed snake skin is 30 inches long. Your paper snake is 20 inches long. Which is longer? By how many inches?
4. **MEDIUM** Show with your arm how a snake moves in an S shape. Then tell how its belly scales help.
5. **HARD** You are on a walk and see a snake lying across the path. What should you do, and why?

COMMON MISTAKES

- Thinking snakes are slimy. A snake's skin is dry and covered with scales.
- Thinking a snake stings with its tongue. The forked tongue is harmless. It is used for smelling.
- Thinking all snakes are dangerous. Most snakes have no venom and help us by eating mice and rats. Still, we never touch a wild snake.

Make it a game • Snake Sniff. Hide a cotton ball with a drop of vanilla or a slice of orange somewhere in one room. Your child is the snake. The snake must keep its hands at its sides, slither along, and “flick its tongue” by sniffing the air to find the smell. When the snake finds it, it “swallows it whole” by scooping it up with no chewing allowed. Then switch and let the snake hide the smell.

Scripture. “There be three things which are too wonderful for me, yea, four which I know not: The way of an eagle in the air; the way of a serpent upon a rock; the way of a ship in the midst of the sea; and the way of a man with a maid.” (Proverbs 30:18-19, KJV)

Agur, a wise man whose words are written in Proverbs, wondered how a snake could glide over a bare rock with no legs at all. Now you know a little of its secret: belly scales and S-shaped waves. God's works are full of wonders to discover.

Practice answers

1. To smell. The tongue picks up smells from the air and the ground and carries them to a smelling spot in the roof of its mouth.
2. Smell with its tongue and swallow an egg whole. A snake cannot blink because it has no eyelids, and it does not chew.
3. The snake skin is longer, by 10 inches. $30 - 20 = 10$.
4. The child waves an arm in S-shaped curves. The belly scales catch on bumps, sticks and rocks, and the snake pushes against them to move forward.
5. Stop, stay back and tell a grown-up. Do not touch it. Most snakes are harmless, but some have venom, and it is hard to tell them apart. Any wild snake may bite if it is scared.

3.3 CROCODILES AND ALLIGATORS

OBJECTIVES

- Tell how a crocodile or alligator is made for hiding in the water: eyes and nostrils on top of its head.
- Tell an alligator from a crocodile by the shape of its snout.
- Tell how a mother alligator cares for her eggs and babies.

Warm-up. Fill a sink or a bowl with water. Float a small toy so that only the top of it shows. Ask: If an animal wanted to hide in a river but still see and breathe, where would its eyes and nose need to be? Now look at a picture of an alligator's head. Where are its eyes and nostrils?

Video. Coming soon. Alligators and crocodiles for kids: eyes and nostrils on top of the head, U-shaped and V-shaped snouts, a mother alligator's nest mound and babies chirping from the eggs; search Smithsonian's National Zoo, National Park Service Everglades, SciShow Kids, Homeschool Pop (Alternate) and nature footage.

KEY TERMS

crocodilian

The family name for crocodiles, alligators and their cousins the caimans. They are big reptiles with long snouts, strong tails and tough, bumpy scales.

snout

The long front part of an animal's face, with the nose and mouth.

nostrils

The holes in the nose that air goes in and out of.

nest

A safe place a mother makes for her eggs. A mother alligator piles up mud and plants into a big mound.

CORE IDEAS

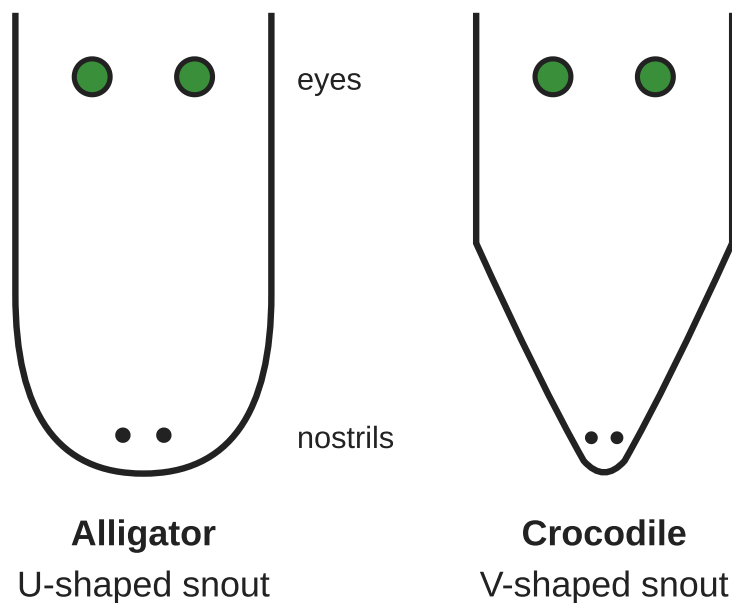
The story. In the 1770s a naturalist from Philadelphia named William Bartram paddled a small boat up the St. Johns River in Florida. As night came, he heard a roar like thunder. The water shook, and the reeds trembled. Big alligators were bellowing all around him! Bartram watched them swim, fight and catch fish. Later he wrote a book about his travels and drew pictures of what he saw. Many people far away learned about Florida's alligators from his book.

How they figured it out. Look closely at an alligator's head. Its eyes and **nostrils** sit on the very top. The alligator can float with almost its whole body under the water. Only its eyes and nose stick out, like little bumps on a log. It can see and breathe while it hides. When it

dives, a clear eyelid slides over each eye like swim goggles. Crocodiles, alligators and caimans are all built this way. Together they are called **crocodilians**.

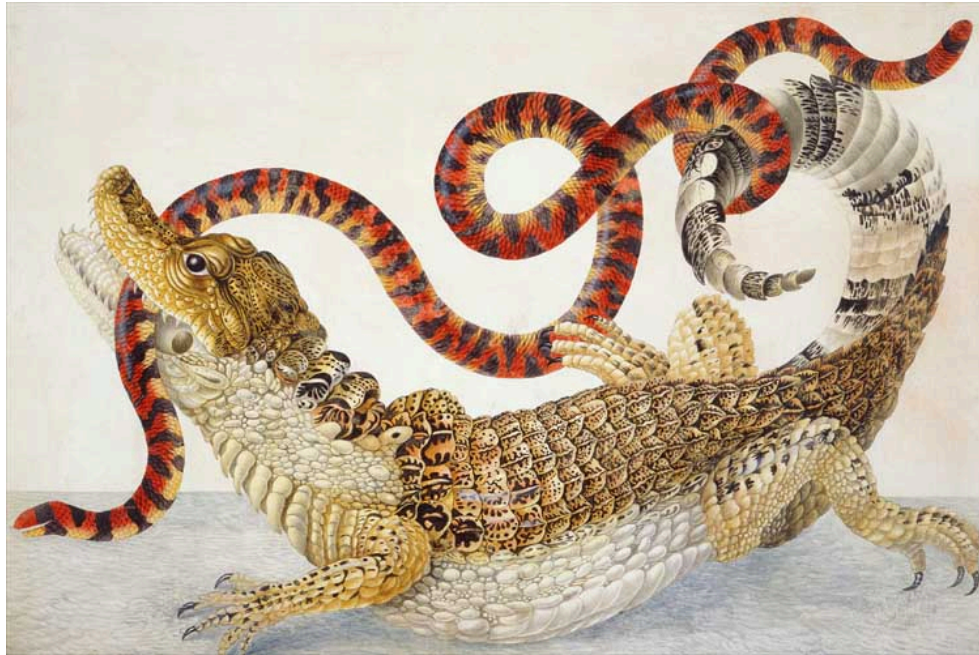
The big idea. Crocodilians are the biggest reptiles. They have thick, bumpy scales, strong tails for swimming and lungs for breathing air. How can you tell an alligator from a crocodile? Look at the **snout**. An alligator's snout is wide and round, like the letter U. A crocodile's snout is narrower and pointed, like the letter V. When a crocodile shuts its mouth, some of its bottom teeth still show. Alligators live in the southern United States and China. Crocodiles live in warm places around the world.

God's handiwork. A crocodilian looks fierce, but its mother is very careful. A mother alligator piles mud and plants into a big **nest** and lays her eggs inside. She guards it all summer. When the babies are ready to hatch, they chirp inside their eggs. The mother hears them, digs open the nest, and carries the babies to the water gently in her big mouth. "O LORD, how manifold are thy works!" (Psalm 104:24).



Alligator or crocodile? Look at the shape of the snout.

PICTURE STUDY



Spectacled Caiman and a Snake, from Metamorphosis insectorum Surinamensium, Maria Sibylla Merian, printed in the 1719 edition of her Surinam book · Hand-colored engraving · Copies are kept in many libraries; the plates can be seen online

Maria Sibylla Merian was a German artist and naturalist. In 1699 she sailed with her daughter to Surinam, in South America, to study the plants and animals of the rain forest. She is most famous for her paintings of caterpillars and butterflies, but she painted other creatures too.

This picture shows a caiman, a small cousin of the alligator that lives in South American rivers, struggling with a brightly banded snake. Both are reptiles. Merian loved to show living things doing what they really do.

Look closely

- Find the caiman's eyes. Are they on the top or the side of its head?
- Find the bumpy scales on the caiman's back. Run your finger along them from head to tail.
- Find the snake. What colors are its bands?
- Look at the caiman's snout. Is it more like a U or a V?

Talk about it

1. How many reptiles can you find in this picture? What kinds are they?
2. Why might a caiman want its eyes on the top of its head?

Safety first. Never go near an alligator or crocodile in the wild. In places where alligators live, stay well back from the edge of ponds, rivers and lakes, and never feed

them. When you draw with chalk outside, stay off the street and work with a grown-up.

MAKE AND DO: A LIFE-SIZE ALLIGATOR

How big is a big alligator? You will draw one full size on the driveway or sidewalk and lie down beside it. Then you will be an alligator hiding in the water.

You will need

- Sidewalk chalk
- A yardstick or a tape measure
- A long string, if you like
- A blanket or a big towel
- Paper and crayons

Steps

1. Ask: How many of you would fit along a big alligator? Say your guess.
2. With a grown-up, draw a straight chalk line. Lay the yardstick down 4 times, end to end, and mark each end. A yardstick is 3 feet, so 4 yardsticks make 12 feet. That is the length of a big alligator.
3. Draw an alligator shape along the line: a U-shaped snout at one end, a body with four short legs in the middle, and a long tail at the other end. Add bumps down the back.
4. Lie down along the alligator, starting at the snout. Have a grown-up mark where your feet reach. Then scoot down and do it again until you reach the tail. How many of you fit?
5. Back inside, lie on the floor and pull a blanket over you up to your eyebrows. Keep your eyes and nose out. You are an alligator hiding in the river! Can you still see and breathe?
6. Draw your chalk alligator in your notebook. Write how many of you fit along it.

Tips

- A big alligator can be even longer than 12 feet, and the biggest crocodiles are longer still.
- Draw a baby alligator next to the big one. A newly hatched alligator is only about as long as a new pencil.

Check your work

- I can tell how many of me fit along a big alligator.
- I can tell why an alligator's eyes and nostrils are on top of its head.
- I can tell an alligator from a crocodile by its snout.

NATURE NOTEBOOK

1. Draw a wavy river line. Draw just the eyes and nostrils of an alligator poking up above the water.
2. Draw an alligator snout and a crocodile snout from above. Write U next to one and V next to the other.
3. Draw a mother alligator by her nest mound with eggs inside. Draw a baby alligator peeking out of an egg.

From history. Long ago, so many alligators were hunted for their skins that they became hard to find in many places. People who cared about them passed laws to protect them, and wildlife workers watched over their swamps. The alligators came back. In 1987 the American alligator was declared fully recovered, and today it is common again in the swamps and rivers of the southern United States.

WORKED EXAMPLES

Example 1. A big alligator is about 12 feet long. A child is about 4 feet tall. How many children, lying head to toe, would fit along the alligator?

1. One child reaches 4 feet.
2. Two children reach 4, 8 feet.
3. Three children reach 4, 8, 12 feet. Now we are at the end of the alligator.
4. We counted by fours 3 times.

Answer: 3 children fit along a 12-foot alligator.

PRACTICE

1. **EASY** Look at the snout picture. Point to the alligator. Point to the crocodile. How did you know?
(Use the map or drawing “Alligator or crocodile?” shown earlier in this lesson.)
2. **EASY** Why are an alligator’s eyes and nostrils on the top of its head?
3. **MEDIUM** A mother alligator laid 35 eggs in her nest. 30 eggs hatched. How many did not hatch?
4. **MEDIUM** Is an alligator a reptile? Tell two clues.
5. **HARD** Tell the story of how a mother alligator takes care of her babies.

COMMON MISTAKES

- Thinking alligators and crocodiles are the same animal. They are cousins in the same family, but an alligator has a U-shaped snout and a crocodile has a V-shaped snout.
- Thinking crocodiles breathe underwater like fish. They breathe air with lungs and must come up for air, but they can hold their breath for a long time.

- Thinking reptile mothers never care for their young. A mother alligator guards her nest and carries her babies to the water.

Make it a game · Log or Alligator?. Lay a blanket on the floor for a river. One player lies under it with only eyes and nose showing. The other player tiptoes along the riverbank. When the alligator blinks twice, the walker must freeze. If the walker moves after the blink, the alligator calls “Snap!” and they switch places. Before each turn, the walker must say one thing that makes an alligator a reptile.

Scripture. “O LORD, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches.” (Psalm 104:24, KJV)

“Manifold” means many and of many kinds. God made the little lizard and the great alligator, and He made each one wisely, from its goggle eyelids to its careful mother.

Practice answers

1. The alligator has a wide, round, U-shaped snout. The crocodile has a narrow, pointed, V-shaped snout.
2. So it can see and breathe while almost all of its body hides under the water.
3. $35 - 30 = 5$ eggs did not hatch.
4. Yes. It has dry, tough scales, it breathes air with lungs, it is cold-blooded and basks in the sun, and it lays eggs. Any two clues are correct.
5. She piles mud and plants into a big nest mound and lays her eggs inside. She guards the nest. When the babies chirp inside their eggs, she digs open the nest and gently carries the babies to the water in her mouth.

3.4 TURTLES

OBJECTIVES

- Tell how a turtle’s shell is part of its body and is covered with plates called scutes.
- Sort turtles by their feet: flippers for the sea, webbed feet for ponds, and stumpy feet for tortoises on land.
- Tell how Archie Carr studied and helped protect the green sea turtles that nest on a beach.

Warm-up. Turn a laundry basket or a big box upside down. Let your child crawl under it and pull in their arms and legs. Ask: How does it feel to carry your house on your back? What could you do if a fox came by? Now feel your own ribs and backbone through your shirt. Today we learn that a turtle’s shell is made partly of its ribs and backbone!

Video. Coming soon. Turtles for kids: the shell and its scutes, a box turtle closing up, tortoises walking, baby sea turtles hatching on the beach and crawling to the sea; search Smithsonian’s National Zoo, NOAA Fisheries, U.S. Fish and Wildlife Service, SciShow Kids, Homeschool Pop (Alternate) and nature footage.

KEY TERMS

shell

A turtle’s hard covering, with a top part and a bottom part. It grows from the turtle’s own ribs and backbone, so it is part of its body.

scutes

The hard plates that cover a turtle’s shell like tiles. They are made of the same stuff as your fingernails.

tortoise

A turtle that lives on land. It has a high, rounded shell and thick, stumpy legs.

flippers

Flat, paddle-shaped legs that sea turtles use to swim.

CORE IDEAS

The story. In 1955 a scientist named Archie Carr began to study turtles on a long, sandy beach called Tortuguero in Costa Rica. The name means “place of turtles.” On dark nights, huge green sea turtles crawled out of the waves. Each mother dug a hole in the sand with her back flippers, laid her eggs, covered them, and went back to the sea. Carr put a small metal tag on each mother’s flipper. Years later, the same tagged turtles came back to the very same beach to lay their eggs again!

How they figured it out. Carr and his helpers counted turtles, nests and tags, year after year. They learned that sea turtles swim far across the ocean but find their way home to

nest. They also saw that people were taking too many turtles and eggs. Carr wrote books and talked to leaders, and the beach was protected. Little by little, more and more turtles came back to nest.

The big idea. Turtles are reptiles with a **shell**. The shell grows from the turtle's own ribs and backbone, so a turtle can never crawl out of it. Hard plates called **scutes** cover the shell. A turtle has no teeth. It has a hard beak like a bird. Every turtle, even a sea turtle, lays its eggs on land. Turtles are made for different homes. Sea turtles have **flippers**. Pond turtles have webbed feet. A **tortoise** lives on land and walks on thick, stumpy legs. A box turtle can pull in its head and legs and shut its shell tight, like a box with a lid.

God's handiwork. God put Adam in the garden "to dress it and to keep it" (Genesis 2:15). Archie Carr kept a turtle beach, and the turtles came back. You can help too. If you see a turtle crossing a road, tell a grown-up. Leave wild turtles in their homes, and watch them from a little way off.

PICTURE STUDY



*Chelonia (Turtles), Plate 89 of Art Forms in Nature, Ernst Haeckel, 1904 · Color lithograph · Prints are kept in many libraries; the book *Kunstformen der Natur* (Art Forms in Nature) was printed in Leipzig, Germany*

Ernst Haeckel was a German scientist who loved to draw. He made a famous book of pictures called *Art Forms in Nature*, with one hundred plates of sea creatures, bats, frogs, shells and more. You may remember his page of bats.

On this page Haeckel drew many kinds of turtles and their shells. He arranged them in a careful pattern, almost like a quilt, so we can compare their shapes and the plates on their backs.

Look closely

- Find a shell with a high, round top. Find one that is flat. Which do you think could swim best?
- Look closely at the plates on one shell. These are the scutes. Can you count some of them?
- Find a head, a leg or a tail if you can.
- Find two shells that look almost the same. How are they different?

Talk about it

1. Why do you think Haeckel put so many turtles on one page?
2. If you could hold one of these turtles, which would you choose? Why?

Safety first. Do not pick up or take home wild turtles. Some turtles bite, and all turtles can carry germs, so always wash your hands with soap after touching any turtle or reptile. Never go into a road to help a turtle; tell a grown-up.

MAKE AND DO: PAPER BOWL TURTLE

You will build a turtle with a top shell, a bottom shell and scutes in the right places. Then you will make it hide inside its shell, just like a box turtle.

You will need

- A paper bowl (for the top shell)
- A paper plate (for the bottom shell)
- Green and brown crayons or markers
- Cardstock or a cereal box for the head, legs and tail
- Child-safe scissors
- Glue or tape

Steps

1. Turn the paper bowl upside down. This is the top shell.
2. Draw a row of 5 scutes down the middle of the shell, from front to back.
3. Draw 4 scutes on the left side and 4 scutes on the right side. Count them all. You should have 13 big scutes.
4. Draw a ring of small scutes around the edge, and color your shell.
5. Cut a head, four legs and a short tail from cardstock. Tape them to the bottom of the plate so they stick out.
6. Glue the bowl on top of the plate. Your turtle is done!
7. Now make it hide. Fold the head, legs and tail under the shell. Unfold them when it is safe to come out again.

Tips

- For a sea turtle, cut wide, flat flippers instead of legs. For a tortoise, use a deep bowl and make thick, round legs.
- Look at a real turtle at a pet store, zoo or nature center and count its scutes. Most turtles have 5 down the middle.

Check your work

- I can point to the top shell and the bottom shell.
- I can count the scutes on my turtle.
- I can tell why a turtle cannot crawl out of its shell.

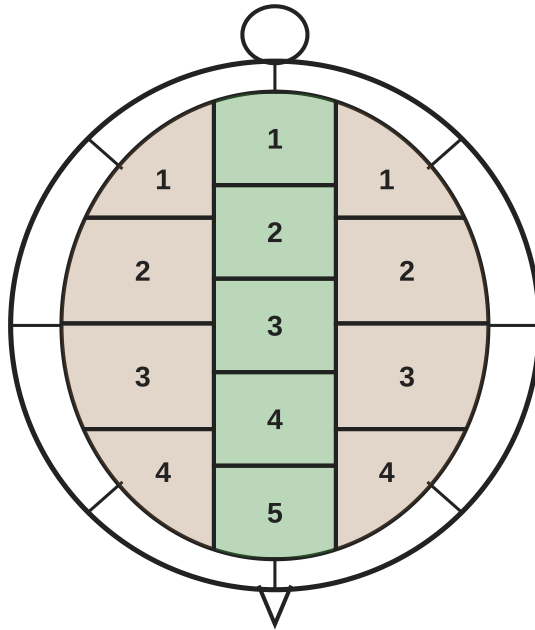
NATURE NOTEBOOK

1. Draw a sea turtle mother digging a nest in the sand at night. Draw the moon and the waves.
2. Draw three turtle feet: a sea turtle flipper, a pond turtle's webbed foot, and a tortoise's stumpy foot. Label each one.
3. Draw a box turtle open, and then draw it shut tight. Label them "open" and "closed."

From history. Archie Carr was a teacher and scientist at the University of Florida. He wrote a book about his turtle travels called *The Windward Road* (1956), and many people who read it wanted to help. Friends of the turtles started a group to protect the nesting beach, and in 1975 Tortuguero became a national park of Costa Rica. In the years since, many more green turtles have come back to nest there.

WORKED EXAMPLES

Example 1. Look at the top of this turtle shell. Count the big scutes inside the edge. How many are down the middle? How many on each side? How many in all?



Middle row: 5. Each side: 4. Edge ring: small scutes.

Counting the big scutes on a turtle's shell.

1. Point to each scute in the middle row and count: 1, 2, 3, 4, 5. That is 5.
2. Point to each scute on the left side and count: 1, 2, 3, 4. That is 4.
3. Point to each scute on the right side and count: 1, 2, 3, 4. That is 4.
4. Add them: $5 + 4 + 4 = 13$.

Answer: 5 down the middle, 4 on each side, 13 big scutes in all.

PRACTICE

1. **EASY** Can a turtle crawl out of its shell? Tell why or why not.
2. **EASY** Match each turtle to its feet: sea turtle, pond turtle, tortoise. The feet are stumpy legs, flippers and webbed feet.
3. **MEDIUM** Two box turtles each have 13 big scutes. How many big scutes do they have together?
4. **MEDIUM** Point to the reptile clues on your paper turtle. Is a turtle a reptile? Tell how you know.
5. **HARD** Where does a sea turtle lay her eggs? What did Archie Carr learn by putting tags on the mothers?

COMMON MISTAKES

- Thinking a turtle can take off its shell like a coat. The shell is joined to its ribs and backbone.
- Thinking all turtles live in water. Tortoises live on land, and even sea turtles lay their eggs on land.
- Thinking the “turtle” in “the voice of the turtle is heard in our land” (Song of Solomon 2:12) is a reptile. In the King James Bible, “turtle” there means the turtledove, a bird that coos in spring.

Make it a game • Turtle Tuck. Your child is a turtle under a blanket shell, with head, arms and legs sticking out. The parent calls out sounds. For a safe sound, like “Rain is falling” or “Sun is shining,” the turtle walks slowly along. For a danger sound, like “Here comes a fox!” or “A dog is barking!” the turtle tucks everything in under the shell and freezes. Count how many times the turtle tucks in just in time.

Scripture. “And the LORD God took the man, and put him into the garden of Eden to dress it and to keep it.” (Genesis 2:15, KJV)

God gave people the job of caring for His world. Archie Carr kept a beach safe for the turtles, and they came back. We can keep the little places around us too.

Practice answers

1. No. The shell grows from the turtle’s own ribs and backbone. It is part of its body.
2. Sea turtle: flippers. Pond turtle: webbed feet. Tortoise: stumpy legs.
3. $13 + 13 = 26$ big scutes.
4. Yes. A turtle has scales and scutes, breathes air with lungs, is cold-blooded and basks in the sun, and lays eggs on land.
5. She crawls onto a sandy beach at night, digs a hole with her back flippers, and lays her eggs on land. Carr learned that the same mothers come back to the very same beach to nest again.

UNIT 3 REVIEW

This is an oral review. Read each question aloud and let your child answer by telling, pointing, counting or showing. Have the paper snake, the paper bowl turtle and the notebook pages nearby. Give full points for a clear answer in your child's own words. The review is worth 20 points.

1. (3 pts) What clues tell you that an animal is a reptile? Name the four reptile groups.
2. (3 pts) Why does a lizard lie on a sunny rock in the morning? What does "cold-blooded" mean?
3. (3 pts) How does a snake move without legs? What does it use its forked tongue for?
4. (3 pts) What does it mean when a snake sheds its skin? What should you do if you see a wild snake?
5. (3 pts) Show me with your hands the shape of an alligator's snout and a crocodile's snout. Why are their eyes and nostrils on top of the head?
6. (3 pts) Can a turtle crawl out of its shell? Count the big scutes on your paper turtle.
7. (2 pts) Tell what Archie Carr learned about green sea turtles and how he helped them.

UNIT PROJECT: MY REPTILE BOOK

Make a small book with a cover and five pages: one page for what makes a reptile, and one page each for lizards, snakes, crocodiles and alligators, and turtles. On each animal page, draw the animal, label one special body part (basking skin, forked tongue, U or V snout, shell scutes), and tell your parent one true sentence to write underneath. Add your thermometer reading, your snake measurement and your scute count. Show the book with your paper snake and paper bowl turtle, and tell the family one story from the unit.

- **Accuracy:** Each reptile is drawn with the right body parts, and each labeled part and sentence is true.
- **Observation:** The book includes the sunny and shady rock reading, the snake measurement and the scute count, with the right numbers.
- **Telling:** The child tells one story from the unit (Catesby's lizards, Bartram's alligators or Carr's turtles) clearly in their own words.
- **Care:** The pages are neat and colorful, the models are finished, and the child can tell how to stay safe around wild reptiles.

Answer key

1. It has dry scales, it breathes air with lungs, and it gets its warmth from the sun and the world around it (most lay eggs too). The four groups are lizards, snakes, turtles, and crocodiles and alligators.
2. It is basking to warm up, because it cannot make its own warmth. Cold-blooded means its body is as warm or as cool as the place around it. Its blood is not really cold.
3. Its belly scales catch on bumps, sticks and rocks, and it pushes against them in S-shaped waves. It uses its tongue to smell.

4. A new skin grows underneath, and the snake crawls out of the old one, often in one piece. If you see a wild snake, stop, stay back and tell a grown-up. Never touch it.
5. Alligator: wide and round like a U. Crocodile: narrow and pointed like a V. The eyes and nostrils are on top so it can see and breathe while it hides in the water.
6. No. The shell grows from its ribs and backbone and is part of its body. The paper turtle has 5 scutes down the middle and 4 on each side, 13 in all.
7. He tagged mother turtles and learned that they come back to the very same beach to lay their eggs. He helped people protect the beach, and more turtles came back.

AMPHIBIANS

Frogs, toads, salamanders and newts are **amphibians**, a name that means “two lives.” Most of them begin life in the water as tadpoles or larvae with gills and tails, and later live on land with lungs and legs. All of them have soft skin with no scales, usually smooth and damp, that they breathe and drink through, so they live in ponds, streams and cool, damp places. In this unit your child will learn how amphibians differ from the reptiles of Unit 3, watch a tadpole change into a frog step by step, meet the salamanders that hide under logs, and care for real tadpoles at home.

Along the way we meet Dr. John Edwards Holbrook of Charleston, who wrote the first big American book about these animals; Jan Swammerdam, who showed that frogs hatch from eggs and grow step by step instead of coming out of mud; Lazzaro Spallanzani, who found that a salamander can grow back a lost leg; and the painter Rösel von Rosenhof, who raised frogs in jars and painted every change. Each one teaches the same lesson a young scientist needs: **look closely, again and again, and write down what you see.** And every tadpole that becomes a frog, never a fish or a bird, shows that God made living things to bring forth “after their kind.”

BEFORE YOU BEGIN

- Can name the main clues that sort mammals, birds and reptiles (fur, feathers, scales) from Units 1–3
- Can count to 20 and add small numbers
- Can listen to a short reading and tell it back in their own words
- Can draw a simple animal and label one or two parts

MASTERY CHECKLIST

- I can tell what “amphibian” means and name frogs, toads and salamanders as amphibians.
- I can tell how an amphibian is different from a reptile.
- I can put the steps of a frog’s life in order: eggs, tadpole, back legs, front legs, frog.
- I can tell how a salamander is different from a lizard and count its toes.
- I can care for tadpoles and return them to the pond they came from.
- I can observe, count and record changes in a journal like a real scientist.

OPTIONAL BOOKS AND RESOURCES

- **AmphibiaWeb** (<https://amphibiaweb.org/>): Free. A large library of photos and facts about the frogs, toads and salamanders of the world, run by scientists at the University of California, Berkeley. Written for adults, so a parent can look up the animals you find and show the child the pictures.

- **USGS Amphibian Research and Monitoring Initiative** (<https://armi.usgs.gov/>): Free. The U.S. Geological Survey's amphibian program, with photos and short articles about frogs and salamanders in America. Good for parents preparing Lessons 4.1 and 4.3.

4.1 TWO LIVES ★

OBJECTIVES

- Tell what the word amphibian means and name frogs, toads and salamanders as amphibians.
- Explain that most amphibians start life in the water with gills and later live on land with lungs.
- Name two ways an amphibian is different from a reptile: smooth, damp skin and soft eggs with no shell.

Warm-up. Get two kitchen sponges. Make one wet and leave one dry. Touch each one with your fingers and then with your cheek. Which one feels like a lizard’s skin? Which one feels more like a frog’s skin? Put both sponges on a sunny windowsill and check them at the end of the lesson. What happened to the wet one?

Video. Coming soon. Amphibians for kids: frogs, toads and salamanders in ponds and woods, a tadpole swimming and a frog hopping on land, frog skin up close, spring peepers calling at night; search Smithsonian’s National Zoo, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and nature footage.

KEY TERMS

amphibian

An animal with smooth, damp skin that usually starts life in the water and later lives on land. Frogs, toads and salamanders are amphibians. The word means “two lives.”

gills

Body parts for breathing under water. A young tadpole breathes with gills.

lungs

Body parts for breathing air. A grown frog breathes with lungs, and through its damp skin too.

cold-blooded

Warming up and cooling down with the air or water around you. Amphibians are cold-blooded, like reptiles.

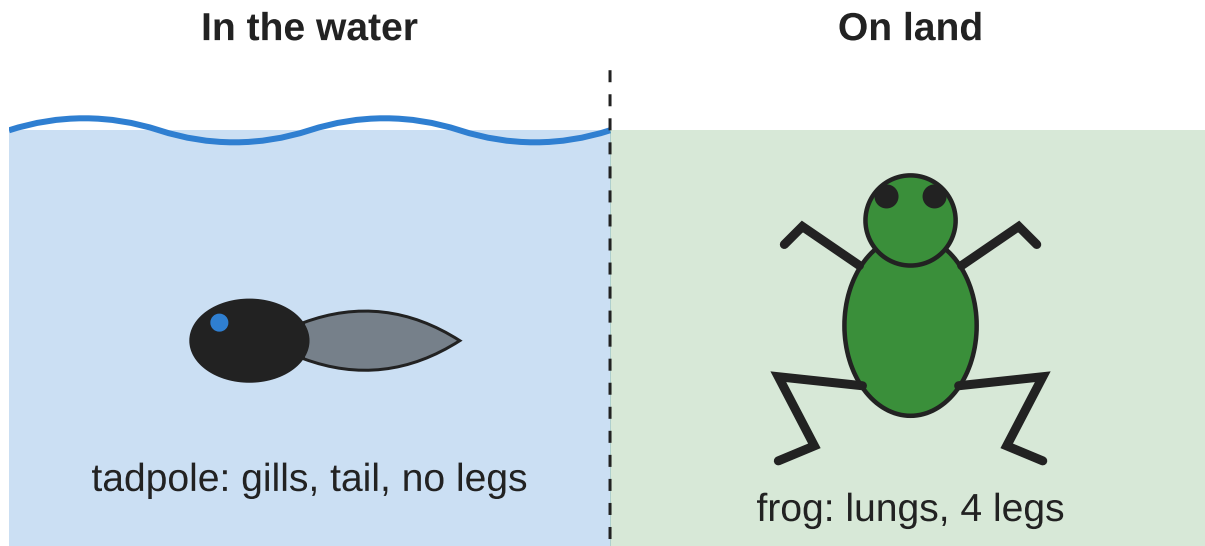
CORE IDEAS

The story. Long ago, in the 1830s, a doctor named John Edwards Holbrook lived in Charleston, South Carolina. He loved the frogs, toads, salamanders, snakes and turtles of America. He collected them, kept careful notes and hired artists to paint them. His big book, *North American Herpetology*, was the first large book about these animals in America. Today we will meet one group from his book: the **amphibians**.

How they figured it out. People watched frogs in ponds. In spring they saw jelly eggs in the water. Out of the eggs came little swimmers with tails and no legs, called tadpoles. A tadpole breathes with **gills**, like a fish. Later the same tadpole grows legs and **lungs**, crawls out and hops on land. So scientists gave these animals a name from an old Greek word: *amphibian*, which means “two lives.” First a life in the water, then a life on land.

The big idea. Frogs, toads, salamanders and newts are amphibians. There is even a kind with no legs at all, called a caecilian, that looks like a big worm. Amphibians have soft skin with no scales, no fur and no feathers, and most have smooth, damp skin. Their skin is so thin that they breathe through it, and they even drink through it! That is why amphibians stay near water or in damp places. They are **cold-blooded**, like the reptiles in Unit 3. But a reptile has dry scales and lays eggs with shells. An amphibian lays soft jelly eggs with no shell, usually in the water. Here is an easy way to tell a frog from a toad: a frog has smooth, wet skin and long legs for leaping. A toad has drier, bumpy skin (but still no scales) and short legs for hopping.

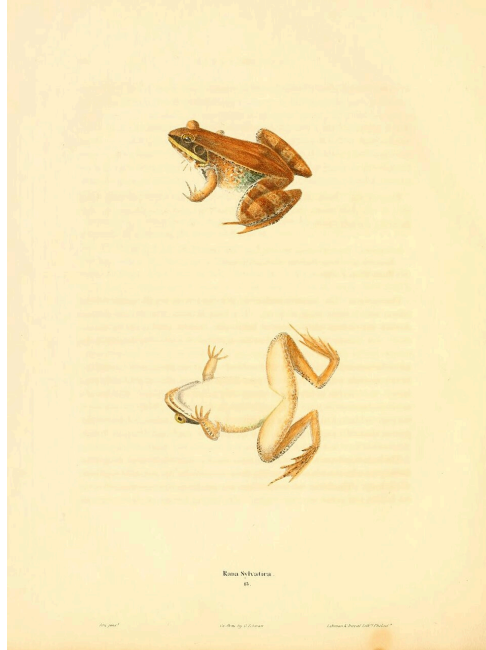
God’s handiwork. The wood frog lives in cold places in North America. In winter it hides under the leaves and freezes almost solid. Its heart stops. When spring comes, it thaws out, its heart starts beating again, and it hops off to the pond to sing! God made each amphibian just right for the place it lives.



Both have smooth, damp skin.

Two lives: a tadpole lives in the water and breathes with gills; a grown frog lives on land and breathes with lungs and skin.

PICTURE STUDY



Wood Frog, from North American Herpetology, Artists working for John Edwards Holbrook, 1836–1842 (the book came out in parts) · Lithograph (colored by hand in many copies) · Published in Philadelphia; copies are kept in many libraries

John Edwards Holbrook was a doctor in Charleston, South Carolina, who spent many years studying the reptiles and amphibians of America. He had artists draw each animal from real ones, so the shapes and markings would be right. This page shows the wood frog.

The wood frog is the same little frog you read about in this lesson: in winter it hides under the leaves and freezes almost solid, and in spring it thaws out and hops off to the pond. Look for the dark “mask” behind its eye. That mark helps people know a wood frog when they see one.

Look closely

- Find the dark mask behind the frog’s eye.
- Look at the back legs. Are they longer or shorter than the front legs? What are long legs good for?
- Look at the skin. Does it look like the dry scales of a snake, or smooth like a frog’s?
- Find the frog’s eyes. Why might it help a frog to have eyes high on its head?

Talk about it

1. How can you tell from this picture that a wood frog is not a reptile?
2. This frog lives in the woods, not in the water. Why does it still need to go back to a pond in the spring?

Safety first. Look at wild frogs and toads with your eyes, or hold one only for a moment with clean, wet hands and with a grown-up's help. Never hold one with sunscreen, bug spray or soap on your hands, because their thin skin soaks things up. Some frogs and toads make a bitter slime, so wash your hands after and never rub your eyes or mouth. Stay with a grown-up near any pond or creek.

MAKE AND DO: THE DAMP SKIN TEST

An amphibian's skin must stay damp. You will make two paper frogs, one wet and one dry, and see how fast a wet skin dries out in the sun and air. Then you will fold a "Two Lives" card to show the water life and the land life of a frog.

You will need

- Two paper towels
- A marker
- A plate and a little water
- A sunny window or a spot outside
- A sheet of paper, crayons (blue, green and brown)

Steps

1. Draw a simple frog on each paper towel and cut or tear around it.
2. Dip one paper frog in water and lay it on the plate. Lay the dry one beside it.
3. Touch both. Which one is like a real frog's skin?
4. Set the plate in the sun. Every 10 minutes, touch the wet frog. Count how many checks until it feels dry.
5. Talk about it: if a real frog sat in the hot sun far from water, what would happen to its skin? Where would a frog go to stay damp?
6. Now fold the sheet of paper in half. On the left half, color a blue pond and draw a tadpole with gills and a tail. On the right half, color green and brown land and draw a frog with four legs.
7. Write "Water life" on the left and "Land life" on the right. On the front, write "Two Lives."

Tips

- A frog hides in mud, under leaves or in the water on hot days to keep its skin damp. A toad's thicker skin lets it go a little farther from water.
- Keep your card. You will add to it in Lesson 4.2.

Check your work

- I can tell what "amphibian" means.
- I can show the water life and the land life of a frog.
- I can tell why a frog needs to keep its skin damp.

NATURE NOTEBOOK

1. Draw a frog and a toad side by side. Under the frog write “smooth, wet skin, long legs.” Under the toad write “dry, bumpy skin, short legs.”
2. Draw a lizard and a salamander side by side. Color the lizard’s scales. Draw the salamander’s skin smooth and shiny.
3. On a spring or summer evening, go outside with a grown-up near a pond or wet ditch and listen. If you hear frogs calling, write the date and draw what the sound made you think of.

From history. When the Swedish scientist Carl Linnaeus sorted animals in the 1700s, he put frogs, toads and salamanders in the same group as snakes, lizards and turtles. He called the whole group Amphibia. Later scientists looked more closely. They saw that frogs and salamanders have damp skin and lay soft eggs in water, while snakes, lizards and turtles have dry scales and lay eggs with shells. So they split them into two groups, amphibians and reptiles, the way we sort them today.

WORKED EXAMPLES

Example 1. Look at the “Two Lives” picture. How many legs does the tadpole have? How many legs does the frog have? How many more legs does the frog have?

(Use the map or drawing “Count the legs in each life.” shown earlier in this lesson.)

1. Find the tadpole in the water. Look all around its body. It has a tail but no legs. That is 0 legs.
2. Find the frog on the land. Count its legs: 2 in front and 2 in back. $2 + 2 = 4$ legs.
3. Compare: $4 - 0 = 4$. The frog has 4 more legs than the tadpole.
4. Think: the tadpole swims with its tail. The frog hops with its legs.

Answer: The tadpole has 0 legs, the frog has 4, so the frog has 4 more legs.

PRACTICE

1. **EASY** What does the word “amphibian” mean?
2. **EASY** Sort these animals. Which are amphibians? Frog, snake, salamander, turtle, toad.
3. **MEDIUM** At a pond you see 7 frogs and 6 toads. How many amphibians do you see in all?
4. **MEDIUM** Point to the right one. Which has dry, scaly skin: a lizard or a salamander? Which has smooth, damp skin?
5. **HARD** Tell in your own words why frogs live near water or in damp places.

COMMON MISTAKES

- Thinking toads give you warts. They do not. Warts come from a tiny germ that passes between people, not from toads. Still, wash your hands after touching a toad, because

some toads make a bitter slime.

- Thinking salamanders are lizards. A lizard is a reptile with dry scales and claws. A salamander is an amphibian with smooth, damp skin and no claws.
- Thinking frogs drink with their mouths. A frog soaks up water through its skin, mostly through the skin on its belly.

Make it a game · Water or Land?. Mark a “pond” on the floor with a blanket or a towel. Your parent calls out a word. If it belongs to the water life, jump onto the pond: “gills,” “tail,” “tadpole,” “jelly eggs.” If it belongs to the land life, jump off: “lungs,” “four legs,” “hopping,” “catching bugs.” If your parent says “damp skin,” crouch and croak, because both lives need it! Then switch and let the child call the words.

Scripture. “And God said, Let the waters bring forth abundantly the moving creature that hath life, and fowl that may fly above the earth in the open firmament of heaven.” (Genesis 1:20, KJV)

God filled the waters with moving creatures. Every spring, ponds fill up with tiny tadpoles, wiggling and swimming, just as God said.

Practice answers

1. “Two lives”: a life in the water and a life on land.
2. Frog, salamander and toad are amphibians. The snake and the turtle are reptiles.
3. $7 + 6 = 13$ amphibians.
4. The lizard has dry, scaly skin. The salamander has smooth, damp skin.
5. A frog’s skin is thin and must stay damp. The frog breathes and drinks through its skin, and in dry air it would dry out. Also, most frogs lay their jelly eggs in water, and the tadpoles live in water.

4.2 TADPOLE TO FROG

OBJECTIVES

- Put the steps of a frog's life in order: eggs, tadpole, tadpole with back legs, froglet with four legs, frog.
- Tell how a tadpole changes as it grows: legs come, gills go, lungs grow and the tail shrinks.
- Explain that frogs come from eggs laid by frogs, each after its kind.

Warm-up. Mix a spoonful of tapioca pearls or chia seeds into a glass of water and let it sit while you start the lesson. Come back and look. Do you see the clear jelly around each little dot? Frog eggs look a lot like this: a dark dot in a ball of clear jelly. Talk about it: why might jelly be a good wrapping for an egg in a pond?

Video. Coming soon. Frog metamorphosis for kids: frog eggs in jelly, tadpoles hatching, back legs then front legs growing, a froglet with a short tail climbing out of the water; search Smithsonian, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and time-lapse nature footage of tadpoles.

KEY TERMS

tadpole

A baby frog or toad that lives in the water. It has a tail for swimming and gills for breathing, and at first no legs.

metamorphosis

A big change in body shape as an animal grows up, like a tadpole changing into a frog.

froglet

A young frog that has four legs and lungs but still has a short tail.

egg mass

A clump of many frog eggs held together in clear jelly. It is also called frog spawn.

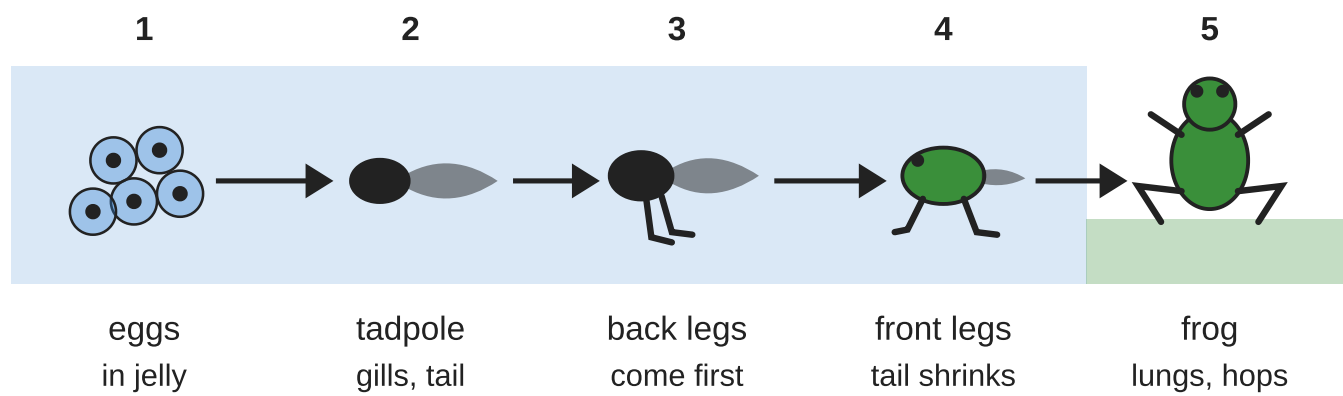
CORE IDEAS

The story. In the 1600s, in the city of Amsterdam in the Netherlands, lived a young scientist named Jan Swammerdam. He studied tiny creatures with very small, strong lenses. Many people then thought frogs simply came up out of the mud. Swammerdam did not guess. He gathered frog eggs from the water, watched them hatch, and looked closely at the tadpoles as they grew. He drew what he saw, step by step.

How they figured it out. Swammerdam showed that a frog does not pop out of mud, and it does not change all at once like magic. It comes from an egg laid by a mother frog, and it grows a little at a time. Inside the tadpole, the frog's new parts are already starting to form. This big change in body shape is called **metamorphosis**.

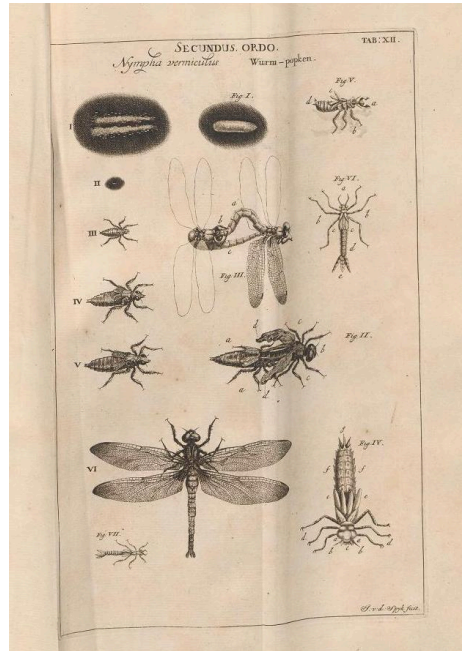
The big idea. Here are the steps. **1. Eggs.** In spring a mother frog lays an **egg mass** in the water, a clump of eggs in clear jelly. **2. Tadpole.** A tiny **tadpole** wiggles out. It has gills and a tail, and it nibbles on soft green plants. **3. Back legs.** Two back legs grow first. **4. Front legs.** Then two front legs pop out. Lungs grow, the gills go away, and the tadpole swims up to gulp air. Now it is a **froglet**. Its tail gets shorter and shorter. The tail does not fall off; the froglet's body uses it up for food! **5. Frog.** The young frog climbs out onto land. Now it eats bugs, catching them with its long, sticky tongue.

God's handiwork. Frog eggs always grow into frogs, and toad eggs always grow into toads. God made living things to bring forth "after their kind" (Genesis 1:25). Each tadpole already carries the plan for the frog it will become. When you see a clump of frog eggs in a spring pond, you are looking at the start of a wonderful change that God planned.



The five steps from egg to frog. The back legs come first; the tail shrinks away last.

PICTURE STUDY



How a Dragonfly Grows, Plate XII of Biblia Naturae (The Bible of Nature), Jan Swammerdam (engraved from his drawings), 1737–1738 (printed long after he died) · Engraving · Published in Leiden, the Netherlands; copies are kept in many libraries

Jan Swammerdam studied insects, frogs and other small creatures with great care. He believed that looking closely at small creatures was a way to see the wisdom of God. After he died, his notes and drawings were printed in a big book. Its name means *The Bible of Nature*.

This page shows another animal with two lives: the dragonfly. A young dragonfly lives under water in a pond, just like a tadpole. When it is ready, it climbs up a plant stem, splits its old skin and comes out as a dragonfly with wings. Swammerdam showed that insects, like frogs, change step by step, not by magic and not out of mud.

Look closely

- Find the young dragonflies that live in the water. Do they have wings yet?
- Look for a grown dragonfly. If you find one, count its wings.
- Find the small numbers or letters beside the drawings. Why do you think he put them there?
- Which drawing looks youngest? Which looks oldest?

Talk about it

1. How is a dragonfly's life like a frog's life? How is it different?
2. How did careful watching help Swammerdam show that frogs and insects do not come from mud?

MAKE AND DO: PLAY DOUGH TADPOLE PARADE

You will build all five steps of a frog's life out of play dough and set them in order on a paper strip. Building each step with your hands helps you remember what changes and when.

You will need

- Green, brown or black play dough (or clay)
- A little white or clear dough, or a few tapioca pearls, for the jelly eggs
- A long strip of paper (tape two sheets end to end)
- A marker
- Your "Two Lives" card from Lesson 4.1

Steps

1. Draw a wavy blue line across the strip. Draw 5 boxes and number them 1 to 5.
2. Box 1: make a clump of small balls for the eggs. Push a dark dot of dough into each one.
3. Box 2: roll a round body and pinch out a long, flat tail. No legs yet!
4. Box 3: make another tadpole and add two tiny back legs near the tail.
5. Box 4: make a froglet. Give it four legs and only a short tail.
6. Box 5: make a frog with four legs and no tail. Give it long, bent back legs for jumping.
7. Point to each step and tell its story out loud, starting with "First the mother frog lays eggs..."
8. Add a small drawing of the five steps inside your "Two Lives" card.

Tips

- Make each new step's tail a little shorter than the last, so you can see the tail shrinking.
- Save one ball of dough to make a fly for the frog to "catch" at the end.

Check your work

- I can put the five steps of a frog's life in order.
- I can tell which legs grow first.
- I can tell what happens to the tadpole's tail.

NATURE NOTEBOOK

1. Draw the five steps of a frog's life in a row with arrows. Label them: eggs, tadpole, back legs, front legs, frog.
2. Draw a tadpole and a frog side by side. Circle the parts the frog has that the tadpole does not (legs). Draw an X on the part the tadpole has that the frog does not (tail).
3. If you can visit a pond in spring with a grown-up, look along the edges for clumps of jelly eggs or tiny tadpoles. Draw what you see and write the date.

From history. Frogs are part of a famous story in the Bible. When Pharaoh would not let the people of Israel go, God sent frogs over the land of Egypt. The Bible says the frogs came up out of the waters and covered the land, even getting into houses, beds and ovens (Exodus 8). The frogs came from the river and ponds, just where real frogs lay their eggs and grow up.

WORKED EXAMPLES

Example 1. Look at the tadpole-to-frog picture. How many steps are there? At which step do the back legs show? How many legs does the animal have at step 4?

(Use the map or drawing “Count the steps and the legs.” shown earlier in this lesson.)

1. Count the drawings from left to right: 1, 2, 3, 4, 5. There are 5 steps.
2. Find the first drawing that has legs. Step 1 is eggs and step 2 has no legs. Step 3 has 2 back legs. So the back legs show at step 3.
3. Look at step 4. It has the 2 back legs and 2 new front legs. $2 + 2 = 4$ legs.
4. Check: step 4 still has a short tail, so it is a froglet, not yet a grown frog.

Answer: 5 steps. The back legs show at step 3. At step 4 the froglet has 4 legs.

PRACTICE

1. **EASY** Put these in order: frog, eggs, froglet, tadpole.
2. **EASY** Which legs does a tadpole grow first, the front legs or the back legs?
3. **MEDIUM** Mom counts frog eggs in a pond. She counts 10 eggs in one part of the clump, 10 in another part and 10 more in a third part. How many eggs did she count?
4. **MEDIUM** True or false: when a froglet is ready, its tail falls off and floats away.
5. **HARD** Draw a tadpole and a frog. Tell two ways the frog is different from the tadpole.

COMMON MISTAKES

- Thinking tadpoles are little fish. Tadpoles swim with tails and breathe with gills like fish, but they are baby frogs or toads. Fish stay fish their whole lives; tadpoles change into frogs.
- Thinking the front legs come first. The back legs grow first. The front legs pop out later.
- Thinking frogs come from mud or rain. Long ago some people believed this. Careful watching showed that every frog hatches from an egg laid by a frog.

Make it a game • Tadpole Grows Up. Everyone starts curled up small on the floor as a frog egg. Your parent calls out the steps in order. “Hatch!”: wiggle on your tummy like a tadpole. “Back legs!”: kick your legs behind you. “Front legs!”: push up on your hands. “Tail shrinks!”: tuck your bottom in. “Frog!”: squat and hop, and flick out your tongue to

catch a pretend fly. Then your parent calls the steps out of order, and you must say “Wait, that’s not next!” and name the right step.

Scripture. “To every thing there is a season, and a time to every purpose under the heaven:” (Ecclesiastes 3:1, KJV)

A frog has a time to be an egg, a time to be a tadpole and a time to hop on land. God gives each step its season, and we grow in steps too.

Practice answers

1. Eggs, tadpole, froglet, frog.
2. The back legs.
3. $10 + 10 + 10 = 30$ eggs.
4. False. The tail gets shorter and shorter because the froglet’s body uses it up for food.
5. Any two: the frog has four legs and the tadpole has none (or only back legs); the frog has no tail and the tadpole has a long tail; the frog breathes with lungs and the tadpole with gills; the frog lives on land and eats bugs, and the tadpole lives in water and eats soft plants.

4.3 SALAMANDERS

OBJECTIVES

- Tell how a salamander is different from a lizard: smooth, damp skin, no scales and no claws.
- Describe where salamanders live and name the newt, the red eft and the hellbender.
- Tell how Lazzaro Spallanzani found that salamanders can grow back a lost leg or tail.

Warm-up. Lay your hand flat on the table and count your fingers. Now look at the picture of the salamander's feet in this lesson and count its toes: front foot, then back foot. Is it the same on the front and the back? Then feel the underside of a stone or a board that has been lying on damp ground outside. Is it cool and damp? That is just the kind of spot a salamander loves.

Video. Coming soon. Salamanders for kids: red-backed salamanders under logs, the red eft and eastern newt, the hellbender in a mountain stream, an axolotl with feathery gills, how salamanders regrow legs; search Smithsonian's National Zoo, USGS, SciShow Kids, Homeschool Pop (Alternate) and nature footage.

KEY TERMS

salamander

An amphibian with a long body, a long tail, four short legs and smooth, damp skin. It looks a little like a lizard, but it has no scales and no claws.

newt

A kind of salamander that spends much of its life in ponds and streams.

eft

A young newt that lives on land for a while before it goes back to the water. The red eft is bright orange-red.

regrow

To grow back a part that was lost. Many salamanders can regrow a tail or even a whole leg.

CORE IDEAS

The story. In 1768, in Italy, the scientist Lazzaro Spallanzani was studying salamanders and newts. (He is the same man who studied bats in Lesson 1.2.) People knew that a lizard can grow back a tail. Spallanzani wondered: what could a salamander grow back? He watched salamanders that had lost a tail, and even a leg. Day after day, he looked and wrote down what he saw.

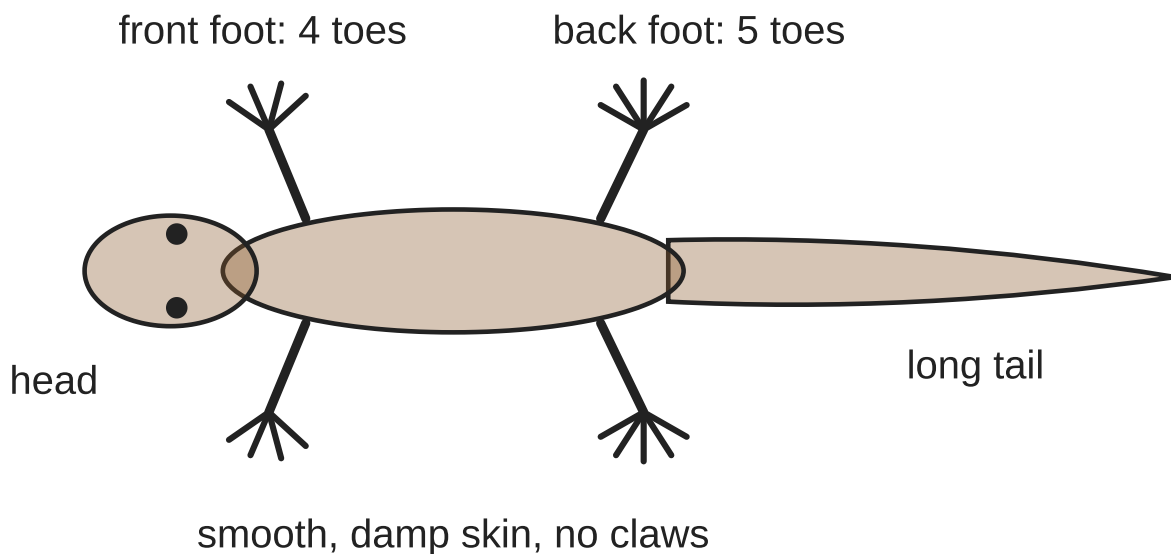
How they figured it out. Spallanzani saw something amazing. A salamander's lost leg grew back, with new bones and new toes, and it worked just like the old one! A lizard's new tail is

not quite as good as the first, but a salamander can **regrow** a whole leg. Scientists today still study salamanders to learn how they do it.

The big idea. A **salamander** looks like a lizard, but it is an amphibian. It has smooth, damp skin with no scales and toes with no claws. Most salamanders have 4 toes on each front foot and 5 toes on each back foot. Most hide in cool, damp places: under logs and rocks, in wet leaves and in streams. They come out on rainy nights to eat worms, slugs and bugs.

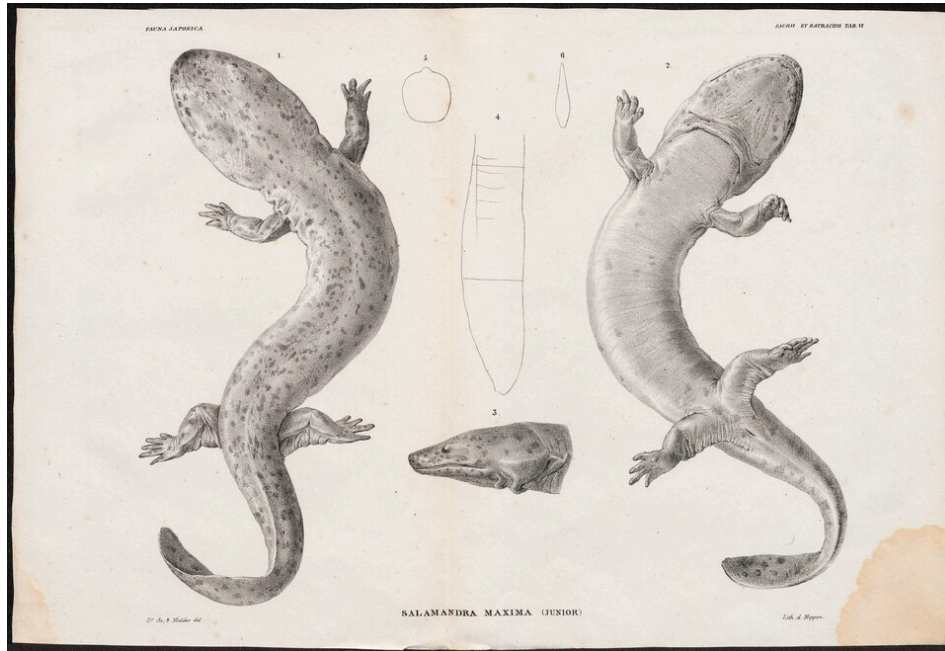
Salamanders live their two lives in different ways. A **newt** hatches in a pond with gills, then lives on land for a while as a bright orange **eft**, then goes back to the pond to live as a grown-up. The little red-backed salamander has no lungs at all; it breathes only through its skin! It lays eggs under a log, and the babies hatch looking like tiny grown-ups, with no tadpole time in the water.

In the world today. In clean, rocky mountain streams lives the hellbender, the biggest salamander in North America. A big one can be longer than your arm. It is flat and brown, with wrinkly skin. Those wrinkles give it more skin to breathe through under the water. In Mexico lives the axolotl, which keeps its feathery gills its whole life. God made the salamanders in many kinds, each one just right for its home.



Most salamanders have 4 toes on each front foot and 5 on each back foot, and no claws.

PICTURE STUDY



Japanese Giant Salamander, from Fauna Japonica, Artists working for Philipp Franz von Siebold, 1838 (in the reptile and amphibian part of the book) · Hand-colored lithograph · Published in Leiden, the Netherlands; copies are kept in many libraries

Philipp Franz von Siebold was a German doctor who lived in Japan long ago. He studied the plants and animals there and had them carefully drawn. Back in Europe, he and other scientists made a great book called *Fauna Japonica*, which means “Animals of Japan.”

This page shows the Japanese giant salamander. It lives in cold, clear mountain streams and is one of the biggest amphibians in the world, much bigger than any salamander you might find under a log.

Look closely

- Look at the head. Is it round, or wide and flat? Why might a flat head help an animal that hides under rocks in a stream?
- Find the eyes. Are they big or tiny?
- Look at the skin. Find the wrinkles and bumps. Remember: more skin means more skin to breathe through!
- Count the toes on a foot you can see clearly.

Talk about it

1. How is this giant salamander like the little salamanders that hide under logs? How is it different?
2. Why do you think the artist drew the salamander from the side and not from the top?

Safety first. Look for salamanders only with a grown-up. Roll a log or rock toward you, so anything under it (including a stinging insect or a snake) is on the far side, and put it back gently just as it was so the animals keep their home. If you hold a salamander, wet your hands first, have no sunscreen, bug spray or soap on them, hold it for only a moment, and set it down right next to its log. Some salamanders and newts have a poison in their skin, so never put one near your mouth or eyes, and wash your hands afterward. Never pick up a hellbender or any big salamander in a stream.

MAKE AND DO: MAKE A CLAY SALAMANDER (AND GO ON A LOG LOOK)

You will model a salamander from clay with the right number of toes and smooth, shiny skin. Then, if you can, you will go with a grown-up to look under logs and rocks for a real one.

You will need

- Play dough or clay (orange, brown, gray or black)
- A toothpick for making eyes and spots
- A spoon of water or a little cooking oil to make the skin shiny
- Your nature notebook and a pencil
- Old shoes and a grown-up, for the log look

Steps

1. Roll a long snake of clay. Make one end round for the head and pinch the other end thin for the tail. The tail should be about as long as the body.
2. Roll 4 short legs and press them on, two in front and two in back.
3. Look at the salamander picture. Make 4 tiny toes on each front foot and 5 tiny toes on each back foot. Do not add claws!
4. Poke two small eyes with the toothpick. Add spots or a stripe down the back if you like.
5. Rub a drop of water or oil over the clay so the skin looks smooth and damp.
6. Count the toes on your salamander out loud. Check: 4, 4, 5, 5.
7. On a cool, damp day after rain, go with a grown-up to a woodsy spot. Gently roll a log or flat rock toward you and look underneath. If you see a salamander, do not grab it. Count its legs, look at its skin, then put the log back just as it was. Draw it in your notebook.

Tips

- Red-backed salamanders are some of the most common salamanders in the woods of eastern North America. Many are dark gray with a reddish stripe down the back.
- If you do not find a salamander, draw the other living things you saw under the log, like worms, beetles and pill bugs. Salamanders eat many of them!

Check your work

- I can tell how a salamander is different from a lizard.

- I can count the toes on a salamander's front and back feet.
- I can tell what Spallanzani found out about salamanders.

NATURE NOTEBOOK

1. Draw a salamander seen from the top. Label the head, the 4 legs, the toes, the smooth skin and the tail.
2. Draw the three homes of the eastern newt in a row: pond (baby with gills), woods (red eft), pond again (grown-up newt). Add arrows.
3. Make a two-column chart: "Salamander" and "Lizard." Write or draw: smooth skin or scales; claws or no claws; amphibian or reptile.

From history. When Philipp Franz von Siebold sailed home from Japan around 1830, he brought a live Japanese giant salamander with him. It was the first one ever seen alive in Europe. It lived for many, many years in the Netherlands, first at the natural history museum in Leiden and later at the Artis zoo in Amsterdam, and crowds came to see the giant salamander from Japan.

WORKED EXAMPLES

Example 1. Look at the salamander picture. Count the toes on one front foot and on one back foot. How many toes are on one side of the salamander? How many toes does it have on all four feet?

(Use the map or drawing "Count the toes: front feet, then back feet." shown earlier in this lesson.)

1. Count the toes on one front foot: 1, 2, 3, 4. That is 4 toes.
2. Count the toes on one back foot: 1, 2, 3, 4, 5. That is 5 toes.
3. One side has one front foot and one back foot: $4 + 5 = 9$ toes.
4. The other side is the same: 9 toes. Both sides: $9 + 9 = 18$ toes.
5. Check another way: $4 + 4 + 5 + 5 = 18$.

Answer: 4 toes on a front foot and 5 on a back foot; 9 toes on one side; 18 toes in all.

PRACTICE

1. **EASY** Is a salamander an amphibian or a reptile? Tell one clue.
2. **EASY** Name two places where you might find a salamander.
3. **MEDIUM** One salamander has 4 toes on each front foot. How many toes are on both front feet together? If you find 3 salamanders, how many legs do they have in all?
4. **MEDIUM** What did Lazzaro Spallanzani find that a salamander can grow back?
5. **HARD** Tell the story of an eastern newt's three homes.

COMMON MISTAKES

- Thinking a salamander is a lizard. Lizards are reptiles with dry scales and claws. Salamanders are amphibians with smooth, damp skin and no claws.
- Believing the old story that salamanders can live in fire. Long ago people saw salamanders crawl out of logs thrown on a fire, because they had been hiding in the damp wood. A real salamander needs cool, damp places and would be hurt by fire.
- Thinking every amphibian has a tadpole time in the water. Most do, but some, like the red-backed salamander, lay eggs on land, and the babies hatch looking like tiny grown-ups.

Make it a game • Salamander Under the Log. One player is the salamander and hides under a “log” (a table, a blanket or a couch cushion). The others are scientists who walk around and say, “Is it damp? Is it cool?” When a scientist gently lifts the blanket, the salamander must freeze. The scientist counts the salamander’s “legs” (arms and legs: 4), says “Back home you go,” and puts the log back just right. Then switch. A scientist who forgets to put the log back gently has to be the next salamander.

Scripture. “O LORD, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches.” (Psalm 104:24, KJV)

“Manifold” means many and different. A tiny salamander that breathes through its skin, a newt that lives in three homes, a giant salamander that can grow longer than your arm: God made them all, and in wisdom.

Practice answers

1. An amphibian. Clues: smooth, damp skin with no scales; no claws; most hatch from soft jelly eggs.
2. Any two: under a log, under a rock, in wet leaves, in a stream or a pond, in a damp cave.
3. $4 + 4 = 8$ toes on the two front feet. 3 salamanders have $4 + 4 + 4 = 12$ legs.
4. A lost tail and even a whole leg, with new bones and toes that work like the old ones.
5. It hatches in a pond and lives there with gills. Then it goes on land and lives in the woods as a bright orange-red eft. Last, it goes back to the pond and lives there as a grown-up newt.

4.4 RAISE TADPOLES

OBJECTIVES

- Set up and care for a tadpole home with clean water, food, a hiding place and a rock to climb out on.
- Watch, count and record the changes in tadpoles, like a real scientist.
- Explain how to care for tadpoles kindly and return the froglets to the pond where they were found.

Warm-up. Before you bring any tadpoles home, play “What does it need?” Your parent names a pet, like a dog, a goldfish or a bird. You tell four things it needs: food, water, a safe home and a grown-up’s care. Now think about a tadpole. What kind of water? What food? Where can it hide? And what will it need when its legs grow and it wants to breathe air?

Video. Coming soon. Raising tadpoles at home for kids: setting up a tadpole tank, feeding tadpoles, back legs and front legs growing, froglets climbing onto a rock, returning froglets to a pond; search Smithsonian, SciShow Kids, Homeschool Pop (Alternate), state wildlife agency videos and nature footage.

KEY TERMS

habitat

The home where an animal finds the food, water, shelter and space it needs. A pond is a tadpole’s habitat.

observe

To watch something carefully and notice what you see, hear, smell or feel.

record

To write or draw what you observed, so you can remember it and compare later.

release

To let an animal go free again, back in the place where it came from.

CORE IDEAS

The story. In the 1700s, in the city of Nuremberg in Germany, lived a painter named August Johann Rösel von Rosenhof. He painted tiny pictures for a living, but he loved small creatures most of all. He gathered frog eggs and kept them in jars of pond water. Every day he watched them and painted what he saw: the eggs, the tadpoles, the legs coming out, the tails shrinking away. In 1758 he printed a beautiful book of hand-colored pictures of the frogs and toads of his land.

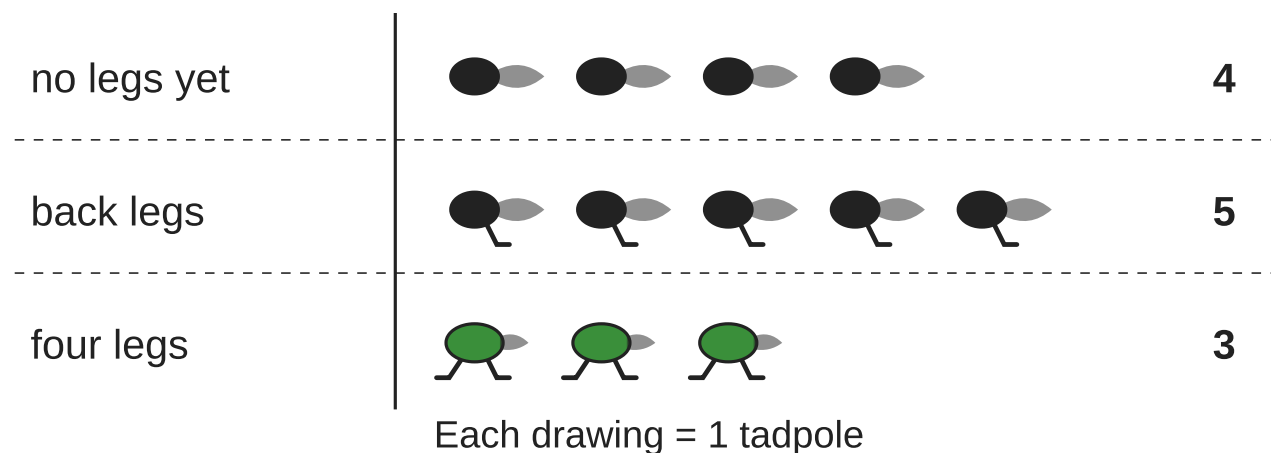
How they figured it out. Rösel did not just look once. He **observed** the same tadpoles again and again, and he **recorded** each change in pictures and words. That is how a scientist

learns: watch, write or draw, and compare. Today you can do the same thing with a few tadpoles at home.

The big idea. To raise tadpoles, you build a tiny **habitat**, a home with everything they need. They need clean pond water, not tap water straight from the faucet, because tap water often has chlorine in it to kill germs, and that can hurt tadpoles. They need room to swim, so keep just a few. They need food: soft, boiled lettuce or spinach, or a pinch of fish food. They need shade, so keep them out of hot sun. And when the front legs pop out, they need a rock or a stick to climb onto, because a froglet breathes air and can drown if it cannot get out of the water!

Try it and see. Count your tadpoles and draw them often. Write down how many have no legs, how many have back legs and how many have four legs. When your froglets are ready, carry them back to the very same pond where the eggs came from and **release** them at the edge. They will grow into frogs that catch bugs and sing in the spring. Caring for small creatures well is part of the work God gave us.

Our tadpole jar on one day



A picture chart of one day's count in a tadpole jar. Each little drawing stands for 1 tadpole.

PICTURE STUDY



Batrachia (Frogs), Plate 68 of *Art Forms in Nature*, Ernst Haeckel, 1904 · Color print made from Haeckel's drawings · Published in Leipzig, Germany; copies are kept in many libraries

Ernst Haeckel was a German scientist who loved to draw living things. You met his pages of bats and turtles. On this page, which he called *Batrachia* (an old name for frogs and toads), he drew ten kinds of frogs from many lands.

Rösel kept frogs in jars so he could watch them grow. Haeckel gathered many frogs onto one page so we can compare them. One of these frogs is a pouch frog: the mother keeps her eggs in a pouch on her back until the tadpoles hatch. God gave each kind of frog its own way to care for its young.

Look closely

- Count the frogs. How many different kinds can you find?
- Find a frog with round pads on the tips of its toes. Pads like these help a tree frog hold on to leaves.
- Find the frog with the longest back legs. What is it good at?
- Which frog do you think is the pouch frog? Look at the backs of the frogs.

Talk about it

1. How is the pouch frog's job like your job when you raise tadpoles in a jar?
2. Why do you think Haeckel put so many frogs on one page?

Safety first. A grown-up must be with you at any pond. Take only a small piece of an egg clump or a few tadpoles, and only where it is allowed; some places have rules, and some kinds of frogs are protected. Wash your hands with soap after touching the water or the

tadpoles, but never put soap in the tadpole home. Use pond water, or tap water treated with a water conditioner from a pet store. Keep the container out of direct sun. Release froglets only into the same pond they came from. Tadpoles from a store or a kit must never be let go outdoors; keep them, or ask the seller what to do.

MAKE AND DO: TADPOLE NURSERY AND JOURNAL

You will set up a small tadpole home, care for a few tadpoles, and keep a journal like Rösel's. Each time you check them, you will count how many have no legs, back legs or four legs. When they become froglets, you will take them back to their pond.

If you cannot find tadpoles where you live, visit the same pond each week and draw what you see there, or watch a tadpole video with your parent and keep the journal from the video.

You will need

- A clear plastic tub or wide jar (a shoebox-sized tub is good for a few tadpoles)
- Pond water from the same pond, or treated tap water
- A few clean pebbles and a flat rock or stick that sticks up out of the water
- A sprig of pond plant, if you can find one
- Food: boiled and cooled lettuce or spinach, torn small, or a pinch of fish food flakes
- A small net or cup for moving tadpoles
- A notebook and pencil for your tadpole journal

Steps

1. With a grown-up, scoop a small piece of an egg clump, or 3 to 6 small tadpoles, into a cup of pond water. Also fill a jug with extra pond water.
2. At home, put pebbles in the tub and fill it with pond water. Add the pond plant. Gently pour in the eggs or tadpoles.
3. Set the tub in a bright spot but out of direct sun, where it will not get hot.
4. Feed a tiny bit of boiled lettuce or a pinch of fish food every day or two. Take out food they do not eat so the water stays clean.
5. Every few days, scoop out some old water and pour in some fresh pond water or treated water.
6. On each journal page, write the date, count the tadpoles, and draw one. Make a tally: no legs, back legs, four legs.
7. When you see front legs, set the flat rock or stick in so it pokes out of the water. Froglets must be able to climb out to breathe.
8. When a froglet has four legs and a short tail, carry it in a cup of water back to the same pond. Let it go at the edge, among the plants. Say goodbye and draw it one last time.

Tips

- Fewer tadpoles stay healthier. If you have too many, put some back in the pond.

- Froglets stop eating while their tails shrink. Once the tail is gone, they need tiny live bugs, which is one more reason to release them at the froglet step.
- Look closely with a magnifying glass. Can you see a tadpole's mouth nibbling on the lettuce?

Check your work

- I can name the things a tadpole needs: clean water, food, shade, space and a way to climb out.
- I can count and record how many tadpoles are at each step.
- I can tell why froglets go back to the same pond they came from.

NATURE NOTEBOOK

1. Draw your tadpole home. Label the water, the pebbles, the plant, the food and the climbing rock.
2. Keep a tadpole journal: each time you check, draw one tadpole and write the date and your tally of no legs, back legs and four legs.
3. On release day, draw the pond and the froglet at the edge. Write one sentence about what you learned.

From history. In 1865 the writer Mark Twain published a funny short story about a frog named Dan'l Webster who was trained to jump. Later it was printed again as "The Celebrated Jumping Frog of Calaveras County." The story made Twain famous. Today Calaveras County, in California, still holds a frog-jumping contest every year at its county fair, and people come from far away to see whose frog can jump the farthest.

WORKED EXAMPLES

Example 1. Look at the picture chart of a tadpole jar. How many tadpoles have no legs yet? How many have back legs? How many have four legs? How many tadpoles are in the jar in all? How many have legs?

(Use the map or drawing "Read the picture chart: each drawing is 1 tadpole." shown earlier in this lesson.)

1. Count the first row, "no legs yet": 1, 2, 3, 4. That is 4.
2. Count the second row, "back legs": 1, 2, 3, 4, 5. That is 5.
3. Count the third row, "four legs": 1, 2, 3. That is 3.
4. Add all the rows: $4 + 5 + 3 = 12$ tadpoles in all.
5. Tadpoles with legs are in the back legs row and the four legs row: $5 + 3 = 8$.
6. Check: 8 with legs + 4 without legs = 12. It matches!

Answer: 4 have no legs, 5 have back legs and 3 have four legs. There are 12 in all, and 8 have legs.

PRACTICE

1. **EASY** Name three things a tadpole needs in its home.
2. **EASY** Why should you not fill a tadpole home with water straight from the faucet?
3. **MEDIUM** You have 15 tadpoles. You put 5 back in the pond so the rest have room. How many are left in your tub?
4. **MEDIUM** Your tadpoles just grew front legs. What must you add to their home right away, and why?
5. **HARD** Where should you let your froglets go, and why there?

COMMON MISTAKES

- Thinking tap water is fine for tadpoles. It often has chlorine, which can hurt them. Use pond water or treated water.
- Thinking froglets can stay in deep water forever. Once they have front legs and lungs, they need to climb out to breathe air.
- Thinking it is kind to let tadpoles go in any pond or stream. Tadpoles belong in the pond they came from, and store-bought tadpoles should never be let go outdoors.

Make it a game · Tadpole Keeper's Checklist. Your parent sets out six slips of paper. Four say good things for a tadpole: "pond water," "boiled lettuce," "shade," "a rock to climb." Two say bad things: "soap," "hot sun." Turn the slips over and mix them up. Take turns flipping one. If it is good for a tadpole, put it in the "tadpole home" (a bowl) and croak once. If it is bad, put it in the "no thank you" pile and tell why. When all the slips are sorted, add one good thing of your own.

Scripture. "A righteous man regardeth the life of his beast: but the tender mercies of the wicked are cruel." (Proverbs 12:10, KJV)

"Regardeth" means cares about and pays attention to. A good person takes care of the animals in his keeping. When you feed your tadpoles, keep their water clean and give them a rock to climb, you are showing that kind of care.

Practice answers

1. Any three: clean pond water (or treated water), food such as boiled lettuce, shade, room to swim, a plant or pebbles to hide by, and a rock to climb out on once it has front legs.
2. Tap water often has chlorine in it to kill germs, and that can hurt tadpoles. Use pond water or tap water treated with a water conditioner.
3. $15 - 5 = 10$ tadpoles.
4. A rock or stick that pokes out of the water. Froglets breathe air with lungs and need to climb out, or they can drown.
5. Back at the edge of the same pond where the eggs or tadpoles came from. That pond is their habitat, with the food and shelter they need, and it keeps frogs from one place from carrying sickness or crowding into another place.

UNIT 4 REVIEW

Oral review. The parent reads each question aloud and the child answers out loud, points or draws. Give full points for a clear answer in the child's own words. The review is worth 20 points.

1. (2 pts) What does the word "amphibian" mean? Name two amphibians.
2. (3 pts) Tell two ways an amphibian is different from a reptile.
3. (2 pts) How can you tell a frog from a toad?
4. (3 pts) Tell the steps of a frog's life in order.
5. (2 pts) What happens to a tadpole's tail?
6. (3 pts) How is a salamander different from a lizard? How many toes does a salamander usually have on each front foot and each back foot?
7. (2 pts) What did Lazzaro Spallanzani find out about salamanders?
8. (3 pts) Name three things you must do to care for tadpoles, and tell where the froglets go at the end.

UNIT PROJECT: MY AMPHIBIAN BOOK

Make a small book about amphibians with at least five pages. Page 1: your "Two Lives" card, showing a tadpole in the water and a frog on land. Page 2: the five steps from egg to frog, drawn in order with arrows and labels. Page 3: a salamander drawn from the top with the right number of toes, and a lizard beside it to compare. Page 4 and beyond: your tadpole journal pages (or your pond-visit drawings), with dates and counts. On the last page, tell your parent one thing you learned and let them write it down, then add a drawing of your favorite amphibian.

- **Accuracy:** The frog's life steps are in the right order, the back legs come before the front legs, and the salamander has smooth skin, no claws and the right toes.
- **Observation:** The journal or pond pages show real things the child saw, with dates and counts.
- **Telling:** The child can tell about each page in their own words, using words like amphibian, tadpole, gills, lungs and froglet.
- **Care:** The pages are neat and colored with care, and the child cared kindly for any animals they watched.

Answer key

1. "Two lives," a life in the water and a life on land. Any two: frog, toad, salamander, newt.
2. Any two: an amphibian has smooth, damp skin, but a reptile has dry scales; an amphibian lays soft jelly eggs with no shell, usually in water, but a reptile lays eggs with shells; most amphibians start life in the water with gills.
3. A frog has smooth, wet skin and long legs for leaping. A toad has dry, bumpy skin and short legs for hopping.

4. Eggs in jelly, tadpole with a tail and gills, tadpole with back legs, froglet with four legs and a short tail, frog.
5. It gets shorter and shorter because the froglet's body uses it up for food. It does not fall off.
6. A salamander is an amphibian with smooth, damp skin and no scales or claws; a lizard is a reptile with dry scales and claws. Usually 4 toes on each front foot and 5 on each back foot.
7. A salamander can grow back a lost tail, and even a whole leg with new bones and toes.
8. Any three: use pond water or treated water, not plain tap water; feed boiled lettuce or fish food; keep them in the shade; do not crowd them; take out old food and change some water; add a rock to climb out on when front legs grow. The froglets go back to the same pond they came from.

FISH

“And God said, Let the waters bring forth abundantly the moving creature that hath life” (Genesis 1:20). In this unit your child meets the animal family of the water: the **fish**. A fish has a backbone, lives in the water, swims with fins and breathes with gills. Your child will watch a goldfish breathe, lift the gill cover on a paper fish, and learn how water flows in the mouth and out over the gills.

Then come three fish stories. Nicolas Steno looks inside a shark’s head in 1666 and discovers that the mysterious “tongue stones” are shark teeth. Salmon leave their home streams, grow big in the ocean and find their way home again by smell, as Arthur Hasler showed at Issaquah Creek. And on the Sea of Galilee, Peter lets down his net at Jesus’ word and catches so many fish that the net begins to break.

Everything in this unit is told, pointed to, counted, built or drawn. Keep the lift-the-flap fish, the shark jaw, the salmon drawings and the Net Test chart in a box. At the end of the unit your child will put them together into a shoebox Fish Aquarium.

BEFORE YOU BEGIN

- Can add numbers to 20 and count by twos, fives and tens to 100
- Can read a simple tally chart and bar chart
- Knows that mammals have fur or hair and breathe air with lungs (Unit 1)
- Can listen to a short story and tell it back

MASTERY CHECKLIST

- I can tell how a fish breathes with its gills.
- I can name the clues of a fish: it lives in water, breathes with gills, swims with fins and has a backbone.
- I can tell why a shark is a fish and name three things that make sharks special.
- I can tell the salmon’s round trip in order and how salmon find home by smell.
- I can retell Peter’s great catch and show how a net catches some fish and lets others go.
- I can say that God made the fish of the sea and gave people the job of caring for them.

OPTIONAL BOOKS AND RESOURCES

- **NOAA Fisheries** (<https://www.fisheries.noaa.gov/>): Free. Search the species pages for the whale shark (Lesson 5.2) and for coho or sockeye salmon (Lesson 5.3) to see photos and short facts to read aloud.
- **Smithsonian Ocean** (<https://ocean.si.edu/>): Free. Photos and short articles from the Smithsonian’s National Museum of Natural History about fish and sharks. A parent can choose pictures to look at together.

5.1 GILLS ★

OBJECTIVES

- Tell how a fish breathes: water goes in the mouth, over the gills and out under the gill cover.
- Name the clues of a fish: it lives in water, breathes with gills, swims with fins and has a backbone.
- Watch a real fish closely and count how often its gill covers move.

Warm-up. Early in the day, fill a clear glass with very cold tap water and set it on the counter. At lesson time, look at the inside of the glass. Do you see tiny bubbles stuck to the sides? That is air that was mixed into the water, and it came out as the water warmed up. Ask: Could an animal breathe the air that hides in water? Today we will meet the animal that does.

Video. Coming soon. How fish breathe with gills for kids: water in the mouth and out the gill cover, close-up of a goldfish breathing, fish body parts (fins, scales, gills); search Smithsonian Ocean, NOAA Fisheries, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and calm aquarium nature footage.

KEY TERMS

fish

An animal with a backbone that lives in water, breathes with gills and swims with fins. Goldfish, trout and sharks are fish.

gills

Soft, red, feathery parts on each side of a fish's head. They take in the air that is mixed into the water.

gill cover

A thin flap on the side of a fish's head that covers and protects the gills. It opens to let water out.

fins

Thin flaps on a fish's body that it uses to swim, steer and stop.

CORE IDEAS

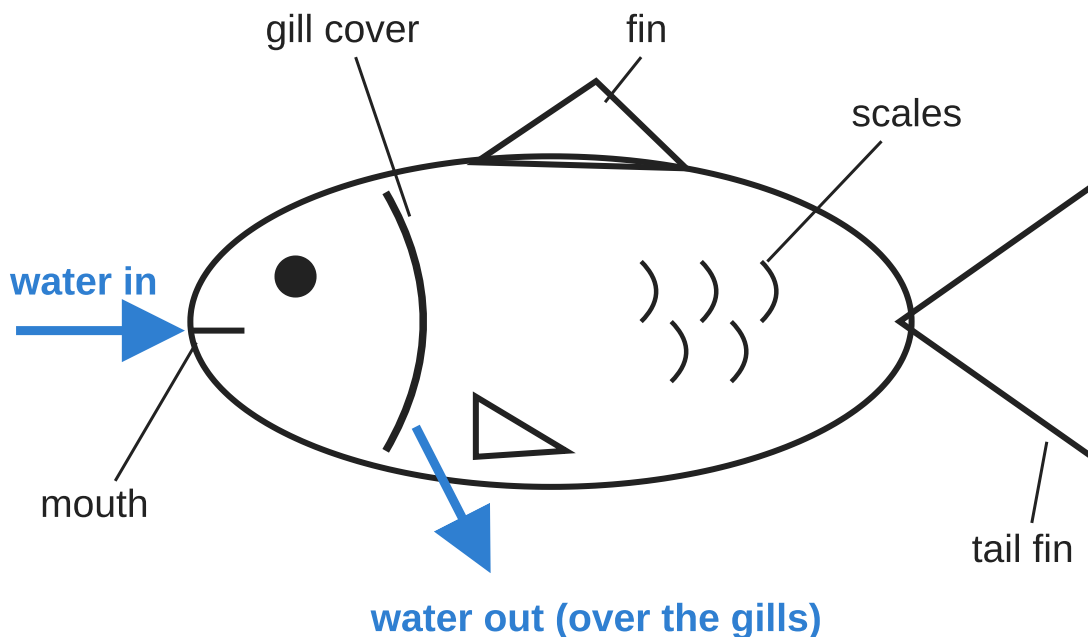
The story. Sit very still beside a goldfish bowl or a fish tank. Watch the goldfish's mouth. It opens and closes, opens and closes. Now look just behind its eye. Do you see a little flap on the side of its head moving out and in? The fish is not eating and it is not talking. It is breathing! That little flap is the **gill cover**, and under it are the fish's **gills**.

How they figured it out. You cannot see gills on a fish swimming in a tank. But if your family buys a whole fish at the store, a grown-up can lift the gill cover. Underneath you will

see rows of bright red, feathery parts. They are red because they are full of blood. Scientists who watched fish carefully saw what happens. The fish gulps water in through its mouth. The water flows over the red gills. Then it flows out under the gill cover. The gills take the air that is mixed into the water and pass it into the fish's blood.

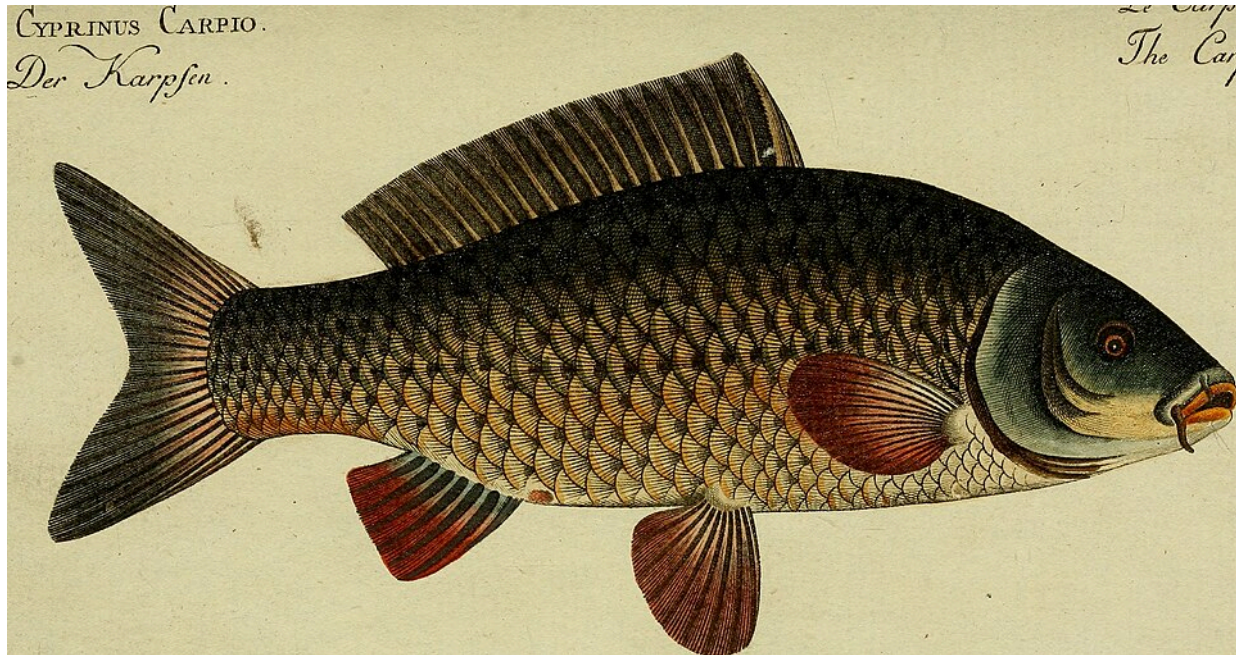
The big idea. A **fish** is an animal with a backbone that lives in water and breathes with gills. It swims with **fins**. Most fish are covered with smooth, slippery scales. Most fish are cold-blooded, so they are as warm or as cool as the water around them. A whale and a dolphin swim like fish, but they must come up to breathe air with lungs. A fish never needs to come up for air. Its gills do the work under water. But take a fish out of the water and its thin gills fold together and dry out. It cannot breathe in the air, just as you cannot breathe under water.

God's handiwork. On the fifth day God said, "Let the waters bring forth abundantly the moving creature that hath life" (Genesis 1:20). He gave the fish just what they need for a life in the water: gills to breathe, fins to swim and scales like a raincoat. When you watch a goldfish breathe, you are watching a small wonder that God designed.



Water goes in the mouth, over the gills, and out under the gill cover.

PICTURE STUDY



The Carp, from Oekonomische Naturgeschichte der Fische Deutschlands (The Natural History of the Fishes of Germany), Marcus Elieser Bloch (hand-colored engraving made for his book), 1782-1784 · Hand-colored engraving · Printed in Berlin, Germany; copies are kept in natural history libraries

Marcus Elieser Bloch was a doctor who lived in Berlin, Germany. He loved fish so much that he collected and studied them in his spare time. He hired artists to draw each fish carefully from a real one, and he printed the pictures in a big book about the fishes of Germany. Then he kept going and made more books about fishes from all over the world.

The carp was one of the most important fish in Germany. Families raised carp in ponds for food. Bloch wanted his readers to see every part of it plainly, so the fish is drawn from the side, like a page in a scientist's notebook.

Look closely

- Find the eye. Now find the curved edge just behind it. That is the gill cover. The red gills are hiding under it.
- Look at the scales. Are they big or small? Do they line up in rows?
- Find the fins. Point to the fin on the back, the fins underneath and the tail fin.
- Find the short whiskers near the carp's mouth. A carp uses them to feel and taste for food in the mud.

Talk about it

1. Why do you think Bloch drew the fish from the side instead of from the front?
2. If you could lift the gill cover in the picture, what would you see underneath?
3. How is this carp like a goldfish? (Goldfish are small cousins of the carp.)

Safety first. If you look at a whole fish from the store, a grown-up lifts the gill cover. The edges of gills and fins can be sharp. Wash hands with soap after touching raw fish. At a fish tank, do not tap the glass or put your hands in the water.

MAKE AND DO: LIFT-THE-FLAP FISH

You will make a paper fish with a gill cover that really lifts up. Under the flap you will glue red, feathery gills. Then you will use your fish to show how water goes in and out.

You will need

- A paper plate or a sheet of heavy paper
- Red tissue paper or red yarn
- Construction paper in any color
- Child-safe scissors, glue stick and tape
- Crayons or markers
- A whole fish from the store or a goldfish to watch (if you can)

Steps

1. Draw a big fish shape on the plate or paper and cut it out. Add an eye, a mouth, fins and a tail fin.
2. Behind the eye, glue on several short strips of red tissue paper or red yarn, side by side, like the teeth of a comb. These are the gills.
3. Cut a half-moon flap of construction paper big enough to cover the gills. Tape only its front edge so it can lift up. This is the gill cover.
4. Draw scales all over the body with little curved lines, like the letter U lying on its side.
5. Use your finger as the water. Start at the mouth, slide over the gills and come out under the gill cover. Say: "Water in, over the gills, water out."
6. If you can, look at a real fish. Watch a goldfish, or have a grown-up lift the gill cover on a store fish. Compare the real gills with your paper ones.

Tips

- Real gills have many thin, feathery parts so that lots of water can touch them. Your many strips of paper show this.
- Make a second fish and label it with these words: mouth, gills, gill cover, fin, tail fin, scales.

Check your work

- I can lift the gill cover and show where the gills are.
- I can trace the path of water through a fish.
- I can tell why a fish cannot breathe out of water.

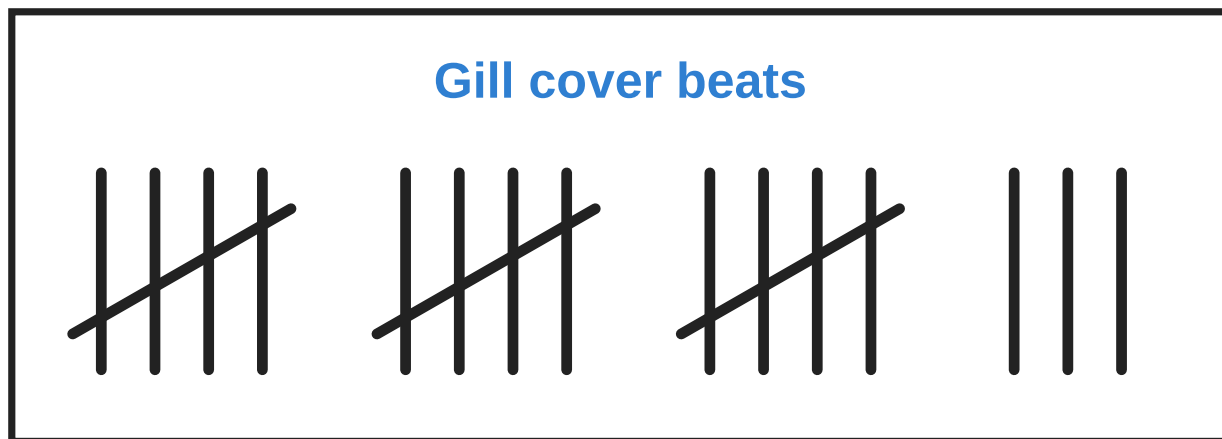
NATURE NOTEBOOK

1. Draw a goldfish or another fish you have seen. Draw a blue arrow going into its mouth and another coming out under its gill cover.
2. Draw a whole fish from the store or from the picture study. Label the eye, mouth, gill cover, fins and tail fin.
3. Make a page called "Fish I Have Seen." Each time you see a fish this week, in a tank, a pond, a store or a book, draw it small.

From history. The goldfish in your bowl first came from China. Long ago, people there noticed that a few wild fish in their ponds were bright gold instead of plain gray. They raised these golden fish in ponds and bowls, and later goldfish were carried to Japan, Europe and America. Today there are goldfish with long flowing tails, goldfish with puffy cheeks and goldfish with big round eyes. They look very different, but they are all one kind of fish: a good example of how much variety God placed within one kind.

WORKED EXAMPLES

Example 1. Mom watched a goldfish while she counted slowly. Each time its gill covers opened, she made a tally mark. Look at her tally chart. How many times did the gill covers open?



Count the bundles by fives, then count on the single marks.

1. Find the bundles of five. Each bundle has four marks standing up and one mark across them. There are 3 bundles.
2. Count the bundles by fives: 5, 10, 15.
3. Now count the single marks after the bundles: 16, 17, 18.
4. So the gill covers opened 18 times.

Answer: The goldfish's gill covers opened 18 times while Mom counted.

PRACTICE

1. **EASY** What part of its body does a fish use to breathe?
2. **EASY** Look at the fish drawing. Point to the mouth, then the gill cover, then the tail fin. Trace with your finger where the water goes.
3. **MEDIUM** Your parent says these animals: goldfish, whale, trout, dolphin, shark, salmon. Clap for each one that breathes with gills. How many did you clap for?
4. **MEDIUM** A tank has 6 goldfish. Each goldfish has 2 gill covers, one on each side of its head. Count by twos. How many gill covers are in the tank?
5. **HARD** Tell why a fish cannot breathe when it is taken out of the water.

COMMON MISTAKES

- Thinking a fish breathes the water itself. It breathes the air that is mixed into the water, and the water flows back out.
- Thinking every animal that swims has gills. Whales, dolphins, seals and turtles must come up to breathe air with lungs.
- Thinking the gill covers are ears. They are flaps that protect the gills and let water out.

Make it a game • Water In, Water Out. You are the fish! Put your hands flat on your cheeks like gill covers. When your parent says “Water in,” open your mouth wide. When your parent says “Water out,” close your mouth and flap your hands out. Your parent will go faster and faster. Then your parent calls out an animal. If it breathes with gills, keep flapping. If it breathes air with lungs, like a whale or a grown-up frog, jump up and take a big breath of air.

Scripture. “Or speak to the earth, and it shall teach thee: and the fishes of the sea shall declare unto thee.” (Job 12:8, KJV)

Job says the fish can teach us. When we sit still and watch a fish breathe, we learn how wisely God made it for its home in the water.

Practice answers

1. Its gills.
2. The child points to each part, then traces from the mouth, past the gills, and out under the gill cover.
3. Goldfish, trout, shark and salmon: 4 claps. The whale and dolphin are mammals that breathe air with lungs.
4. 2, 4, 6, 8, 10, 12. There are 12 gill covers.
5. Gills work only with water flowing over them. In the air the thin, feathery gills fold together and dry out, so the fish cannot take in the air it needs.

5.2 SHARKS ★

OBJECTIVES

- Explain that a shark is a fish because it lives in water, breathes with gills and swims with fins.
- Name three ways a shark is different from a goldfish: gill slits, a skeleton of bendy cartilage, and rows of teeth that keep being replaced.
- Tell how Nicolas Steno looked at a shark's head and solved the puzzle of the "tongue stones."

Warm-up. Touch the tip of your nose and wiggle it. Now fold the top of your ear. They bend and spring back! Now press on your knee or your elbow. That is hard bone, and it does not bend. The bendy stuff in your nose and ears is called cartilage. Ask: What if a whole animal had a skeleton made of bendy cartilage instead of bone? Today we will meet one.

Video. Coming soon. Sharks for kids: shark gill slits, cartilage skeleton, rows of teeth, whale shark filter feeding and small sharks; search NOAA Fisheries, Smithsonian Ocean, SciShow Kids, Homeschool Pop (Alternate), Science Max and gentle aquarium or ocean nature footage (avoid shark-attack programs).

KEY TERMS

shark

A fish with gill slits, rough skin and a skeleton made of cartilage instead of bone.

gill slits

Openings in a row on each side of a shark's head where water flows out over its gills. Most sharks have five on each side.

cartilage

Strong, bendy body stuff that is softer than bone. The tip of your nose and your ears are made of it. A shark's whole skeleton is cartilage.

CORE IDEAS

The story. In 1666 some fishermen near the town of Livorno, in Italy, caught a huge shark. The ruler of that land, the Grand Duke of Tuscany, had its great head sent to a young scientist in Florence named Nicolas Steno. Steno looked inside the mouth. He saw row after row of sharp, flat, three-cornered teeth. And he was sure he had seen teeth just like these before.

How they figured it out. For a long time people had found pointed stones in the rocks and soil. They called them "tongue stones" because they looked like little stone tongues. Some people said they grew inside the rocks. Steno held the shark's teeth beside the tongue

stones. They matched! He explained that the tongue stones were really teeth from sharks that had once lived there, buried and turned to stone. He had solved the puzzle by looking closely and comparing.

The big idea. A shark is a **fish**. It lives in water, breathes with gills and swims with fins. But it is a special kind of fish. Instead of one gill cover, a shark has a row of **gill slits** on each side of its head. Its skeleton is not made of bone. It is made of bendy **cartilage**, like your nose and ears. Its skin feels rough like sandpaper, because it is covered with tiny tooth-like scales. A shark has rows of teeth. When a front tooth falls out, a new one moves up from behind to take its place. That is why shark teeth are so easy to find on some beaches!

God's handiwork. Sharks come in many sizes. The whale shark is the biggest fish in the world. It can grow about as long as a school bus, yet it eats tiny sea creatures that it strains from the water. The dwarf lanternshark is so small it could lie across your hand. Most sharks stay far away from people. The psalm says of the sea, "wherein are things creeping innumerable, both small and great beasts" (Psalm 104:25). Small sharks and great sharks are all part of God's good work.

PICTURE STUDY



The Gulf Stream, Winslow Homer, 1899 · Oil on canvas · The Metropolitan Museum of Art, New York

Winslow Homer was an American painter who loved the sea. In the winters he sailed south to Florida and to the islands of the Bahamas, where the warm ocean current called the Gulf Stream flows past. There he watched sharks, flying fish and sudden storms, and he painted them in bright colors.

In this painting a sailor's small boat has lost its mast in a storm. Sharks swim around it in the waves. But look closely: far away, there is a ship. Homer leaves us to wonder what will happen next.

Look closely

- How many sharks can you find? Look for their fins, their tails and their open mouths.
- Find the mast. What happened to it?
- Find the tall twisting cloud reaching down to the water. It is a waterspout, a kind of whirlwind over the sea.
- Look all the way to the edge of the sea. What do you see far away?

Talk about it

1. What clues in the painting tell you the sharks are fish? (Fins, tails, living in the water.)
2. What do you think the ship far away will do? How would that help the sailor?

Safety first. If you hunt for shark teeth on a beach, stay with a grown-up and keep away from deep water and big waves. At an aquarium, touch animals only in a touch tank, with two fingers, when a keeper says it is all right.

MAKE AND DO: SHARK JAW WITH MOVING TEETH

A shark never runs out of teeth. You will make a paper shark jaw with a strip of extra teeth hidden behind the front row. When a front tooth “falls out,” you will slide the next one up into its place.

You will need

- A paper plate
- A long strip of white paper, about two fingers wide
- Gray crayon or marker
- Child-safe scissors and tape
- A piece of sandpaper (to feel what shark skin is like)

Steps

1. Fold the paper plate in half. Color the outside gray. This is the shark’s head and jaw.
2. Have a grown-up cut a slot along the fold, a little shorter than the white strip is wide, so the strip can slide through.
3. Draw a row of three-cornered teeth all along the white strip, point side up. Make lots of them.
4. Slide the strip up through the slot so one row of teeth shows in the shark’s mouth. The rest of the teeth wait inside.
5. Pretend the shark bites a fish and a tooth falls out. Tear or fold that tooth down. Then slide the strip so a new tooth moves up into its place.
6. Now draw five gill slits, five short lines, on the side of the shark’s head. Feel the sandpaper and say: “Shark skin feels rough like this.”

Tips

- Shark skin feels smooth if you stroke it from head to tail and rough if you stroke it from tail to head, because its tiny scales all point back toward the tail.
- Count how many teeth you drew. That is how many times your shark can lose a tooth and still have a new one ready.

Check your work

- I can show how a new shark tooth moves up when one falls out.
- I can point to the gill slits on my shark.
- I can tell why a shark is a fish.

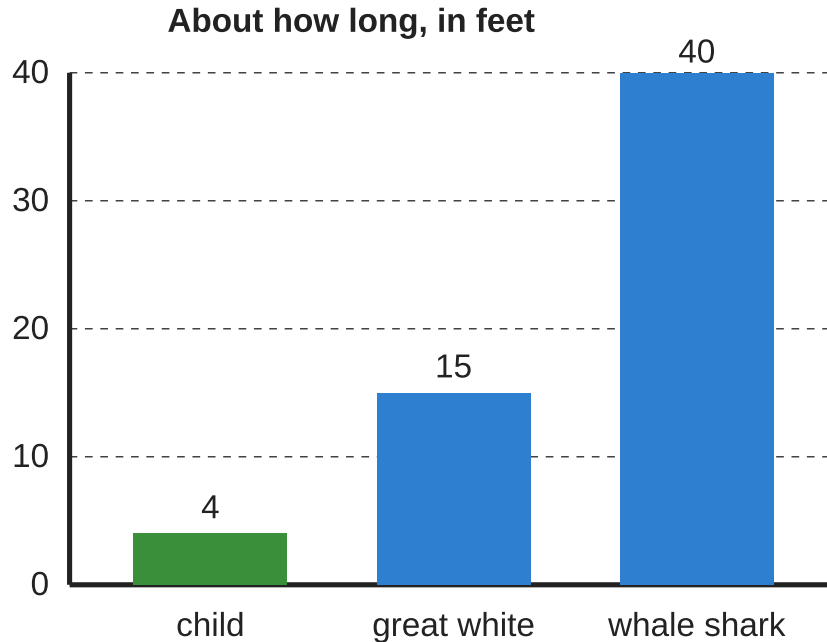
NATURE NOTEBOOK

1. Draw a shark from the side. Draw its five gill slits, its fins and its tail. Label the gill slits.
2. Trace a real shark tooth, or copy one from a picture: a flat, three-cornered tooth. Write: "A shark grows new teeth."
3. Draw a whale shark and a dwarf lanternshark on the same page. Make the whale shark as big as the page and the lanternshark as small as your thumb.

From history. Nicolas Steno was born in Denmark. His Danish name was Niels Stensen. He wrote about the shark's head in a little book printed in 1667. Steno kept asking how the shark teeth got into the rocks, and that question led him to study the layers of rock in the hills of Italy. He became one of the first great scientists of rocks and layers. Later in his life he became a bishop and spent his days teaching and caring for poor people.

WORKED EXAMPLES

Example 1. Look at the bar chart. It shows about how long a second grader, a great white shark and a whale shark are, in feet. Which is the longest? How many feet longer is the whale shark than the great white shark?



About how long? A child, a great white shark and a whale shark.

1. Read the top of each bar. The child is about 4 feet. The great white shark is about 15 feet. The whale shark is about 40 feet.
2. The tallest bar is the whale shark, so it is the longest.
3. To find how much longer, count up from 15 to 40. From 15 to 20 is 5. From 20 to 40 is 20. $5 + 20 = 25$.
4. Check: $40 - 15 = 25$.

Answer: The whale shark is the longest. It is about 25 feet longer than the great white shark.

PRACTICE

1. **EASY** Is a shark a fish or a mammal? How do you know?
2. **EASY** Touch a part of your body that is made of cartilage, like a shark's skeleton.
3. **MEDIUM** A shark has 5 gill slits on one side of its head and 5 on the other side. How many gill slits does it have in all?
4. **MEDIUM** On a beach, Sam found 8 shark teeth on Monday and 9 shark teeth on Tuesday. How many shark teeth did Sam find?
5. **HARD** Tell why people can find so many shark teeth on some beaches.

COMMON MISTAKES

- Thinking a shark is a mammal like a whale. A shark breathes with gills, so it is a fish.
- Thinking all sharks are huge and dangerous. Many sharks are small, and most stay away from people.
- Thinking a shark has bones like a goldfish. Its skeleton is made of bendy cartilage.

Make it a game · Sharks and Minnows. Play outside or in a big room. One player is the shark and stands in the middle of the “sea.” Everyone else is a minnow and lines up on one side. When the shark calls, “Fishy, fishy, cross my sea!” the minnows run to the other side. Anyone the shark tags becomes a shark too. Before each round, the shark must answer one question to start: How many gill slits? What is my skeleton made of? What happens when I lose a tooth?

Scripture. “So is this great and wide sea, wherein are things creeping innumerable, both small and great beasts.” (Psalm 104:25, KJV)

The sea is full of creatures too many to count, from tiny lanternsharks to giant whale sharks. God made them all and knows each one.

Practice answers

1. A fish. It lives in water, breathes with gills and swims with fins.
2. The child touches the tip of the nose or the outer ear.
3. $5 + 5 = 10$ gill slits.
4. $8 + 9 = 17$ shark teeth.
5. A shark keeps losing teeth all its life. Each time one falls out, a new one moves up to take its place. The hard teeth sink, last a long time and wash up on the beach.

5.3 SALMON RUN HOME

OBJECTIVES

- Tell the salmon's journey in order: eggs in a stream, young fish swim to the ocean, grow big, then swim upstream home to lay eggs.
- Explain that a salmon finds its home stream by smell, and tell how Arthur Hasler tested this.
- Name one way people help salmon get home, such as building fish ladders.

Warm-up. Close your eyes. Your parent holds a few things under your nose one at a time: an orange peel, a cinnamon stick, a bar of soap, a slice of onion. Can you name each one by smell alone? Now think: what does your own home smell like when you walk in the door? Today we will meet a fish that finds its way home with its nose.

Video. Coming soon. Salmon run for kids: salmon leaping up waterfalls and fish ladders, salmon life cycle from egg to ocean and back, bears catching salmon; search NOAA Fisheries, U.S. Fish and Wildlife Service, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and nature footage of salmon runs in Alaska and the Pacific Northwest.

KEY TERMS

salmon

A strong fish that hatches in a stream, grows up in the ocean, and swims back to its home stream to lay eggs.

upstream

Toward the place where a stream begins, against the flowing water. Downstream is the way the water flows.

spawn

To lay eggs in the water. Salmon spawn in the gravel of the stream where they hatched.

fish ladder

A row of small pools built like steps beside a dam, so fish can jump up one step at a time.

CORE IDEAS

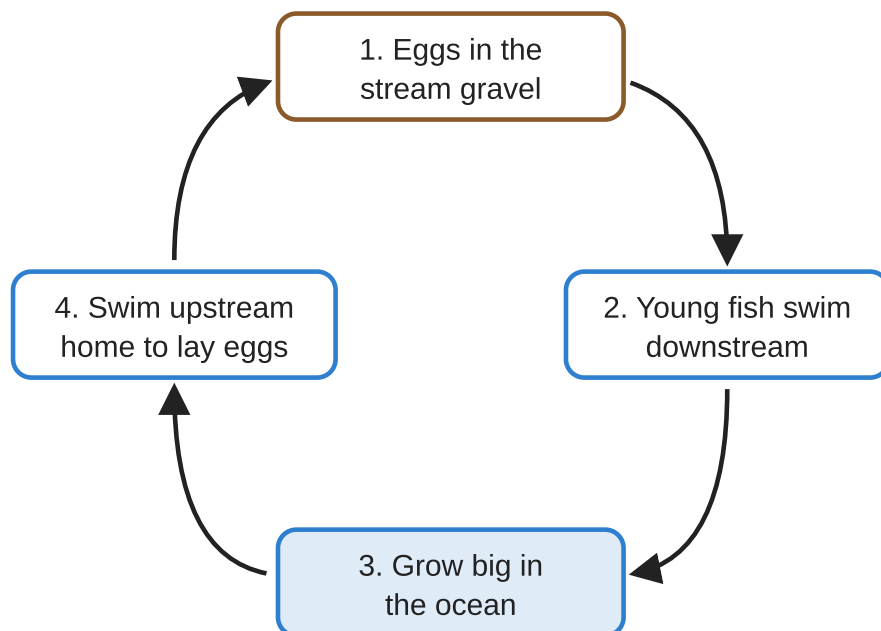
The story. Every fall, families in the town of Issaquah, Washington, stand on a bridge over a creek and look down. The water is full of big red and silver fish pushing their way up the stream. They splash. They leap over rocks. These are **salmon**, and they are coming home. Each one hatched in this very creek. It swam far away to the ocean and grew big. Now it has found its way back, past many other rivers and streams, to the place where it began.

How they figured it out. How does a salmon know which stream is home? A scientist named Arthur Hasler wondered about this. One day, walking in the mountains of Utah where

he grew up, he smelled a stream and suddenly remembered being a boy there. He thought, maybe salmon remember the smell of home too! In the 1950s he and his helpers tested his idea at Issaquah Creek, which splits into two branches. They caught salmon from each branch and gently plugged the noses of some of them. Then they let all the fish go downstream. The salmon that could smell swam back up their own branch. The salmon with plugged noses got mixed up and picked a branch by chance. Salmon find home by smell!

The big idea. A salmon's life is a long round trip. Its mother **spawns**, laying eggs in the gravel of a cool stream. Tiny fish hatch and hide in the stream. When they are bigger, they swim downstream to the ocean. They eat and grow big and strong. Then they swim back and go **upstream**, against the rushing water, to the stream where they hatched. They leap up small waterfalls. There they lay their eggs, and the round trip starts again. Bears and eagles wait by the streams to catch salmon for food.

In the world today. When people built big dams across rivers, the salmon could not get home. So engineers built **fish ladders**: rows of small pools that climb up beside the dam like stairs. The salmon jump up one pool at a time. At some dams you can watch them swim past a window under the water. This is good dominion: using our skill to care for the creatures God gave us (Genesis 1:28).



The salmon's round trip: from the stream to the ocean and home again.

PICTURE STUDY



Leaping Trout, Winslow Homer, 1889 · Watercolor on paper · Cleveland Museum of Art, Ohio; Homer painted it on a fishing trip in the Adirondack Mountains of New York

Winslow Homer loved to fish. In the summer of 1889 he stayed at a fishing club in the Adirondack Mountains of New York and spent his days by the lakes and streams. He painted the trout he watched jumping out of the water, quickly, in watercolor, to catch the moment before it was gone.

Trout and salmon are close cousins in the same family of fish. Both are strong swimmers, and both can leap right out of the water. When you look at this trout, picture a salmon leaping up a waterfall on its way home.

Look closely

- Find the fish in the air. What shape is its body making?
- Look at the trout's side. Can you find its spots and colors?
- Find the fins and the tail. Are they folded or spread out?
- Look at the water. How did Homer show the splash?

Talk about it

1. Why do you think a fish leaps out of the water? (To catch a bug, to get away, or, for a salmon, to jump up a waterfall.)
2. Homer painted fast to catch a fish in the air. How is this like a scientist who must watch carefully and quickly?

Safety first. Use only safe kitchen smells, like vanilla, lemon, cinnamon and orange. Never sniff cleaning products. Wave the smell toward your nose instead of sniffing hard.

Ask about food allergies first. If you visit a salmon stream, stay with a grown-up and away from the edge of fast water.

MAKE AND DO: SMELL YOUR WAY HOME

You will be a salmon! First you will learn the smell of your “home stream.” Then you will close your eyes and try to find your home by smell alone, just as Arthur Hasler’s salmon did.

You will need

- Five small cups that look the same (paper cups or yogurt cups)
- Five cotton balls
- Five safe kitchen smells, such as vanilla, lemon juice, cinnamon, peppermint extract and orange peel
- A blindfold or a scarf
- Paper and crayons

Steps

1. A grown-up puts a drop or a pinch of a different smell on each cotton ball and puts one in each cup.
2. Your parent picks one cup to be your “home stream.” Smell it for a few moments and remember it. This is like a baby salmon learning the smell of its stream.
3. Go to another room and “swim to the ocean” for a few minutes. Your parent mixes up the cups.
4. Put on the blindfold. Your parent holds the cups up one at a time. Smell each one and say, “Home!” or “Not home!”
5. Take off the blindfold. Did you find your home stream? Try again with a new home smell.
6. Now try it with a clothespin on your nose or with your fingers pinching your nose. Can you still find home? Draw a picture of what happened.

Tips

- Hasler’s salmon with plugged noses could not find their home branch. Your pinched nose works the same way.
- Keep score with tally marks: one tally for each right answer with your nose open, and one for each right answer with it pinched.

Check your work

- I can find my home smell with my eyes closed.
- I can tell what happened when I could not smell.
- I can tell how salmon find their home stream.

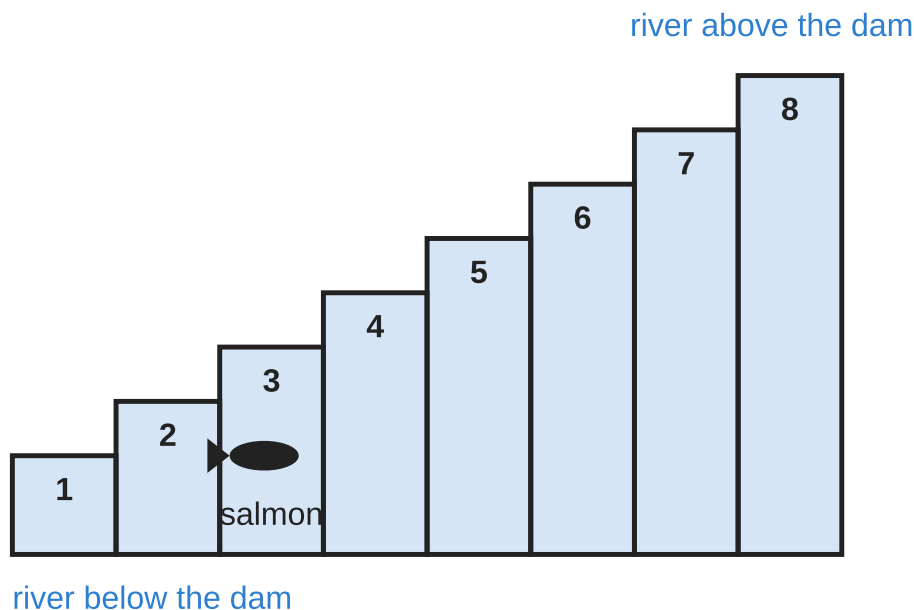
NATURE NOTEBOOK

1. Draw the salmon's round trip in four boxes: eggs in the gravel, young fish going downstream, big salmon in the ocean, salmon jumping upstream.
2. Draw a salmon leaping up a waterfall. Draw an arrow to show which way is upstream.
3. Draw a fish ladder beside a dam, with a salmon in one of the pools.

From history. In the 1930s the United States built Bonneville Dam across the great Columbia River, between Oregon and Washington. The builders knew the salmon had to pass, so they built fish ladders beside the dam. Visitors can go down to rooms with big windows under the water and watch the salmon swim by on their way home. People called fish counters sit at windows like these and count the fish, so we know how many make the trip.

WORKED EXAMPLES

Example 1. Look at the fish ladder. It has 8 pools, like steps. A salmon is resting in pool 3. How many more jumps does it need to reach pool 8 at the top?



A fish ladder lets salmon jump up past a dam one pool at a time.

1. Put your finger on the salmon in pool 3.
2. Jump your finger up one pool at a time and count the jumps: pool 4 is 1, pool 5 is 2, pool 6 is 3, pool 7 is 4, pool 8 is 5.
3. Check: $8 - 3 = 5$.

Answer: The salmon needs 5 more jumps to reach the top of the fish ladder.

PRACTICE

1. **EASY** Where does a salmon hatch from its egg?
2. **EASY** Your parent draws four cards: big salmon in the ocean, eggs in gravel, salmon jumping up a waterfall, tiny fish in a stream. Put them in order.
3. **MEDIUM** A bear caught 3 salmon in the morning, 4 at noon and 2 in the evening. How many salmon did the bear catch?
4. **MEDIUM** Point to show which way a salmon swims when it goes upstream: the way the water flows, or against it?
5. **HARD** How did Arthur Hasler show that salmon find home by smell?

COMMON MISTAKES

- Thinking a salmon lives in one place all its life. It hatches in a stream, grows up in the ocean and comes back.
- Thinking upstream means going downhill with the water. Upstream means swimming against the water, toward where it comes from.
- Thinking salmon find home by looking at the shore. Near home, they mostly follow the smell of their own stream.

Make it a game · Salmon Run. Make a “river” down a hallway or across the yard with pillows and rugs for rocks and waterfalls. Put your home smell cup at the far end. You are the salmon: crawl, hop and leap upstream over the rocks. A parent is the bear and calls out a question at each waterfall: Which way is upstream? What do salmon lay in the gravel? How do they find home? Answer right and you may leap ahead. Reach the cup, smell it, and shout “Home!”

Scripture. “All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again.” (Ecclesiastes 1:7, KJV)

The water runs down to the sea, and the salmon ride the rivers down to the sea too. Then, as God designed them, they find their way back to the place they came from.

Practice answers

1. In the gravel of a cool stream.
2. Eggs in gravel, tiny fish in a stream, big salmon in the ocean, salmon jumping up a waterfall (going home to lay eggs).
3. $3 + 4 + 2 = 9$ salmon.
4. Against the flowing water, toward where the stream begins.
5. He plugged the noses of some salmon and left others alone. The salmon that could smell swam back to their own branch of the creek. The ones with plugged noses got mixed up and could not find their home branch.

5.4 PETER'S GREAT CATCH (LUKE 5)

OBJECTIVES

- Retell the story of Peter's great catch of fish from Luke 5.
- Tell how fishermen on the Sea of Galilee caught fish with nets, and that fish swim together in groups called schools.
- Test how the size of the holes in a net decides which fish it catches.

Warm-up. Hold a kitchen colander or a mesh fruit bag. Drop in a spoonful of dry rice and a few dry beans and shake it over a bowl. What falls through? What stays? Ask: If this were a fishing net, which fish would it catch? Today we will hear about a net so full of fish that it began to break.

Video. Coming soon. Sea of Galilee fishing and the Galilee boat for kids: casting nets, tilapia (St. Peter's fish), the ancient fishing boat found at Ginosar; search Smithsonian, Homeschool Pop (Alternate), Moody Science classics, Bible lands documentary footage and Christian children's Bible story retellings of Luke 5.

KEY TERMS

net

Strings or cords tied together with holes between them, used to catch fish. Fish bigger than the holes are caught.

school

A big group of fish that swim together, all turning at the same time.

fresh water

Water that is not salty, like the water in most lakes, rivers and ponds. The Sea of Galilee is fresh water.

tilapia

A flat, silver-gray fish that lives in the Sea of Galilee. People there call it "St. Peter's fish."

CORE IDEAS

The story. Simon Peter was a fisherman on the Sea of Galilee, a big lake in the land of Israel. One night he and his partners fished and fished, and caught nothing. In the morning they were washing their empty nets. Then Jesus came and taught the crowd from Peter's boat. When He finished, He said, "Launch out into the deep, and let down your nets for a draught." Peter answered, "Master, we have toiled all the night, and have taken nothing: nevertheless at thy word I will let down the net" (Luke 5:4–5). He let it down, and the net filled with so many fish that it began to break! Peter called his partners James and John to bring their boat. They filled both boats so full that the boats began to sink. Peter fell down at

Jesus' knees. Jesus told him, "Fear not; from henceforth thou shalt catch men" (Luke 5:10). Then they left their boats and followed Jesus.

How they figured it out. In 1986 the Sea of Galilee was very low after a long time without rain. Two brothers who were fishermen walked along the muddy shore and found the outline of an old wooden boat. Scientists came and dug it out very carefully. It was a fishing boat from the time of Jesus! It is almost as long as two cars parked end to end, with room for a crew of fishermen and their nets. Today you can see it in a museum by the lake. It shows us what boats like Peter's were really like.

The big idea. The Sea of Galilee is not salty like the ocean. It is **fresh water**. Many fish live in it, like the flat **tilapia** and small silver fish like sardines. Fish often swim together in a **school**. When a fisherman's **net** goes around a school, it can catch many fish at once. Fish bigger than the holes in the net are caught. Fish smaller than the holes slip through. Peter knew all about fishing. But that morning the great catch came because Jesus spoke.

God's handiwork. God gave people "dominion over the fish of the sea" (Genesis 1:28). Fish are a good gift for food. Good fishermen take care of the gift. They use nets with holes big enough to let little fish go free, so the little ones can grow up and lay eggs.

PICTURE STUDY



The Miraculous Draught of Fishes, Raphael, 1515 · Glue-based paint on paper, mounted on canvas (a full-size design, called a cartoon, for a tapestry) · Victoria and Albert Museum, London (lent by the Royal Collection)

Raphael was one of the greatest painters of Italy. Pope Leo X asked him to design ten huge woven tapestries for the Sistine Chapel in Rome, showing the lives of Peter and Paul. Raphael painted full-size designs on paper, called cartoons, for the weavers to copy. This one shows Peter's great catch from Luke 5.

The cartoon is still bright and clear. Look at the boats. They are far too small for the big men in them! Raphael kept them small so your eyes would go straight to the people and to the moment when Peter kneels before Jesus.

Look closely

- Find Peter kneeling with his hands together. Whom is he looking at?
- Find the fish piled in the bottom of the first boat. Can you see different kinds?
- Look at the second boat. Find the men pulling hard on the heavy net.
- Find the three big birds standing on the shore. They are cranes, birds that catch fish too.

Talk about it

1. How do you think Peter felt when the net filled with fish after a night of catching nothing?
2. Why might Raphael have painted the boats so small?
3. Why do you think the cranes are standing by the water?

Safety first. A grown-up should watch whenever there is a tub of water. Wipe up spills so no one slips. Use dry pasta and beans only for play, not for eating afterward.

MAKE AND DO: THE NET TEST

Which fish does a net catch? You will make a pretend lake full of “fish” of different sizes and scoop them up with two kinds of nets. Then you will sort what you caught, like a real fisherman.

You will need

- A dishpan or tub of water
- Pretend fish of three sizes: big pasta shells or corks (big fish), small pasta like macaroni (middle fish), and dry lentils or rice (tiny fish)
- Two nets: a mesh fruit or onion bag (big holes) and a kitchen strainer or colander (small holes)
- Three small bowls labeled big, middle and tiny
- Paper and crayons

Steps

1. Pour all the pretend fish into the tub of water and stir them around. This is your lake.
2. Guess: Which net will catch more kinds of fish, the bag with big holes or the strainer with small holes?
3. Scoop through the lake once with the mesh bag. Sort what you caught into the three bowls and count each kind.
4. Put the fish back. Now scoop once with the strainer. Sort and count again.

5. Draw a simple chart: two rows for the two nets, and draw how many big, middle and tiny fish each net caught.
6. Tell what you found: Which net let the little fish go free? Which net caught almost everything?

Tips

- The bag with big holes lets the tiny fish slip through. Real fishermen use nets like this so little fish can grow up.
- Try swirling all the “fish” into one group first, like a school, and then scoop around them. Do you catch more?

Check your work

- I can tell which fish a big-hole net catches and which ones it lets go.
- I can count and sort my catch into groups.
- I can retell Peter’s great catch in my own words.

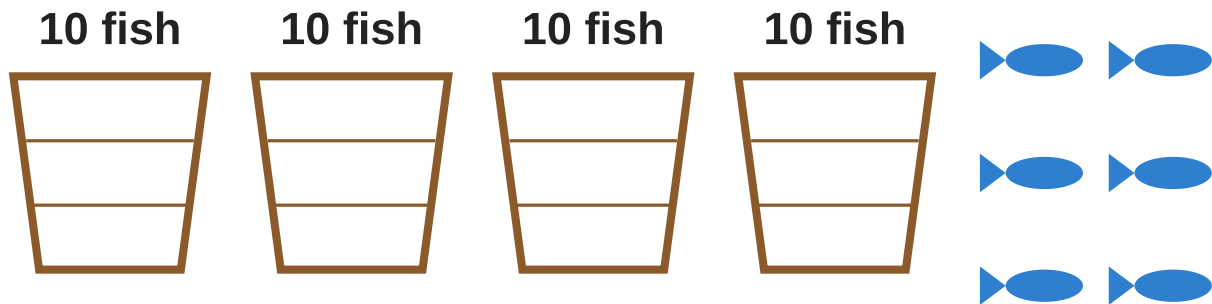
NATURE NOTEBOOK

1. Draw Peter’s boat with the net so full of fish that it is breaking. Draw the second boat coming to help.
2. Draw a tilapia, St. Peter’s fish, from a picture. Label its fins, tail and gill cover.
3. Draw your Net Test chart and write one sentence about what you learned.

From history. The old boat found in the mud of the Sea of Galilee in 1986 was soft and waterlogged. If it had dried out, the wood would have cracked and crumbled. So the workers wrapped it in a cocoon of foam, floated it to a new home, and soaked it for years in a tank of a special waxy liquid that slowly filled the wood and made it strong. Then it was put on display in a museum at Ginosar, near the shore where it was found. People sometimes call it “the Jesus boat,” because it is the kind of boat Peter and the other fishermen used.

WORKED EXAMPLES

Example 1. The fishermen put their fish into baskets of 10. Look at the picture. There are 4 full baskets and some fish left over. How many fish are there in all?



4 baskets of 10 and 6 loose fish

Count the baskets by tens, then count on the loose fish.

1. Count the full baskets by tens: 10, 20, 30, 40.
2. Count on the loose fish one at a time: 41, 42, 43, 44, 45, 46.
3. Check: 4 tens and 6 ones make 46.

Answer: There are 46 fish in all.

PRACTICE

1. **EASY** Where was Peter fishing? Is the water there salty or fresh?
2. **EASY** Tell what happened when Peter let down the net because Jesus said to.
3. **MEDIUM** James and John packed 5 baskets with 10 fish each, and 3 fish were left over. Count by tens. How many fish did they have?
4. **MEDIUM** A net has holes as big as your thumbnail. Point to the fish it will catch: a tiny fish as small as a grain of rice, or a tilapia as big as your hand?
5. **HARD** Tell why good fishermen use nets with holes big enough to let little fish go.

COMMON MISTAKES

- Thinking the Sea of Galilee is a salty ocean. It is a freshwater lake.
- Thinking a “school” of fish is a building. It is a group of fish swimming together.
- Thinking a net catches every fish in the water. Fish smaller than the holes swim right through.

Make it a game • Magnet Fishing. Cut out paper fish of different sizes and slide a paper clip onto each one. On the back of each fish write a question from this unit, such as “What do gills do?” or “How does a salmon find home?” Spread the fish on the floor, your “Sea of Galilee.” Tie a magnet to a string on a stick to make a fishing pole. Catch a fish, answer its question, and keep it in your boat. Fill your boat until it is “ready to sink”!

Scripture. “And Simon answering said unto him, Master, we have toiled all the night, and have taken nothing: nevertheless at thy word I will let down the net.” (Luke 5:5, KJV)

Peter was a skilled fisherman, and he was tired. But he trusted Jesus and obeyed. We can work hard like Peter, and still trust God for the results.

Practice answers

1. On the Sea of Galilee (also called the Lake of Gennesaret). It is fresh water.
2. The net caught so many fish that it began to break. Both boats were filled so full that they began to sink.
3. 10, 20, 30, 40, 50, then 51, 52, 53. They had 53 fish.
4. The tilapia. The tiny fish is smaller than the holes, so it slips through.
5. So the little fish can grow up and lay eggs. Then there will be fish to catch in the years ahead. That is taking good care of God’s gift.

UNIT 5 REVIEW

This is an oral review. Read each question aloud and let your child answer by telling, pointing, counting or showing. Have the lift-the-flap fish, the shark jaw and the salmon drawings nearby. Give full points for a clear answer in your child's own words. The review is worth 20 points.

1. (3 pts) Show me on your lift-the-flap fish how a fish breathes. Where does the water go in, and where does it go out?
2. (3 pts) I will name some animals: trout, whale, goldfish, dolphin, shark. Which ones are fish? How many are fish?
3. (3 pts) Is a shark a fish? Tell two ways a shark is different from a goldfish.
4. (3 pts) What did Nicolas Steno find out when he looked inside the shark's head?
5. (3 pts) Tell the salmon's round trip in order.
6. (2 pts) How does a salmon find its home stream? What did the salmon with plugged noses do?
7. (3 pts) Tell me the story of Peter's great catch. Then tell why a net with big holes lets some fish go.

UNIT PROJECT: MY FISH AQUARIUM

Turn a shoebox on its side to make an aquarium. Paint or color the inside blue like water. Hang paper fish from the top with string: a goldfish with its gill cover labeled, a shark with five gill slits and rows of teeth, and a salmon jumping up a waterfall at one end. Glue sand or small pebbles on the bottom for the gravel where salmon lay their eggs, and add a little net made from a piece of mesh bag with paper fish inside it. Then give your family an aquarium tour, telling how each fish breathes and one special thing about it.

- **Accuracy:** Each fish shows the right parts: gills or gill cover on the goldfish, gill slits on the shark, and the salmon going upstream.
- **Observation:** The fish show real details the child noticed in a tank, a store fish or the picture studies, such as fins, scales and spots.
- **Telling:** On the tour the child explains in their own words how fish breathe, why a shark is a fish, how salmon find home, and Peter's great catch.
- **Care:** The aquarium is neat and colorful, the fish hang securely, and the labels are easy to read.

Answer key

1. The water goes in the mouth, flows over the red gills, and goes out under the gill cover. The gills take in the air that is mixed into the water.
2. Trout, goldfish and shark are fish: 3 fish. The whale and the dolphin are mammals that breathe air with lungs.
3. Yes, it breathes with gills and swims with fins. Any two: it has gill slits instead of one gill cover; its skeleton is cartilage, not bone; its skin is rough with tiny tooth-like scales; it grows

new teeth again and again.

4. He saw that the shark's teeth matched the "tongue stones" people found in rocks, so the tongue stones were really shark teeth that had turned to stone.
5. Eggs are laid in the gravel of a stream; young fish swim downstream to the ocean; they grow big in the ocean; they swim upstream to their home stream and lay eggs.
6. By smell. The salmon with plugged noses got mixed up and could not find their home branch.
7. Peter fished all night and caught nothing. Jesus told him to let down his nets in the deep water, and he caught so many fish that the net began to break and two boats began to sink. A net with big holes lets fish smaller than the holes slip through, so little fish can grow up.

INSECTS

“There be four things which are little upon the earth, but they are exceeding wise” (Proverbs 30:24). In this unit your child meets the smallest animal family in the course and the biggest one on earth: the **insects**. There are more kinds of insects than any other kind of animal, yet every one is built on the same plan. Your child will learn to count six legs and three body parts (head, thorax and abdomen), and to tell an insect from a spider, a worm or a pill bug.

Then come three true stories of people who watched insects closely. Robert Hooke drew a flea through his microscope in 1665. Fred Urquhart and a crowd of volunteers tagged monarch butterflies until the butterflies’ winter home was found on a mountain in Mexico. Karl von Frisch put dots of paint on honeybees and discovered that they dance to tell each other where the flowers are. Last of all, your child becomes a naturalist like Jean-Henri Fabre and builds a bug hotel in the yard.

Everything in this unit is counted, built, danced or drawn. Keep the egg carton insect, the tagged paper monarch, the sketchbook pages and the bug hotel tally chart. At the end of the unit your child will put them together into an Insect Field Guide.

BEFORE YOU BEGIN

- Can count by twos and add numbers to 30
- Can make and read simple tally marks
- Can sort animals into groups by one clue, as in the mammal, bird and fish units
- Can listen to a short true story and tell it back

MASTERY CHECKLIST

- I can name the three body parts of an insect and show that its six legs grow from the thorax.
- I can tell why a spider and a pill bug are not insects.
- I can tell where monarchs fly in the fall and how tags helped people find their winter home.
- I can do the round dance and the waggle dance and tell what each one means.
- I can build a bug hotel and keep a tally of the guests.
- I can say that God made every creeping thing after its kind and gave us the work of caring for His creatures.

OPTIONAL BOOKS AND RESOURCES

- **Monarch Watch** (<https://monarchwatch.org/>): Free to browse. A monarch tagging program run from the University of Kansas. Families can learn how to tag monarchs in the fall, read about the migration and find out how to plant milkweed (Lesson 6.2).

- **Smithsonian National Museum of Natural History** (<https://naturalhistory.si.edu/>): Free. The museum in Washington has a living insect zoo. Its website has insect pictures and short articles a parent can share. If you visit, count the legs on every insect you see.
- **Jean-Henri Fabre's insect books (free at Project Gutenberg)** (<https://www.gutenberg.org/ebooks/search/?query=Fabre>): Free. Fabre's true stories of bees, beetles, crickets and spiders, in English translations. A parent can choose a short chapter to read aloud with Lesson 6.4.

6.1 SIX LEGS ★

OBJECTIVES

- Name the three body parts of an insect (head, thorax and abdomen) and show that its six legs grow from the thorax.
- Sort small creatures into insects and not-insects by counting legs and body parts.
- Tell how Robert Hooke looked at a flea through a microscope and drew what he saw.

Warm-up. Play a counting game around the house. How many legs does a chair have? (Four.) How many legs do you have? (Two.) How many legs does a dog or cat have? (Four.) Now look out the window, or at a picture of an ant or a ladybug. Count its legs together. Six! Today we learn that six legs is the big clue for an insect.

Video. Coming soon. Insect body parts for kids: head, thorax, abdomen, six legs and antennae, and why a spider is not an insect; search Smithsonian National Museum of Natural History (Insect Zoo), SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and close-up nature footage of ants, beetles and ladybugs.

KEY TERMS

insect

A small animal with six legs, three body parts and two antennae. Ants, bees, beetles and butterflies are insects.

thorax

The middle part of an insect's body. All six legs, and the wings if it has them, grow from the thorax.

abdomen

The back part of an insect's body. It is often the biggest part.

antennae

Two feelers on an insect's head. The insect uses them to touch and smell.

CORE IDEAS

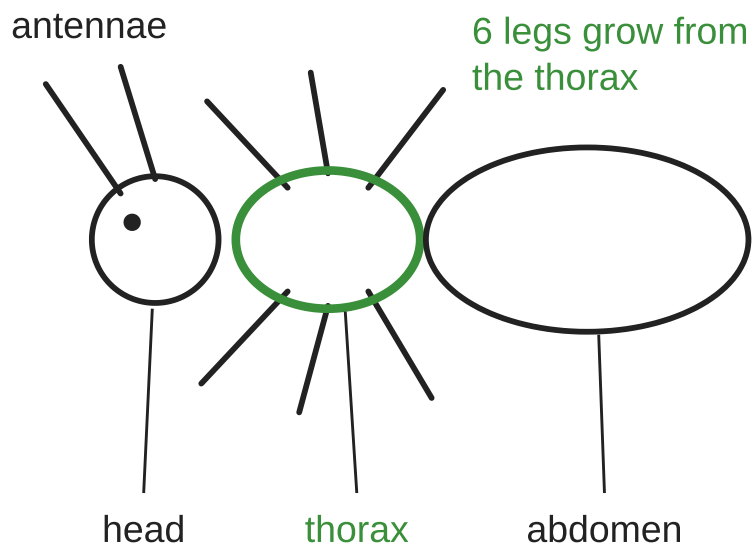
The story. In 1665 a scientist in London named Robert Hooke made a book of pictures. He had a microscope, a tube with glass lenses that makes tiny things look big. He put a flea under it. A flea is smaller than a grain of rice. But through the lenses Hooke saw a flea as big as a bird! He drew it very carefully, and his drawing was so big it had to be folded up inside the book. People were amazed. Now everyone could see the flea's hairy, jointed legs and its shiny hard shell.

How they figured it out. Hooke did not guess. He looked, and looked again, and drew only what he saw. Scientists still sort small animals that way. They count the legs. They count the

body parts. A flea has six legs. So does an ant, a bee and a beetle. A spider has eight legs, so a spider is *not* an insect. A worm has no legs at all, so it is not an insect either.

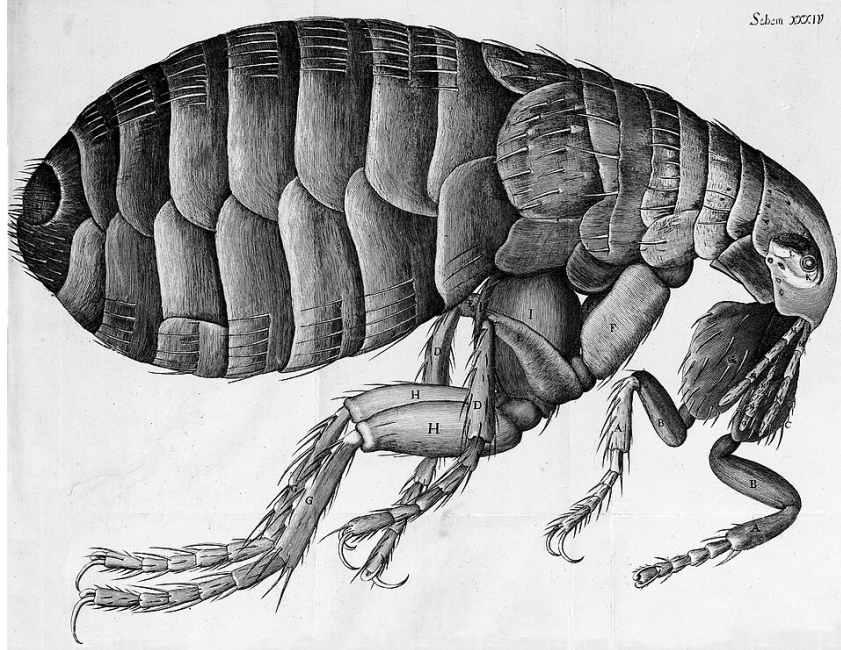
The big idea. Every **insect** has three body parts. The **head** has the eyes, the mouth and two **antennae** for feeling and smelling. The **thorax** is the middle part, and all six legs grow from it. Many insects have wings on the thorax too. The **abdomen** is the back part. An insect has no bones inside. Instead it wears a hard shell on the outside, like a little suit of armor. Most insects have wings, but some, like fleas and worker ants, do not. Wings or no wings, every insect has six legs.

God's handiwork. There are more kinds of insects than any other kind of animal on earth. Shiny beetles, buzzing bees, painted butterflies and busy ants are all built on the same plan: three parts and six legs. Yet each kind is different. The Bible says God made "every thing that creepeth upon the earth after his kind" (Genesis 1:25). When you count an ant's legs, you are looking closely at His work, just as Hooke did.



Every insect has three body parts and six legs. All six legs grow from the thorax.

PICTURE STUDY



The Flea, from Micrographia, Robert Hooke, 1665 · Engraving, printed as a large fold-out page in the book Micrographia · Copies of the book are kept in many libraries and museums, including the Royal Society in London

Photo: Wellcome Collection · CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0>) · via Wikimedia Commons

Robert Hooke was a clever English scientist who loved to build instruments. He had a microscope built to his own design and looked at everything he could find: a cork, a feather, the point of a needle, a louse and a flea. In 1665 he put his drawings in a book called *Micrographia*, which means “small drawings.” The flea was one of the biggest and most famous pictures in it.

Hooke wrote that the flea seemed to wear a polished suit of black armor. Look closely and you will see why he said that.

Look closely

- Count the legs on the flea. How many can you find? (Six.)
- Find the long back legs. What do you think a flea does with such strong legs? (It jumps!)
- Look at the shell. Find the plates that look like armor and the stiff little hairs.
- Find the small head. Can you see the eye and the mouth parts?

Talk about it

1. A real flea is tiny. Why did Hooke need a microscope to draw it like this?
2. Is a flea an insect? What clue tells you?
3. A flea has no wings. Can it still be an insect?

Safety first. A grown-up should cut the egg carton and poke the holes for the legs. Pipe cleaner ends can be sharp, so bend the tips over.

MAKE AND DO: EGG CARTON INSECT

You will build an insect with all the right parts: a head, a thorax and an abdomen, two antennae and six legs. When you are done, you can point to each part and name it like a scientist.

You will need

- A cardboard egg carton
- 4 pipe cleaners
- Markers, crayons or paint
- Wax paper or tissue paper for wings (if you like)
- Glue or tape
- Scissors and a pencil (for a grown-up)

Steps

1. A grown-up cuts a strip of three egg cups from the carton. These are the three body parts.
2. Color the strip. Pick one end cup to be the head. Draw two eyes on it.
3. Point to each cup and name it out loud: head, thorax, abdomen.
4. A grown-up cuts 3 pipe cleaners in half. Now you have 6 legs. Count them!
5. A grown-up pokes 3 holes on each side of the *middle* cup only. Push one leg through each hole and bend the ends to make feet.
6. Poke a short pipe cleaner into the head and bend it into two antennae.
7. If your insect has wings, cut two or four wing shapes from wax paper and tape them on top of the thorax.
8. Show your insect to your family. Point to the thorax and say, "All six legs grow here."

Tips

- Make your insect a real kind. A red carton with black dots makes a ladybug. A yellow one with black stripes makes a bee.
- If someone puts legs on the head or the abdomen, ask: "Where do an insect's legs really grow?"

Check your work

- I can point to the head, the thorax and the abdomen.
- I can count six legs, all on the thorax.
- I can show the two antennae and tell what they are for.

NATURE NOTEBOOK

1. Draw a big insect. Label the head, thorax and abdomen. Count and color its six legs.
2. Go outside with a grown-up and find one real insect. Draw it small and write how many legs you counted.
3. Draw a spider and an ant side by side. Under each one, write how many legs it has. Circle the insect.

From history. Hooke's book *Micrographia* had many other surprises. When he looked at a thin slice of cork, he saw rows of tiny empty boxes. He called the little boxes **cells**, an old word for small rooms. Scientists still use that word today for the tiny parts all living things are made of. A man named Samuel Pepys wrote in his diary that he stayed up very late reading Hooke's book because he liked it so much.

WORKED EXAMPLES

Example 1. Three ladybugs are sitting on a leaf. Each ladybug has 6 legs. How many legs are there in all?

(Use the map or drawing "One insect has 6 legs: 3 on each side." shown earlier in this lesson.)

1. Look at the insect picture and count the legs on one ladybug: 3 on one side and 3 on the other side. That is 6.
2. Count by sixes, one number for each ladybug: 6, 12, 18.
3. Check by adding: $6 + 6 + 6 = 18$.

Answer: 18 legs. Three ladybugs with 6 legs each have 18 legs in all.

PRACTICE

1. **EASY** How many legs does every insect have? How many body parts?
2. **EASY** On your egg carton insect, point to the thorax. What grows from it?
3. **MEDIUM** Listen and sort: ant, spider, bee, worm, beetle. Which ones are insects?
4. **MEDIUM** Two ants walk across the table. How many legs is that in all?
5. **HARD** A flea has no wings. Tell why it is still an insect.

COMMON MISTAKES

- Thinking a spider is an insect. A spider has eight legs and two body parts, so it is not an insect.
- Thinking an insect's legs grow all along its body. All six legs grow from the middle part, the thorax.
- Thinking every small crawling thing is an insect. Worms, spiders and pill bugs are not insects, because they do not have six legs.

Make it a game · Six Legs or Not?. Your parent names a small creature. If it is an insect, hold up six fingers and say “Six legs!” If it is not, shake your head and tell how many legs it has if you know. Try: ant, spider, bee, worm, ladybug, snail, grasshopper, butterfly, centipede, fly. Score a point for each right answer. Then crawl around the room like your favorite insect and let your family guess what you are.

Scripture. “And God made the beast of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind: and God saw that it was good.” (Genesis 1:25, KJV)

Insects are some of the smallest creeping things, but God made them too, each after its own kind, and He called them good.

Practice answers

1. Six legs and three body parts (head, thorax and abdomen).
2. The child points to the middle cup. All six legs grow from the thorax, and the wings too if the insect has them.
3. The ant, the bee and the beetle are insects. The spider has eight legs and the worm has no legs, so they are not insects.
4. $6 + 6 = 12$ legs.
5. Because it has six legs and three body parts. Not every insect has wings, but every insect has six legs.

6.2 MONARCH MIGRATION

OBJECTIVES

- Tell how monarch butterflies fly south to the mountains of Mexico in the fall and how their children and grandchildren fly back north in the spring.
- Tell how Fred Urquhart and many helpers used tiny tags to find the monarchs' winter home.
- Say why monarch caterpillars need milkweed.

Warm-up. Get out a map or a globe. Find where you live. Now find Mexico. Trace a path from your home to the mountains in the middle of Mexico with your finger. Then hold up a sheet of paper. Is it heavy? A monarch butterfly weighs even less than that sheet of paper, yet many monarchs fly a path like the one you traced, all on their own wings.

Video. Coming soon. Monarch butterfly migration for kids: monarchs clustered on fir trees in the mountains of Mexico, tagging monarchs, caterpillars eating milkweed; search Monarch Watch, U.S. Fish and Wildlife Service, Smithsonian, SciShow Kids, Homeschool Pop (Alternate) and nature footage of the monarch winter forests.

KEY TERMS

migration

A long trip some animals take at the same time each year, to find food or a better place to spend the winter.

monarch

A big orange and black butterfly. It is an insect with six legs and four wings.

milkweed

A wild plant with milky juice. It is the only food monarch caterpillars eat.

tag

A tiny sticker with a number, put on an animal so people can tell where it went if it is found again.

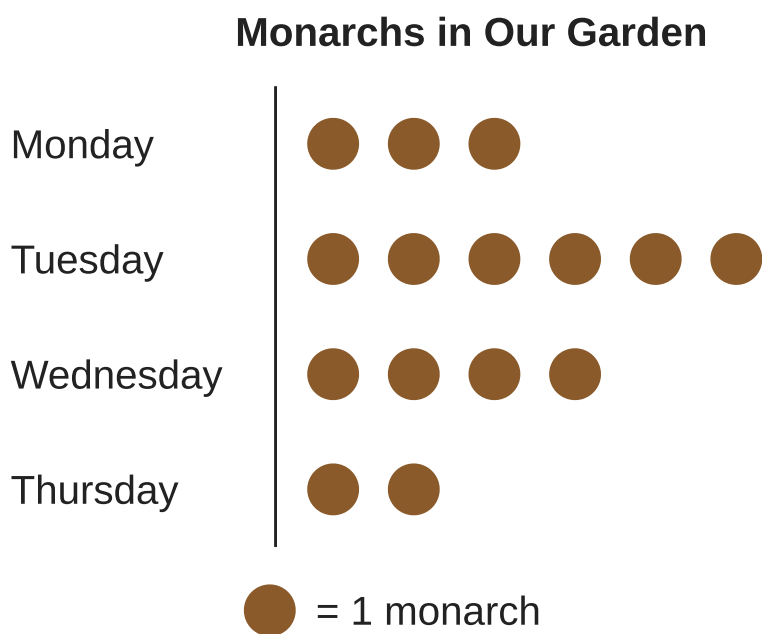
CORE IDEAS

The story. A scientist in Canada named Fred Urquhart watched monarch butterflies every summer. Each fall they flew away. But where did they go? Nobody he knew could tell him. So he and his wife, Norah, asked people to help. Volunteers caught monarchs in nets and stuck tiny tags on their wings. Each tag asked the finder to send it back. For years the tags came back from farther and farther south. Then in January 1975 two searchers, Ken Brugger and Catalina Aguado, climbed a mountain in Mexico. They found trees covered with millions of monarchs!

How they figured it out. The next winter Fred Urquhart climbed that mountain himself. The butterflies hung on the trees so thick that a branch broke under their weight. On that branch Urquhart found a monarch wearing a little white tag. Volunteers in Minnesota had put it on the fall before. Now he knew for sure. The monarchs he had wondered about for so long had flown all the way to Mexico.

The big idea. A **migration** is a long trip that animals take at the same time each year. In the fall, many monarchs in the eastern United States and Canada fly south to the fir forests on the mountains of Mexico. They rest there all winter, packed together on the trees. In the spring they fly north and lay eggs on **milkweed**. Their caterpillars eat only milkweed. The juice of the plant makes them taste bad to birds. The new butterflies keep flying north, and their children go north again. In the fall, great-grandchildren who have never seen Mexico fly south and find the same mountains!

God's handiwork. No one teaches a monarch the way. God made it to know when to go and where. Many families help the monarchs today. They plant milkweed in their gardens. Children and parents put tags on monarchs in the fall and send the numbers to scientists. Good care of God's creatures can start in your own yard.



A picture chart of monarchs counted in a garden during their fall trip.

PICTURE STUDY



Long Grass with Butterflies, Vincent van Gogh, 1890 · Oil on canvas · The National Gallery, London

Vincent van Gogh was a Dutch painter who lived in the south of France near the end of his life. In the spring of 1890 he painted a patch of long grass in a garden. He did not paint the sky or any trees. He looked down at the grass and painted it close up, with little butterflies dancing over it.

These are not monarchs. They are small white butterflies that live in Europe. But every butterfly is an insect, with six legs, four wings and two antennae, just like the monarch.

Look closely

- Find the butterflies. How many can you count?
- Look at the brush strokes in the grass. Do they look still, or do they look like the grass is moving in the wind?
- Look for any flowers in the grass. Why might a butterfly visit a flower? (To sip sweet nectar.)
- Where would a butterfly hide or rest in this grass?

Talk about it

1. How is a monarch different from these butterflies? How is it the same?
2. If you could paint a monarch's winter home, what would you paint?

Safety first. If you touch milkweed, wash your hands afterward. Its milky juice can sting if it gets in your eyes. Be gentle with real butterflies: look, but do not grab their wings.

MAKE AND DO: TAG AND FLY A PAPER MONARCH

You will make your own paper monarch, give it a tag like Fred Urquhart's helpers did, and fly it on a long migration across your floor from "home" to "Mexico."

You will need

- Orange paper (or white paper and an orange crayon)
- A black marker or crayon
- A clothespin or a pipe cleaner for the body
- A small round sticker for the tag
- Masking tape
- Two sheets of paper: one marked HOME and one marked MEXICO

Steps

1. Fold a piece of paper in half. Draw half a butterfly shape against the fold and cut it out (a grown-up can help). Open it up: four wings!
2. Color the wings orange. Add black lines and a black edge with white dots, like a real monarch.
3. Clip the clothespin on the middle for the body, or twist a pipe cleaner around it. Bend the top of the pipe cleaner into two antennae.
4. Write a number on the round sticker and stick it on a back wing. That is your tag. Write the number in your notebook too.
5. Put the HOME sign at one end of a long room or hall and the MEXICO sign at the other end. Make a path of masking tape between them.
6. Fly your monarch along the path, step by step. Count your steps out loud. Write the number down.
7. At MEXICO, rest your monarch on a "fir tree" (a chair or a houseplant). Then tell the story of the tagged monarch Urquhart found on the branch.

Tips

- Make several monarchs with different tag numbers and send each one on a trip with a different family member.
- If you have a sunny spot outside, ask a grown-up about planting milkweed in the spring. You might find monarch eggs and caterpillars on it in the summer.

Check your work

- I can tell where many monarchs go in the fall.
- I can tell how a tag helped scientists find the monarchs' winter home.
- I can say what monarch caterpillars eat.

NATURE NOTEBOOK

1. Draw a monarch with its wings open. Color it orange and black. Count and draw its six legs and two antennae.
2. Draw a simple map with your home at the top and Mexico at the bottom. Draw an arrow for the fall trip south.
3. Draw a milkweed plant with a striped caterpillar eating a leaf.

From history. The people who lived in the mountain villages of Mexico had seen the butterflies arrive every fall for as long as anyone could remember. What they did not know was where the butterflies came from. It took the farmers of the mountains and the tagging volunteers of the north, together, to solve the puzzle. Fred Urquhart told the whole story in *National Geographic* magazine in 1976. Today people all over North America still tag monarchs every fall.

WORKED EXAMPLES

Example 1. A family counted monarchs in their garden as the butterflies passed through on their fall trip. Read the picture chart. Which day had the most monarchs? How many monarchs did they count in all?

(Use the map or drawing “Each dot stands for 1 monarch.” shown earlier in this lesson.)

1. Each dot stands for 1 monarch. Count the dots on each row: Monday 3, Tuesday 6, Wednesday 4, Thursday 2.
2. Find the longest row. Tuesday has 6 dots, more than any other day.
3. Add all the rows: $3 + 6 = 9$, then $9 + 4 = 13$, then $13 + 2 = 15$.

Answer: Tuesday had the most monarchs (6). The family counted 15 monarchs in all.

PRACTICE

1. **EASY** Which way do the monarchs fly in the fall: north or south? Point on a map to where many of them go.
2. **EASY** What is the only food a monarch caterpillar eats?
3. **MEDIUM** A monarch has 4 wings. How many wings do 3 monarchs have?
4. **MEDIUM** Tell how the little tags helped Fred Urquhart find where the monarchs go.
5. **HARD** When you look at a monarch resting on a flower, you may see only four legs. Is it still an insect? Tell why.

COMMON MISTAKES

- Thinking the same butterfly flies south and then all the way back north again. The ones that fly north lay eggs along the way, and it takes their children and grandchildren to reach the north again.

- Thinking butterflies are not insects. A butterfly has six legs, three body parts and two antennae, so it is an insect.
- Thinking a monarch caterpillar can eat any leaf. It eats only milkweed, so monarchs need milkweed to grow.

Make it a game • Monarch Journey. Everyone is a monarch. Flap your “wings” and fly around the room while your parent calls out signals. “Fall!” means fly to the south wall. “Winter!” means huddle close together like monarchs on a fir tree. “Spring!” means fly north. “Milkweed!” means stop, bend down and “lay an egg” by tapping the floor. A bird might call “Peck!” Anyone who has eaten milkweed (everyone!) says “Yuck, I taste bad!” and keeps flying. Play until the great-grandchildren fly south again.

Scripture. “Yea, the stork in the heaven knoweth her appointed times; and the turtle and the crane and the swallow observe the time of their coming; but my people know not the judgment of the LORD.” (Jeremiah 8:7, KJV)

The “turtle” here is the turtledove, a bird. Birds, and butterflies too, know the times God set for them to come and go. God wants His people to know Him and His ways even better.

Practice answers

1. South. The child points to the mountains in the middle of Mexico.
2. Milkweed.
3. $4 + 4 + 4 = 12$ wings.
4. People put numbered tags on monarchs’ wings. When tagged monarchs were found, the tags were sent back, so scientists could see where the butterflies had gone. A monarch tagged in Minnesota was found on a tree in the mountains of Mexico.
5. Yes. A monarch really has six legs. Its two front legs are very short and folded up against its body, so they are hard to see. It also has three body parts and two antennae, so it is an insect.

6.3 THE BEES' DANCE

OBJECTIVES

- Tell how Karl von Frisch watched marked honeybees and learned that they dance to tell other bees where to find food.
- Act out the round dance for food nearby and the waggle dance for food far away.
- Name what worker bees gather and what they make.

Warm-up. Hide a small snack somewhere in the room while your child closes their eyes. Then, without saying a single word, use only your arms and body to show them where it is. Can they find it? Now switch. It is hard to give directions without words! Honeybees do it every day, and today we will learn how.

Video. Coming soon. Honeybee waggle dance for kids: bees dancing on the comb in an observation hive, round dance and waggle dance, Karl von Frisch's experiments, worker bees gathering nectar and pollen; search Smithsonian, U.S. Department of Agriculture, SciShow Kids, Homeschool Pop (Alternate), Moody Science classics and close-up beehive nature footage.

KEY TERMS

honeybee

A bee that lives in a big family in a hive and makes honey and wax. It is an insect with six legs and four wings.

hive

The home of a honeybee family. Inside are rows of wax rooms called honeycomb.

nectar

A sweet juice inside flowers. Bees sip it and turn it into honey.

waggle dance

A dance a honeybee does on the honeycomb to show the other bees which way to fly and how far to go to find flowers.

CORE IDEAS

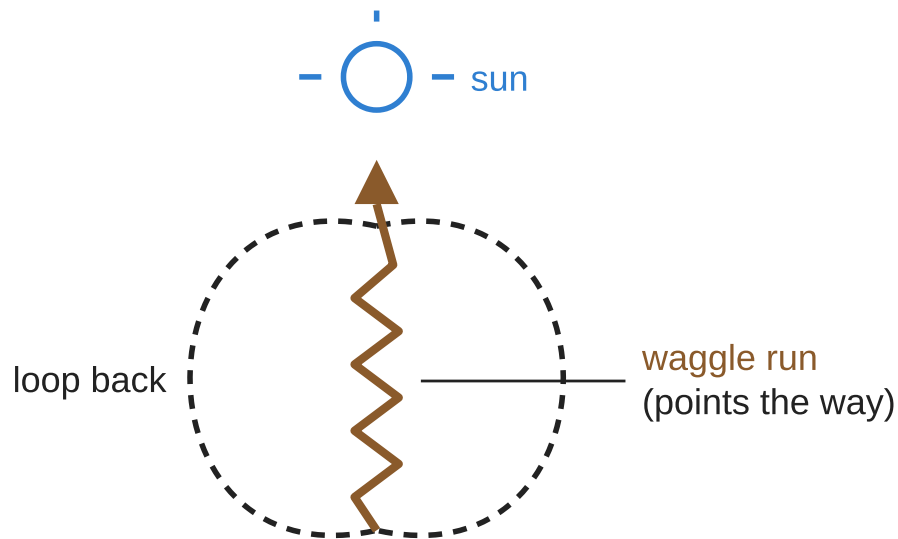
The story. Long ago, a scientist from Austria named Karl von Frisch loved to watch honeybees. He kept bees in a special hive with glass walls, so he could see inside. One day he set out a little dish of sugar water. When a bee came to drink, he put a tiny dot of paint on her back. Now he could find that one bee again. He watched her fly home to the hive. Then something wonderful happened. She began to dance! Soon many more bees came flying to his dish.

How they figured it out. Von Frisch did the test again and again. When the dish was close to the hive, the bee danced in little circles. He called it the round dance. It means, "Food is

near! Go out and look.” When he moved the dish far away, the bee did a different dance. She ran in a straight line, wiggling her body, then looped around and did it again. This is the **waggle dance**. Von Frisch saw that the straight wiggling run pointed the way. A short waggle run meant the flowers were not far. A long waggle run meant they were far away.

The big idea. A honeybee is an insect, with six legs, four wings and two antennae. Its family lives in a **hive**. There is one queen, who lays the eggs, and thousands of worker bees. The workers fly out to gather sweet **nectar** and yellow pollen from flowers. They carry pollen home in little baskets on their back legs. In the hive they make honey and wax. When a worker finds good flowers, she dances on the honeycomb. If she waggles straight up the comb, it means, “Fly toward the sun!”

God’s handiwork. A bee has a brain smaller than a seed, yet God made it to give directions with a dance! Von Frisch spent his whole life watching bees, and his work won a great prize in 1973. Every spoonful of honey on your toast came from bees who danced, flew and worked together.



Straight up the comb means:
fly toward the sun.

The waggle dance. The bee wiggles along the straight run, then loops back around, first one way and then the other.

PICTURE STUDY



The Beekeepers, Pieter Bruegel the Elder, about 1568 · Pen and brown ink drawing on paper ·
Kupferstichkabinett (Museum of Prints and Drawings), Berlin

Pieter Bruegel the Elder was a great painter from Flanders, in the land we now call Belgium. He loved to draw country people at work. In this drawing he shows beekeepers caring for their bees in the old way.

In Bruegel's day, beehives were not wooden boxes. They were domes woven from straw, called skeps. The beekeepers wore masks of woven straw to keep the bees from stinging their faces.

Look closely

- Find the straw beehives. What shape are they?
- Look at the beekeepers' faces. What are they wearing? Why do you think they wear it?
- Count the beekeepers. How many do you see?
- Look in the background. Who has climbed up into the tree?

Talk about it

1. How are these old straw hives different from von Frisch's hive with glass walls?
2. Why would a beekeeper want to see inside a hive?

Safety first. Honeybees can sting. Watch bees from a few steps away. Never swat at a bee or touch a hive. If anyone in your family is allergic to bee stings, do this lesson's outdoor watching only with a grown-up close by, or watch bees through a window or on video.

MAKE AND DO: DANCE TO THE FLOWERS

You will be a honeybee. You will hide a paper flower, then dance to show your family where it is, with no words at all. They must use your dance to find it.

You will need

- A paper flower (draw and cut one out, or use a yellow sticky note)
- A spoonful of honey on a plate, for a taste at the end
- A room or a yard with room to move
- A pillow or chair to be the “hive”

Steps

1. Make your paper flower and color it bright blue or yellow. Bees see those colors well.
2. Set the pillow down. That is the hive. Everyone else waits at the hive with eyes closed.
3. Hide the flower *close* to the hive. Come back and do the round dance: turn in small circles, first one way and then the other. Your family hunts nearby.
4. Now hide the flower *far* away. Come back and do the waggle dance. Stand facing the flower. Walk straight toward it a few steps while wiggling your hips. Then loop back around to where you started and do it again.
5. For flowers very far away, make your waggle run long. For flowers closer by, make it short.
6. Your family follows the way your waggle run pointed. Did they find the flower?
7. When the game is done, everyone gets a taste of honey. Bees made it from nectar!

Tips

- A real bee dances on the honeycomb in the dark hive, and the other bees feel the dance with their antennae. Try dancing for someone with their eyes closed and their hand on your shoulder.
- Take turns being the bee who dances and the bees who search.

Check your work

- I can do the round dance for food that is near.
- I can do the waggle dance and point the way to food that is far away.
- I can tell how von Frisch learned what the dances mean.

NATURE NOTEBOOK

1. Draw a honeybee. Label its head, thorax and abdomen, and draw six legs and four wings. Draw a yellow pollen basket on a back leg.
2. Draw the path of the waggle dance: a wiggly line going up, with a loop on each side.
3. Watch a flower patch outside (from a few steps away) for five minutes. Make a tally mark for every bee you see visit a flower.

From history. Before he studied the dances, von Frisch asked another question: can bees see colors? He set a dish of sugar water on a blue card, among gray cards of every shade from white to black. The bees learned to visit the blue card. When he took the sugar water away, they still flew to the blue card and not to any gray one. That showed they could tell blue from gray, so they really see color. In 1973 von Frisch shared the Nobel Prize with two other scientists who studied how animals behave.

WORKED EXAMPLES

Example 1. Two bees come home and do the waggle dance. Bee A waggles 3 times on her straight run. Bee B waggles 9 times on her straight run. Which bee found flowers farther away? How many more waggles did she make?

1. A longer waggle run means the flowers are farther away.
2. Compare: 9 is more than 3, so Bee B's run is longer.
3. Find how many more: count up from 3 to 9: 4, 5, 6, 7, 8, 9. That is 6 more. Or subtract: $9 - 3 = 6$.

Answer: Bee B found flowers farther away. She made 6 more waggles than Bee A.

PRACTICE

1. **EASY** Show me the round dance. What does it tell the other bees?
2. **EASY** What do worker bees gather from flowers? What do they make in the hive?
3. **MEDIUM** Four bees land on a flower. How many legs is that in all? Count by sixes.
4. **MEDIUM** Why did von Frisch put a dot of paint on the bee's back?
5. **HARD** A bee does the waggle dance straight up the honeycomb. Which way should the other bees fly?

COMMON MISTAKES

- Thinking bees make honey from pollen. Bees make honey from nectar, the sweet juice in flowers. Pollen is food for the baby bees.
- Thinking the queen bee is the boss who gives orders. Her main work is laying eggs. The workers decide where to gather food by sharing dances.
- Thinking every buzzing yellow and black insect is a honeybee. Wasps, hornets and some flies look a little like bees, but they are different insects.

Make it a game · Who Lives in the Hive?. Your parent calls out a job, and you act out who does it. "Lays the eggs" means sit like a queen and pretend to lay eggs. "Flies out for nectar" means buzz around the room like a worker. "Dances on the comb" means do a waggle dance. "Makes honey" means fan your arms fast, because workers fan their wings to dry the nectar into honey. Then trade places and let your parent be the bee.

Scripture. “More to be desired are they than gold, yea, than much fine gold: sweeter also than honey and the honeycomb.” (Psalm 19:10, KJV)

The psalm is talking about God’s words. Honey from the comb is one of the sweetest foods there is, and the Bible says God’s words are sweeter still.

Practice answers

1. The child turns in small circles, one way and then the other. It tells the bees, “Food is near! Look close to home.”
2. They gather nectar and pollen. They make honey and wax.
3. 6, 12, 18, 24. That is 24 legs.
4. So he could tell that one bee apart from all the others and watch what she did when she went home to the hive.
5. Toward the sun. Straight up on the comb means “fly toward the sun.”

6.4 BUG HOTEL

OBJECTIVES

- Build a bug hotel that gives insects shelter, and tell what a habitat must give an animal.
- Watch the bug hotel, keep a tally of the visitors and sort them into insects and not-insects.
- Tell how Jean-Henri Fabre watched insects in his own wild garden.

Warm-up. With a grown-up, go outside and gently tip over a flat rock, a flowerpot or an old board. Who is hiding underneath? Look, count the legs, and then set the rock back just the way it was. (No yard? Look at the cracks along a sidewalk or the bark of a tree.) Ask: Why do little creatures like dark, snug hiding places?

Video. Coming soon. How to build a bug hotel or insect hotel with children: hollow stems for mason bees, bark and pinecones for ladybugs and beetles; search U.S. Fish and Wildlife Service, Smithsonian Gardens, university extension services, SciShow Kids, Homeschool Pop (Alternate) and garden nature footage of solitary bees nesting in hollow stems.

KEY TERMS

habitat

The place where an animal lives and finds everything it needs: food, water and shelter.

shelter

A safe place to hide, rest, stay dry and lay eggs.

naturalist

A person who studies living things by watching them carefully in nature and writing down what they see.

tally

A way to count with little lines. Every fifth line crosses the other four to make a bundle of 5.

CORE IDEAS

The story. In 1879 a French naturalist and longtime teacher named Jean-Henri Fabre bought a house with a stony, weedy field in a village in the south of France. Most people would have pulled out the weeds. Not Fabre! He called the field his *harmas*, an old word for wild, untilled land. He let thistles and wildflowers grow. Soon bees, wasps, beetles and crickets moved in. Fabre now had a whole world of insects right outside his door.

How they figured it out. Fabre was a **naturalist**. He did not catch insects just to pin them in a box. He sat in his garden for hours and watched them live. He watched bees build their

nests and beetles roll balls of dung. He wrote down everything in plain, lively words. His books are full of patient watching, and people all over the world still read them.

The big idea. Every animal needs a **habitat** with food, water and **shelter**. Many insects need snug hiding places. Some bees lay their eggs inside hollow stems and seal the doors with mud. Ladybugs creep into dry cracks to sleep through the winter. Beetle grubs live in old, soft wood. A bug hotel is a pile of sticks, stems, bark and pinecones that gives them shelter. Other small creatures will check in too. A pill bug has fourteen legs and a spider has eight, so they are not insects. Count the legs to sort your guests!

God's handiwork. God put Adam in the garden "to dress it and to keep it" (Genesis 2:15). Taking care of the little creatures in your yard is part of that good work. Most insects are helpers. Bees carry pollen from flower to flower so fruit can grow. Ladybugs eat the tiny aphids that harm garden plants. Beetles and pill bugs turn dead leaves and wood back into rich soil.

PICTURE STUDY



Stag Beetle, Albrecht Dürer, 1505 · Watercolor and gouache on paper · J. Paul Getty Museum, Los Angeles

Albrecht Dürer, the same German artist who made the rhinoceros print, painted this beetle in 1505. This time he had the real animal right in front of him, and you can tell! He painted every shiny plate and every jointed leg.

A male stag beetle has huge jaws that look like the antlers of a stag, which is a male deer. Stag beetle grubs live for a long time inside old, rotting logs and stumps before they become beetles. A pile of old wood in a quiet corner of a garden is just the kind of shelter they need.

Look closely

- Count the beetle's legs. Are they all there? (Six.)

- Find the big jaws. What do they look like to you?
- Find the two thin antennae. Where are they on the head?
- Look at the shadow under the beetle. Why does a shadow make the beetle look real?

Talk about it

1. Dürer had a real beetle to look at this time. How does this picture look different from his rhinoceros?
2. If a stag beetle came to your bug hotel, which part of the hotel would it like best?

Safety first. A grown-up should do all the cutting, and should cover any sharp edges on a can with tape. Wear garden gloves when you gather sticks and bark. Look at bugs but do not grab them, and stay away from bees and wasps. Wash your hands when you are done.

MAKE AND DO: BUILD A BUG HOTEL

You will build a small hotel for insects, set it outside, and check on it like a naturalist. Each time you look, you will keep a tally of who has checked in.

You will need

- A clean, empty food can with the label removed, a cardboard milk carton or a small wooden box, open at one end
- Hollow stems or short pieces of bamboo (a grown-up cuts them to fit)
- Small sticks, pieces of bark, pinecones, dry leaves and straw
- String or twine
- Masking tape or duct tape
- Garden gloves
- Notebook and pencil for the tally chart

Steps

1. Put on your gloves and go on a hunt with a grown-up. Gather sticks, bark, pinecones, dry leaves and hollow stems.
2. A grown-up covers the open edge of the can with tape so it is not sharp, and cuts the stems to fit inside.
3. Pack the hollow stems in tightly, with the open ends facing out. These are rooms for bees.
4. Fill the other spaces with sticks, bark, pinecones and straw. Pack it snug so nothing falls out when you tip it.
5. Tie string around the can. Hang it or set it on its side in a dry place, a little off the ground, where the morning sun can reach it.
6. Make a tally chart in your notebook with four rows: ladybug, beetle, bee and pill bug, and room to add more.

7. Check your hotel a few times each week. Look closely but do not pull anything out. Make a tally mark for each guest you see.

Tips

- Be patient. Bees and ladybugs may take weeks to find your hotel, just as Fabre's insects took time to move into his harmas.
- If you see a little stem plugged with mud, a mason bee may have laid her eggs inside. Leave it alone and watch for new bees in the spring!

Check your work

- I can name the three things a habitat gives: food, water and shelter.
- I can show which part of my bug hotel is for bees and which is for beetles.
- I can keep a tally and tell which guests are insects.

NATURE NOTEBOOK

1. Draw your bug hotel. Label the hollow stems, the sticks, the bark and the pinecones.
2. Draw one guest you found in your hotel. Count its legs and write the number. Is it an insect?
3. Sit still near a flower bed for five minutes like Fabre. Write or tell three things you saw an insect do.

From history. Fabre wrote ten books of stories about the insects he watched. He wrote them so clearly that children and grown-ups alike loved to read them, and people came to call him "the Homer of insects," after a great storyteller of long ago. His house and wild garden in the village of Sérignan, in the south of France, are still there today, and visitors can walk through the harmas where he watched his insects.

WORKED EXAMPLES

Example 1. A family kept a tally of the guests at their bug hotel. Read the tally chart. How many insects did they find in all? Which guest did they see the most, and is it an insect?

Bug	Tally	Number	Insect?
ladybug		3	yes
beetle		5	yes
bee		2	yes
pill bug		6	no

A tally chart of guests at a bug hotel.

1. Read each tally. A bundle with a line across it is 5. Ladybug: 3. Beetle: 5. Bee: 2. Pill bug: 5 and 1 more, which is 6.
2. Find the insects. Ladybugs, beetles and bees have six legs, so they are insects. A pill bug has fourteen legs, so it is not.
3. Add the insects: $3 + 5 + 2 = 10$.
4. Find the biggest number: the pill bug, with 6.

Answer: They found 10 insects. The guest they saw most was the pill bug (6), and it is not an insect.

PRACTICE

1. **EASY** What three things does every habitat give an animal?
2. **EASY** Point to the part of your bug hotel where a bee might lay her eggs.
3. **MEDIUM** Make tally marks for 7. Then tell how many bundles of 5 you made.
4. **MEDIUM** Sort these hotel guests: ladybug, spider, beetle, pill bug, bee. Which are insects?
5. **HARD** Tell one way a bee helps a garden and one way a ladybug helps a garden.

COMMON MISTAKES

- Thinking every little crawling creature is an insect. Pill bugs and spiders often live in bug hotels, but they do not have six legs.
- Thinking all bugs are pests. Most insects are helpers: they carry pollen, eat harmful bugs and turn dead leaves into soil.
- Pulling the hotel apart to see who is inside. A naturalist watches without bothering the animals, just as Fabre did.

Make it a game · Who Checked In?. Your parent is the hotel clerk and describes a guest: how many legs, how many body parts, and where it likes to stay. You guess who it is and say “Insect!” or “Not an insect!” Try: six legs and loves hollow stems (bee, insect); eight legs and spins a web (spider, not an insect); fourteen legs and rolls into a ball (pill bug, not an insect); six legs, red with black spots (ladybug, insect); six legs and huge jaws, loves old logs (stag beetle, insect). Then you be the clerk.

Scripture. “Go to the ant, thou sluggard; consider her ways, and be wise:” (Proverbs 6:6, KJV)

A sluggard is a lazy person. God tells us to go and watch the ant and learn from her hard work. Watching insects, like Fabre did, can make us wise.

Practice answers

1. Food, water and shelter.
2. The child points to the hollow stems or bamboo pieces.
3. One bundle of 5 (four lines with a fifth line across them) and 2 more lines. That is 1 bundle of 5.
4. The ladybug, the beetle and the bee are insects. The spider has eight legs and the pill bug has fourteen, so they are not insects.
5. A bee carries pollen from flower to flower so fruit and seeds can grow. A ladybug eats aphids, tiny bugs that hurt garden plants.

UNIT 6 REVIEW

This is an oral review. Read each question aloud and let your child answer by telling, pointing, counting, acting or showing. Have the egg carton insect, the paper monarch and the bug hotel tally chart nearby. Give full points for a clear answer in your child's own words. The review is worth 20 points.

1. (3 pts) On your egg carton insect, point to the head, the thorax and the abdomen. Where do the six legs grow?
2. (3 pts) Is a spider an insect? Tell why or why not.
3. (3 pts) Where do many monarch butterflies go in the fall? What do their caterpillars eat?
4. (2 pts) How did little tags help Fred Urquhart find where the monarchs go?
5. (3 pts) Show me the waggle dance. What does a long waggle run tell the other bees? What does wagging straight up the comb mean?
6. (2 pts) How did Karl von Frisch keep track of one bee among all the others?
7. (2 pts) What three things does a habitat give an animal? Which of them does a bug hotel give?
8. (2 pts) Read your bug hotel tally chart to me. How many guests were insects?

UNIT PROJECT: MY INSECT FIELD GUIDE

Make a small field guide by folding and stapling sheets of paper. Make one page for each lesson: a big insect with its head, thorax, abdomen, six legs and antennae labeled; a monarch with a map arrow pointing south to Mexico and a milkweed plant; a honeybee beside a drawing of the waggle dance; and your bug hotel with its tally chart. On the cover, draw your favorite insect. Then set out the field guide with your egg carton insect and tagged paper monarch, and give your family a short tour, counting the legs on each insect and telling one true story from the unit.

- **Accuracy:** Each insect has six legs on the thorax, three body parts and two antennae, and the monarch, bee and bug hotel pages show the right facts.
- **Observation:** Drawings and the tally chart show real details the child saw in the yard, at the bug hotel or in pictures.
- **Telling:** On the tour the child tells one of the true stories (Hooke, Urquhart, von Frisch or Fabre) in their own words.
- **Care:** The guide is neat and colorful, the models are complete, and the bug hotel guests were watched gently and left in peace.

Answer key

1. The child points to each part in order. All six legs grow from the thorax, the middle part.
2. No. A spider has eight legs and two body parts. An insect has six legs and three body parts.
3. They fly south to the fir forests on the mountains of Mexico. Monarch caterpillars eat only milkweed.

4. Volunteers put numbered tags on monarchs' wings. Urquhart found a tagged monarch from Minnesota on a tree in the mountains of Mexico, so he knew they flew all the way there.
5. The child walks straight while wiggling, then loops back and does it again. A long waggle run means the flowers are far away. Straight up the comb means "fly toward the sun."
6. He put a tiny dot of paint on her back.
7. Food, water and shelter. A bug hotel gives shelter.
8. The child reads each tally correctly and adds only the guests with six legs. (In the lesson example: 3 ladybugs + 5 beetles + 2 bees = 10 insects; the 6 pill bugs are not insects.)

DINOSAUR KINDS

God made the beasts of the earth “after his kind” (Genesis 1:25), and some of the most amazing beasts were the dinosaurs. In this unit you will learn to sort dinosaurs the way real scientists do. You will find out that one hip bone splits them into two big groups, the lizard-hipped and the bird-hipped. Then you will meet two kinds of bird-hipped plant-eaters: the armored dinosaurs, with bony plates and tail clubs, and the horned dinosaurs, with horns, frills and beaks.

You will meet Harry Seeley, who sorted dinosaurs by their hips; Barnum Brown, who named *Ankylosaurus*; O. C. Marsh, who once mistook *Triceratops* horns for bison horns; and Benjamin Waterhouse Hawkins, who held a dinner party inside a dinosaur model. You will build paper hips, a clay armored dinosaur and a three-horned mask. Last of all you will walk the length of a real *Triceratops* and make a model of it to scale.

BEFORE YOU BEGIN

- Can count to 50 and add small numbers
- Can measure with a ruler in inches, with help
- Knows that reptiles have scales and lay eggs (Unit 3)
- Can sort objects into two groups by one feature

MASTERY CHECKLIST

- I can tell how Harry Seeley sorted dinosaurs by their hip bones.
- I can sort dinosaurs into lizard-hipped and bird-hipped.
- I can describe how armor and a tail club helped *Ankylosaurus*.
- I can name the horns, frill and beak of *Triceratops*.
- I can explain what a scale model is and make one where 1 inch stands for 1 foot.

OPTIONAL BOOKS AND RESOURCES

- **Smithsonian National Museum of Natural History** (<https://naturalhistory.si.edu/>): Free. Browse the museum’s dinosaur and fossil pages and photos of real skeletons, including *Triceratops* and *Stegosaurus*. A parent can preview and choose what to show.
- **Yale Peabody Museum** (<https://peabody.yale.edu/>): Free to browse online. The museum holds many of the fossils collected for O. C. Marsh (Lessons 7.1 and 7.3). A good trip if you live near New Haven, Connecticut.
- **Dinosaur National Monument (National Park Service)** (<https://www.nps.gov/dino/>): Free. Photos and kid pages about a famous wall of dinosaur bones still in the rock on the Utah and Colorado border. A parent can preview, since park signs use museum words for time.

7.1 LIZARD-HIPPED AND BIRD-HIPPED ★

OBJECTIVES

- Tell how Harry Seeley sorted dinosaurs into two big groups by looking at their hip bones.
- Point to the pubis bone in a hip drawing and say whether a dinosaur is lizard-hipped or bird-hipped.
- Sort a set of dinosaur pictures or toys into the two hip groups and count each group.

Warm-up. Stand up and put your hands on your hips. Press gently and feel the hard bones under your skin. Now walk, march and kick one leg forward. Your hip bones join your legs to your backbone, and they move every time you walk. If you have a toy dinosaur, turn it over and find where its back legs join its body. That is its hip!

Video. Coming soon. Dinosaur hip bones explained for kids, lizard-hipped (saurischian) and bird-hipped (ornithischian) dinosaurs; search Smithsonian National Museum of Natural History, American Museum of Natural History, SciShow Kids, Homeschool Pop (Alternate), and museum fossil-hall tours showing real skeletons.

KEY TERMS

hip bones

The strong bones that join the back legs to the backbone. You have them, and so did every dinosaur.

lizard-hipped

A dinosaur whose front hip bone, the pubis, points forward toward the head, like a lizard's.

bird-hipped

A dinosaur whose pubis bone points backward toward the tail, like a bird's.

classify

To sort things into groups by what they have in common.

CORE IDEAS

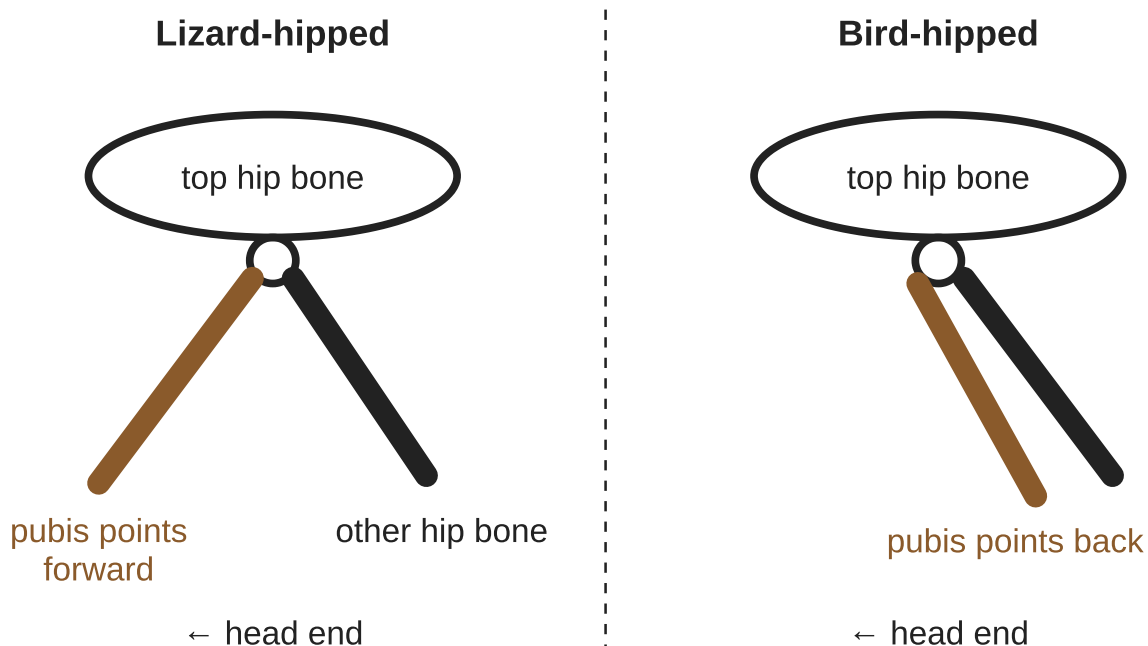
The story. Put your hands on your hips. Under your skin are strong hip bones. They join your legs to your backbone. In 1887, in London, an English scientist named Harry Seeley looked closely at the hip bones of many dinosaur skeletons. He noticed something. The hips were not all the same! They came in two different shapes. So Seeley sorted all the dinosaurs into two big groups. Scientists still use his two groups today.

How they figured it out. Each side of a dinosaur's hip has three bones. One of them is called the **pubis** (say PYOO-bis). Seeley looked at which way the pubis pointed. In some dinosaurs it pointed forward, toward the head, like the hip of a lizard. He called them **lizard-hipped**. In other dinosaurs it pointed backward, toward the tail, like the hip of a bird. He

called them **bird-hipped**. Look at the drawing. Find the brown bone in each hip. Which way does it point?

The big idea. The lizard-hipped group has the big meat-eaters, like *Tyrannosaurus rex*. It also has the giant long-necked plant-eaters, like *Brachiosaurus*. Nearly all the bird-hipped dinosaurs ate plants. They include *Stegosaurus* with its back plates, *Triceratops* with its horns, and the duck-billed dinosaurs. Here is a funny thing: bird-hipped dinosaurs were not birds! The name only tells the shape of one bone. Sorting living things by a body part you can see and measure is called **classifying**. It is real scientist work.

God's handiwork. The Bible says God made the beasts of the earth "after his kind." Each kind has its own shape, down to its bones. When we sort dinosaurs into groups, we notice the order God built into His creatures. Today you will make two paper hips and sort dinosaurs into two boxes, just like Harry Seeley.



Find the brown bone, the pubis. Forward means lizard-hipped. Backward means bird-hipped.

Thinking About Time

What the sign says. Museum signs say dinosaurs lived long, long ago, before any people. They use museum words like Jurassic and Cretaceous for those times.

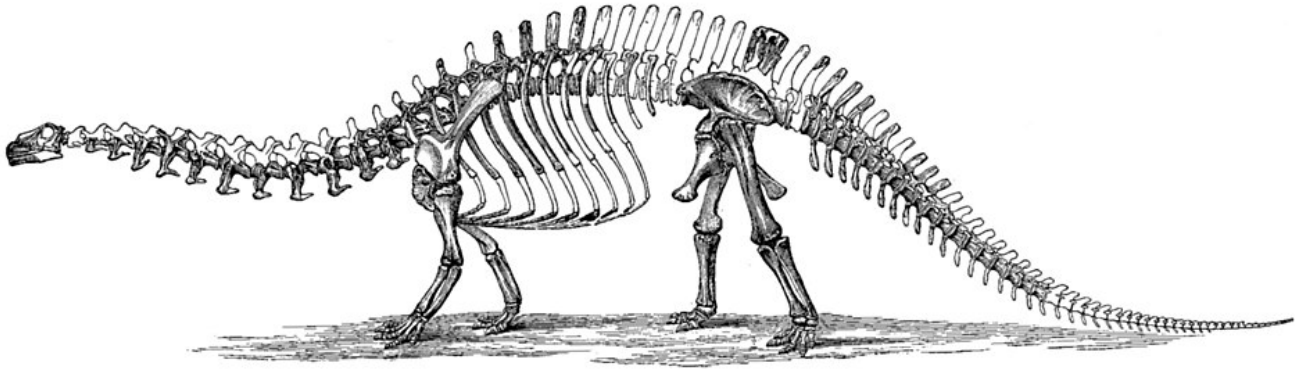
What we observe. We find dinosaur bones inside rock layers. We can see, touch and measure the bones, but no one wrote down when the animals lived.

How Christians read it. Many Christians believe God made the land animals on the sixth day, the same day He made Adam. They believe many dinosaurs were buried in mud during Noah's Flood.

Try it. Find the word Jurassic or Cretaceous in a dinosaur book and read it out loud.

Genesis 1:24-31

PICTURE STUDY



Restoration of Brontosaurus, Othniel Charles Marsh, 1896 (first version 1883) · Printed scientific drawing ·
Printed in *The Dinosaurs of North America*, a U.S. Geological Survey report, 1896

O. C. Marsh was a fossil scientist at Yale College in New Haven, Connecticut. His teams dug up dinosaur bones in the American West. In 1883 he printed a drawing of a whole *Brontosaurus* skeleton. It was the first full skeleton drawing ever made of a long-necked dinosaur. This picture is his later, corrected version, printed in 1896. *Brontosaurus* was lizard-hipped.

Marsh did not have every bone, so a few parts were guesses. The small head is one of them. Later scientists found skulls that showed the real head was a different shape. Good scientists keep looking and fix their drawings.

Look closely

- Find the long neck and the long tail. Which looks longer to you?
- Find the hip, right above the back legs. Can you see a bone that points down and forward, toward the front legs? That is the pubis.
- Count the legs. Are they thin like a bird's legs or thick like tree trunks?
- Find the tiny head. How big is it next to the body?

Talk about it

1. Is this dinosaur lizard-hipped or bird-hipped? How can you tell?
2. Why do you think Marsh had to guess about some parts?
3. If you could ask Marsh one question about his drawing, what would you ask?

MAKE AND DO: PAPER HIPS AND THE TWO SORTING BOXES

You will build two paper dinosaur hips, one of each kind. Then you will be a scientist like Harry Seeley and sort dinosaurs into two groups.

You will need

- Two paper plates
- Card stock or a cereal box, cut into six strips about as long as your finger
- A brown crayon or marker
- Glue stick or tape
- Two shoeboxes or two bowls, labeled “Lizard hip” and “Bird hip”
- Toy dinosaurs, or picture cards your parent draws or cuts from a magazine: *Tyrannosaurus rex*, *Brachiosaurus*, *Allosaurus*, *Stegosaurus*, *Triceratops*, *Ankylosaurus*, a duck-billed dinosaur

Steps

1. Color two of the strips brown. These are the pubis bones.
2. On each plate, draw a big oval near the top. This is the top hip bone. Draw an arrow on the plate that says “head this way” pointing left.
3. On the first plate, glue a plain strip pointing down and back (to the right). Glue a brown strip pointing down and forward (to the left, toward the head). Write “Lizard hip.”
4. On the second plate, glue both a plain strip and a brown strip pointing down and back (to the right), side by side. Write “Bird hip.”
5. Set each plate beside its box. Now pick up one dinosaur at a time. Your parent tells you which way its pubis pointed (use the answer list in the tips). Put it in the right box.
6. Count the dinosaurs in each box. Which box has more?

Tips

- Answer list for the parent: lizard-hipped are *Tyrannosaurus rex*, *Brachiosaurus* and *Allosaurus*; bird-hipped are *Stegosaurus*, *Triceratops*, *Ankylosaurus* and the duck-billed dinosaurs.
- A quick clue: the big meat-eaters and the long-necked giants are lizard-hipped. Horns, plates, armor and duck bills mean bird-hipped.

Check your work

- I can point to the pubis on both paper hips.
- I can say which way it points for each group.
- I sorted my dinosaurs and counted each group.

NATURE NOTEBOOK

1. Draw your own hips as a stick figure and color the hip bones. Label them “my hip bones.”
2. Draw the two dinosaur hips from the lesson. Color the pubis brown in each and draw an arrow showing which way it points.
3. Draw one lizard-hipped dinosaur and one bird-hipped dinosaur. Write their names under them.

From history. The word “dinosaur” was made up by the English scientist Richard Owen in 1842. It means “terrible lizard.” Owen made the name for just three animals known at the time: *Megalosaurus*, *Iguanodon* and *Hylaeosaurus*. Using Seeley’s groups, *Megalosaurus* was lizard-hipped, and the other two were bird-hipped.

WORKED EXAMPLES

Example 1. Here is a picture chart. Row 1, lizard-hipped: *T. rex*, *Brachiosaurus*, *Allosaurus*. Row 2, bird-hipped: *Triceratops*, *Stegosaurus*, *Ankylosaurus*, a duck-billed dinosaur. How many are in each row? Which row has more, and how many more? How many dinosaurs in all?

1. Point and count Row 1: one, two, three. There are 3 lizard-hipped dinosaurs.
2. Point and count Row 2: one, two, three, four. There are 4 bird-hipped dinosaurs.
3. Compare: 4 is bigger than 3. Line them up one by one, and the bird-hipped row has 1 left over.
4. Add them together: $3 + 4 = 7$.

Answer: 3 lizard-hipped and 4 bird-hipped. The bird-hipped row has 1 more. There are 7 dinosaurs in all.

PRACTICE

1. **EASY** Put your hands on your hips. What do your hip bones join together?
2. **EASY** Look at the hip drawing. Point to the pubis on the lizard hip. Which way does it point?
3. **MEDIUM** Sort these four into two groups: *Triceratops*, *Brachiosaurus*, *Stegosaurus*, *T. rex*.
4. **MEDIUM** A museum shelf has 6 lizard-hipped dinosaur toys and 9 bird-hipped dinosaur toys. Which group has more? How many toys are on the shelf in all?
5. **HARD** Tell in your own words how Harry Seeley sorted the dinosaurs. Was a bird-hipped dinosaur a bird?

COMMON MISTAKES

- Thinking bird-hipped dinosaurs were birds. The name only tells which way one hip bone pointed.
- Thinking dinosaurs were just big lizards. A lizard's legs stick out to the sides, but a dinosaur's legs stood straight under its body.
- Thinking every big animal from long ago was a dinosaur. The flying pterosaurs and the swimming plesiosaurs were not dinosaurs.

Make it a game · Hip Hop Sort. Your parent calls out a dinosaur name. If it is lizard-hipped, hop one big hop forward, because its pubis pointed forward. If it is bird-hipped, hop one hop backward, because its pubis pointed back. Get it right and you score a point. Try to reach the far wall!

Scripture. “And God made the beast of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind: and God saw that it was good.” (Genesis 1:25, KJV)

God made each creature after its kind. When we sort animals into groups, we are seeing the order He put into His good world.

Practice answers

1. They join the legs to the backbone (the body).
2. Forward, toward the head.
3. Lizard-hipped: *Brachiosaurus* and *T. rex*. Bird-hipped: *Triceratops* and *Stegosaurus*.
4. The bird-hipped group has more (3 more). There are $6 + 9 = 15$ toys in all.
5. He looked at the hip bones and saw which way the pubis pointed. Forward meant lizard-hipped and backward meant bird-hipped. No, bird-hipped dinosaurs were not birds; the name only tells the shape of one bone.

7.2 ARMORED DINOSAURS

OBJECTIVES

- Describe how armored dinosaurs like *Ankylosaurus* were protected by bony plates and a tail club.
- Compare dinosaur armor with the armor of animals today, such as the armadillo and the turtle.
- Make a model armored dinosaur and test whether armor protects.

Warm-up. Knock gently on a walnut shell, a hard-boiled egg or the back of a spoon. Then press gently on a soft sponge or a slice of bread. Which one is hard like armor? Which one would get hurt more if something bumped it? Now feel your own fingernails and your kneecap. Hard parts help protect soft parts.

Video. Coming soon. Armored dinosaurs for kids, *Ankylosaurus* tail club and *Stegosaurus* plates, and the well-preserved armored nodosaur at the Royal Tyrrell Museum; search Smithsonian, American Museum of Natural History, Royal Tyrrell Museum, SciShow Kids, Homeschool Pop (Alternate), and nature footage of armadillos.

KEY TERMS

armor

A hard covering that protects a soft body, like a knight's metal suit or a turtle's shell.

bony plates

Flat pieces of bone that grew in the skin of armored dinosaurs, fitting together like tiles.

tail club

A big knob of bone at the end of an *Ankylosaurus* tail that it could swing like a hammer.

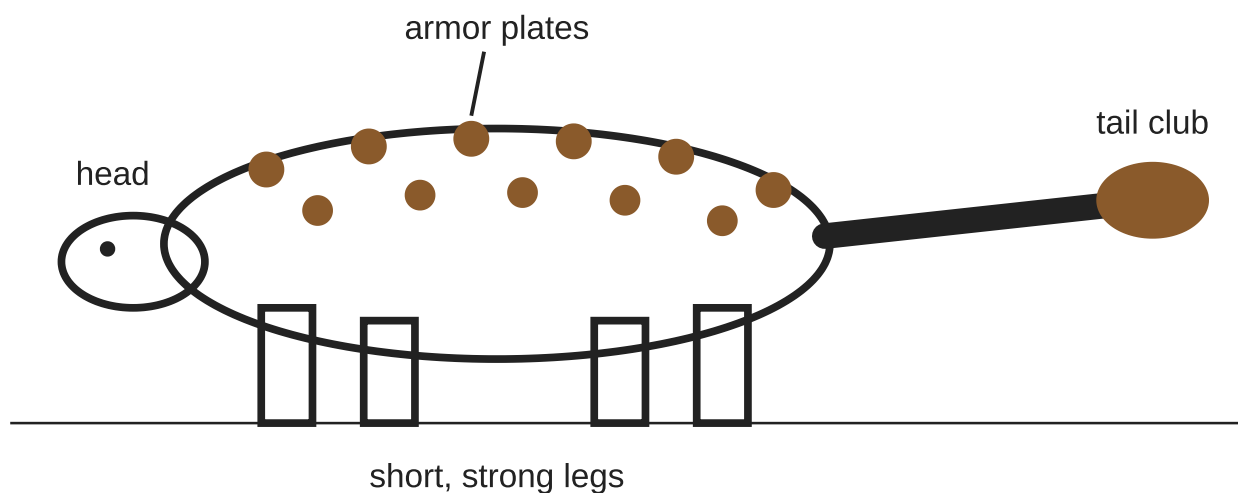
CORE IDEAS

The story. In 1908, a famous fossil hunter named Barnum Brown gave a name to a strange dinosaur. His team had dug up its bones in Montana. Its back was covered with thick bony plates, like a knight's armor. Brown named it *Ankylosaurus* (say an-KY-lo-SAWR-us). The name means "fused lizard," because so many of its bones were joined tight together.

How they figured it out. The bony plates were not part of the skeleton. They grew inside the skin, side by side like tiles on a floor. Fossil hunters found them lying in rows over the back. In Canada, workers once found an armored dinosaur so well kept in the rock that its armor was still in place, and it looks almost like a statue! At the end of the *Ankylosaurus* tail was a big round club of bone. The tail bones just in front of the club were locked stiff, like the handle of a hammer.

The big idea. Armored dinosaurs were low, wide plant-eaters with short, strong legs. They could not run fast. Their armor helped keep them safe from big meat-eaters. *Stegosaurus* was a cousin with a different kind of armor. It had two rows of tall plates along its back and four sharp spikes on its tail. Scientists still wonder what the plates were for. Maybe they were for showing off. All these armored dinosaurs were bird-hipped.

In the world today. God still makes animals with armor. The armadillo has bands of bony armor. The turtle carries a shell. The crocodile has bony plates in the skin of its back. Each one fits the life God gave it. Today you will build an armored dinosaur and test its armor yourself.



Ankylosaurus: armor plates on its back and a club on its tail.

Thinking About Time

What the sign says. Museum signs say armored dinosaurs lived long, long ago and slowly turned to stone over a very long time.

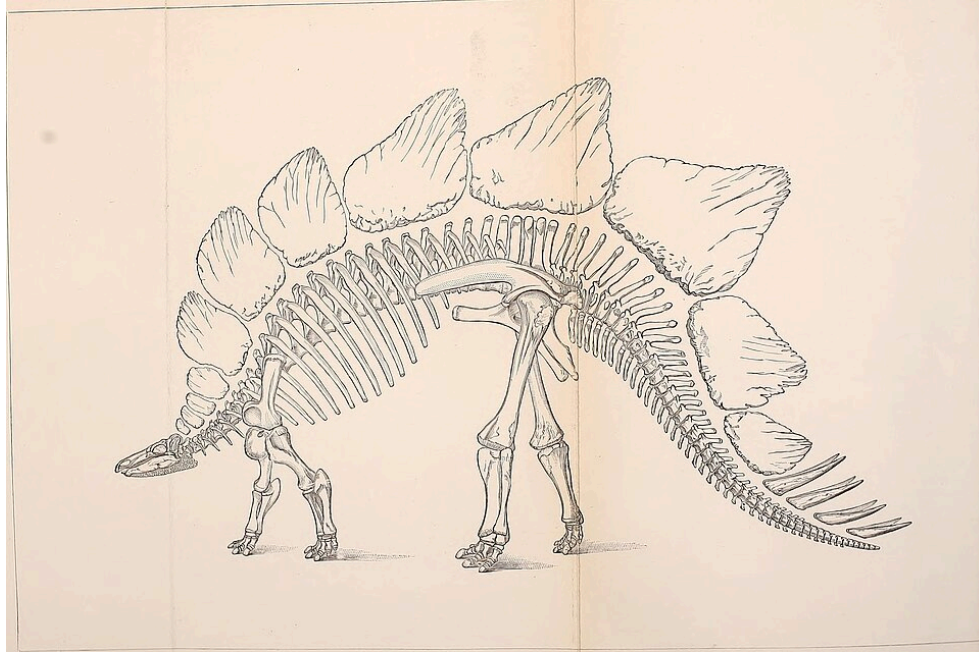
What we observe. Some armored dinosaurs are found with their armor still in place, and some even show the shape of their skin.

How Christians read it. Many Christians think these animals were buried fast under lots of mud, like the mud of Noah's Flood, so they did not fall apart.

Try it. Press a toy into soft clay, then lift it out. A quick burial keeps a clear shape!

Genesis 7:19

PICTURE STUDY



Restoration of Stegosaurus, Othniel Charles Marsh, 1891 · Printed scientific drawing · Printed in the *Geological Magazine*, London, 1891

O. C. Marsh named *Stegosaurus* in 1877. The name means “roof lizard,” because at first he thought its big flat plates lay down over its back like the tiles on a roof. In 1891 he printed this drawing of its whole skeleton, with the plates standing up along its back.

Marsh drew only one row of plates and more tail spikes than most scientists count today. Later finds showed two rows of plates and four tail spikes. Marsh made his best guess from the bones he had, and later scientists fixed the drawing as more bones were found. That is how good science works.

Look closely

- Find the tall plates along the back. How many rows of plates did Marsh draw?
- Find the spikes at the end of the tail. Count them.
- Compare the front legs and the back legs. Which are longer?
- Find the small head. How big is it next to the body?

Talk about it

1. How did plates and spikes help keep *Stegosaurus* safe?
2. Marsh drew one row of plates, but most scientists now think there were two. Why do scientists sometimes change their drawings?
3. Is *Stegosaurus* lizard-hipped or bird-hipped? How do you know?

MAKE AND DO: BUILD AN ARMORED DINOSAUR AND TEST THE ARMOR

First you will make an *Ankylosaurus* out of clay and give it armor. Then you will do a test like a real scientist: does armor protect a soft body?

You will need

- Play dough or modeling clay
- Dry pasta shapes, dry cereal pieces or plastic bottle caps for armor plates
- A small wooden block or a big spoon
- A ruler

Steps

1. Roll a fat oval of clay for the body. Press it a little flat so it is low and wide.
2. Add a small head, four short, thick legs and a long tail. Roll a ball of clay and stick it on the tail tip for the club.
3. Press pasta pieces or cereal into the back in rows, like tiles. That is your armor.
4. Now the test. Make two flat clay pancakes the same size. Leave one plain. Cover the other with bottle caps or pasta. These are two dinosaur backs.
5. Hold the block one ruler high over the plain pancake and drop it. Do the same over the armored pancake, from the same height.
6. Look closely. Which pancake has the deeper dent? Tell your parent what you saw.

Tips

- Drop the block from the same height both times, or the test is not fair.
- The armored pancake should show a smaller dent, because the hard plates spread out the bump.

Check your work

- My *Ankylosaurus* has armor plates, short legs and a tail club.
- I dropped the block the same way on both pancakes.
- I can tell which one the armor protected.

NATURE NOTEBOOK

1. Draw your clay *Ankylosaurus*. Label the armor plates and the tail club.
2. Draw the two test pancakes after the drop. Show how big each dent was.
3. Draw an armored animal of today, like an armadillo or a turtle, beside an armored dinosaur.

From history. One of the very first dinosaurs ever named was an armored one. In 1833 an English doctor named Gideon Mantell named *Hylaeosaurus*, from bones and spines

found in a block of stone from Tilgate Forest in southern England. The name means “forest lizard.”

WORKED EXAMPLES

Example 1. A *Stegosaurus* has 4 spikes on its tail. A museum hall has 3 *Stegosaurus* skeletons. How many tail spikes are there in all?

1. Draw 3 tails. Draw 4 spikes on each tail.
2. Count the first tail: 4.
3. Add the second tail: $4 + 4 = 8$.
4. Add the third tail: $8 + 4 = 12$.

Answer: There are 12 tail spikes in all.

PRACTICE

1. **EASY** What is armor? Name one thing that wears armor.
2. **EASY** Look at the *Ankylosaurus* drawing. Point to the tail club. Point to the armor plates.
3. **MEDIUM** Match each animal to its armor: *Ankylosaurus*, *Stegosaurus*, turtle, armadillo. (a) a shell (b) bony bands (c) plates on the back and spikes on the tail (d) bony plates and a tail club
4. **MEDIUM** Two *Stegosaurus* stand side by side. Each has 4 tail spikes. How many spikes are there?
5. **HARD** *Ankylosaurus* could not run fast. Tell why armor was a good gift for it.

COMMON MISTAKES

- Thinking the armor plates were part of the skeleton. They grew in the skin, like tiles.
- Thinking armored dinosaurs were meat-eaters. They ate plants and used armor to stay safe.
- Thinking *Stegosaurus* had one row of plates. Most scientists now think it had two rows along its back.

Make it a game • Armor Up! One player is a slow, armored *Ankylosaurus* and crawls on hands and knees with a pillow on the back for armor. The other player is a meat-eater who tries to tag the armored dinosaur anywhere except the pillow. The *Ankylosaurus* turns to keep its armor toward the tagger. Count how many tags land in one minute, then switch.

Scripture. “Put on the whole armour of God, that ye may be able to stand against the wiles of the devil.” (Ephesians 6:11, KJV)

God gave *Ankylosaurus* armor for its body. He gives His children a different kind of armor: truth, faith and His Word, to help us stand strong.

Practice answers

1. A hard covering that protects a soft body. Examples: a knight, a turtle, an armadillo, *Ankylosaurus*.
2. The tail club is the brown knob at the end of the tail. The armor plates are the brown bumps along the back.
3. *Ankylosaurus*: (d). *Stegosaurus*: (c). Turtle: (a). Armadillo: (b).
4. $4 + 4 = 8$ spikes.
5. Since it could not run away, its hard plates kept its soft body safe from meat-eaters, and it could swing its tail club to fight back.

7.3 HORNED DINOSAURS

OBJECTIVES

- Name and point to the horns, frill and beak of *Triceratops*.
- Tell how O. C. Marsh first mistook *Triceratops* horns for bison horns, and how more bones fixed the mistake.
- Compare the horns of *Triceratops* with horned animals of today.

Warm-up. Look at a picture of a cow, a goat or a rhinoceros. Count its horns. Now put two fingers up over your eyebrows and one finger on your nose. How many “horns” do you have? You are a three-horned face! Today you will meet a dinosaur with that very name.

Video. Coming soon. Triceratops and horned dinosaurs (ceratopsians) for kids, horns, frill and beak, with real skulls in museum halls; search Smithsonian National Museum of Natural History, Yale Peabody Museum, American Museum of Natural History, SciShow Kids, Homeschool Pop (Alternate), and nature footage of rhinoceroses and bison.

KEY TERMS

horn

A hard, pointed part that grows from an animal’s head.

frill

A wide shield of bone at the back of a horned dinosaur’s head, like a big collar.

beak

A hard, pointed mouth tip with no teeth, good for snipping plants. Birds and turtles have beaks too.

evidence

Clues we can see and measure that help us find out what is true.

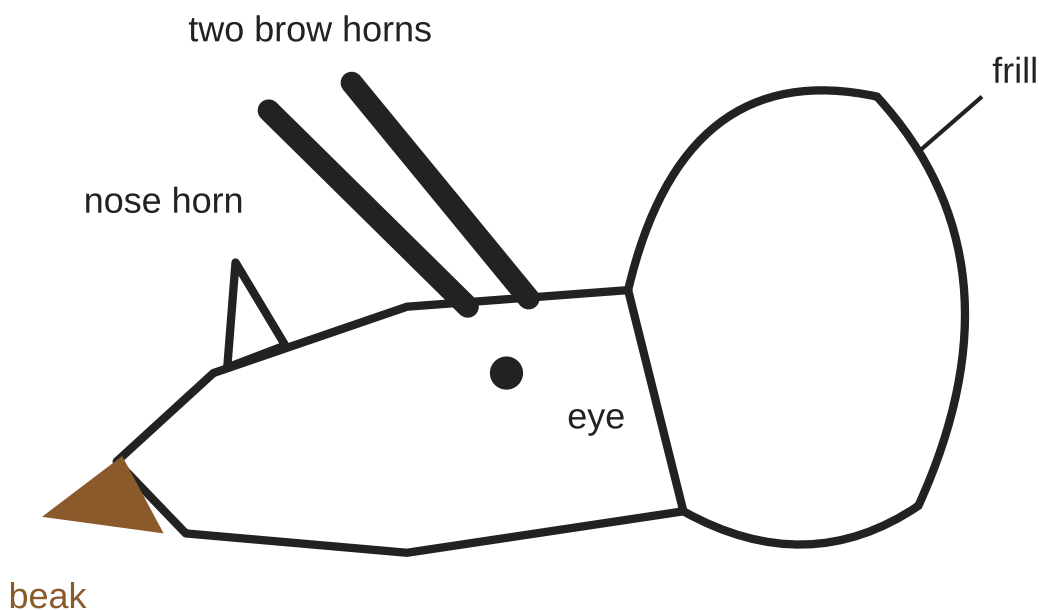
CORE IDEAS

The story. In 1887, near Denver, Colorado, a pair of huge horns was found sticking out of the rock. The horns were sent to O. C. Marsh, the fossil scientist at Yale College. Marsh looked at them carefully. They looked like the horns of a bison, only much bigger. So Marsh said they came from a giant kind of bison! But he had only the horns. He did not have the rest of the head.

How they figured it out. Soon a fossil hunter named John Bell Hatcher dug up whole skulls in Wyoming. Those skulls had the same kind of horns. But they also had a parrot-like beak and a huge shield of bone at the back. That was no bison! In 1889 Marsh gave the animal a new name: *Triceratops* (say try-SAIR-uh-tops). It means “three-horned face.” Marsh changed his mind because he found more **evidence**. Good scientists do that.

The big idea. *Triceratops* had two long horns above its eyes and one short horn on its nose. At the back of its head was a bony **frill**, like a collar. Its mouth ended in a **beak** for snipping tough plants, and rows of teeth in its cheeks chopped them up. Some *Triceratops* skulls are about as long as a grown-up is tall! Its cousins had other shapes. *Styracosaurus* had long spikes all around its frill. *Protoceratops* was small and had no big horns at all. Horned dinosaurs ate plants, and they were all bird-hipped.

In the world today. God still makes animals with horns. The rhinoceros, the bison and the bighorn sheep all have horns. Horns can help an animal guard itself and its young. Today you will make a *Triceratops* mask with a frill and three horns.



A Triceratops head: beak, nose horn, two brow horns and frill. Count the horns: 3.

Thinking About Time

What the sign says. Museum signs say *Triceratops* lived long, long ago, near the end of what they call the Cretaceous.

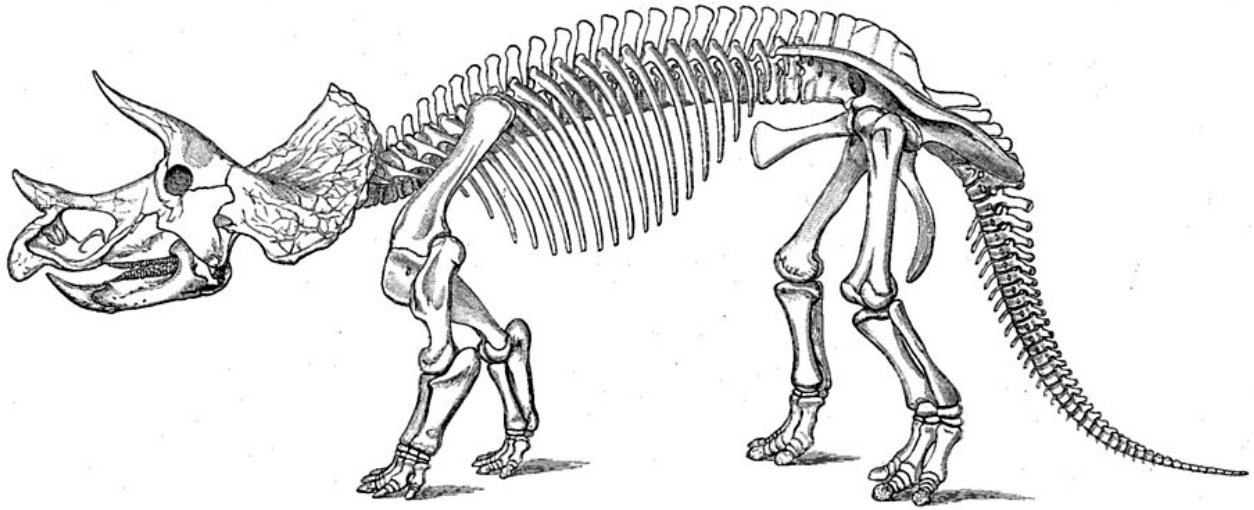
What we observe. We find *Triceratops* skulls and bones in rock in places like Montana, Wyoming and the Dakotas. We can measure them, but they do not come with a date written on them.

How Christians read it. Many Christians believe *Triceratops* was made by God with the other land animals on the sixth day, and was buried later in Noah's Flood.

Try it. Ask: what do we really see in the rock, and what is a guess?

Genesis 1:24

PICTURE STUDY



Restoration of Triceratops, Othniel Charles Marsh, 1896 (first printed in 1891) · Printed scientific drawing · Printed in *The Dinosaurs of North America*, a U.S. Geological Survey report, 1896; first printed in the *American Journal of Science*, 1891

A few years after he named *Triceratops*, O. C. Marsh printed this drawing of its whole skeleton. By then John Bell Hatcher had sent him many bones and skulls. Marsh put the clues together to show what the whole animal looked like inside.

Look at how big the head is next to the body. This was the same scientist who once thought the horns came from a bison. Now, with more evidence, he could draw the real animal.

Look closely

- Find the head. Is it big or small next to the body?
- Find the horns. Count the ones you can see.
- Find the frill at the back of the head. What does it remind you of?
- Count the legs. Does this dinosaur walk on two legs or four?

Talk about it

1. How is this drawing different from the bison Marsh first imagined?
2. Why do you think *Triceratops* needed such strong legs?
3. If you found just one horn in the rock, what would you want to find next?

Safety first. A parent should cut the eye holes in the paper plate. Children use only child-safe scissors.

MAKE AND DO: MAKE A THREE-HORNED FACE MASK

You will make a *Triceratops* mask with a frill, a beak and three horns. Then you can look in a mirror and count your horns.

You will need

- Two paper plates
- Brown or white construction paper
- Child-safe scissors
- Glue stick or tape
- Crayons or markers
- Yarn, string or a craft stick to hold the mask

Steps

1. Your parent cuts two eye holes in the middle of one plate. This is the face.
2. Cut a big half circle from the second plate. Glue it to the top of the face plate so it sticks up behind. This is the frill. Draw a fancy pattern on it.
3. Roll three cones from construction paper. Make two long ones and one short one.
4. Tape the two long horns just above the eye holes. Tape the short horn below the eyes, where your nose will be.
5. Draw a pointed beak at the bottom of the face.
6. Tie on yarn or tape a craft stick so you can hold the mask. Look in a mirror and count your horns out loud.

Tips

- Paper cones hold better if you tape the cut edges on the inside.
- Make the brow horns longer than the nose horn, like a real *Triceratops*.

Check your work

- My mask has two brow horns, one nose horn, a frill and a beak.
- I can point to each part and name it.
- I can tell what *Triceratops* means.

NATURE NOTEBOOK

1. Draw a *Triceratops* head from the side. Label the beak, nose horn, brow horns and frill.
2. Draw Marsh's mix-up: on one side a giant bison with big horns, and on the other side the real *Triceratops*.
3. Draw a horned animal of today, like a rhinoceros or a bighorn sheep, and count its horns.

From history. People today still love *Triceratops*. It is the official state fossil of South Dakota and the official state dinosaur of Wyoming, the state where John Bell Hatcher dug

up the first good skulls.

WORKED EXAMPLES

Example 1. *Triceratops* has 3 horns. An African white rhinoceros has 2 horns. Which has more horns, and how many more? How many horns do they have together?

(Use the map or drawing “Count the *Triceratops* horns: one on the nose and two over the eyes.” shown earlier in this lesson.)

1. Draw 3 little horns in one row for *Triceratops*.
2. Draw 2 little horns in the row below for the rhinoceros.
3. Match them up one to one. *Triceratops* has 1 horn left over, so it has 1 more.
4. Count them all: $3 + 2 = 5$.

Answer: *Triceratops* has 1 more horn. Together they have 5 horns.

PRACTICE

1. **EASY** Look at the drawing. How many horns does *Triceratops* have? Point to each one.
2. **EASY** What is a frill? Point to it on the drawing.
3. **MEDIUM** Four *Triceratops* skulls are in a museum. Each has 3 horns. How many horns are there?
4. **MEDIUM** Sort these animals into “has horns” and “no horns”: rhinoceros, horse, bison, dog, *Triceratops*, cat.
5. **HARD** Why did Marsh first think the horns came from a bison? What helped him find the truth?

COMMON MISTAKES

- Thinking *Triceratops* ate meat because it had horns. It was a plant-eater with a beak for snipping plants.
- Thinking all horned dinosaurs had three horns. *Styracosaurus* had many frill spikes, and *Protoceratops* had no big horns at all.
- Thinking a scientist who changes his mind did a bad job. Changing your mind when you find better evidence is good science.

Make it a game • Horn Count Freeze. Put on your *Triceratops* mask and stomp around the room. When your parent calls out an animal (cow, horse, rhinoceros, *Triceratops*, dog, goat), freeze and hold up that many fingers for its horns. A cow or goat is 2, a horse or dog is 0, *Triceratops* is 3. Score a point for each right answer.

Scripture. “Behold now behemoth, which I made with thee; he eateth grass as an ox.” (Job 40:15, KJV)

God told Job to look at behemoth, a great plant-eating beast He had made. Some people think it was an elephant or a hippo, and some wonder if it was a great creature like a dinosaur. Either way, God made the big plant-eaters, and they show His power.

Practice answers

1. 3 horns: two long horns above the eyes and one short horn on the nose.
2. A wide shield of bone at the back of the head, like a collar.
3. $3 + 3 + 3 + 3 = 12$ horns.
4. Has horns: rhinoceros, bison, *Triceratops*. No horns: horse, dog, cat.
5. He had only the horns, and they looked like giant bison horns. When John Bell Hatcher found whole skulls with the same horns, plus a beak and a frill, Marsh saw it was a dinosaur. More evidence helped him.

7.4 BUILD A DINOSAUR MODEL TO SCALE

OBJECTIVES

- Explain that a scale model is a smaller copy where every part is shrunk the same amount.
- Measure a real dinosaur's length outdoors and make a paper model where 1 inch stands for 1 foot.
- Read a simple bar chart to compare the lengths of a child, a car and two dinosaurs.

Warm-up. Find a toy car and a real car. Use your hands to measure the toy car: how many hands long is it? Now, with a parent, walk beside the real car and count your steps. The toy is a small copy of the real thing. Is every part of the toy smaller, or just some parts?

Video. Coming soon. Crystal Palace dinosaurs of Benjamin Waterhouse Hawkins, and how museums build life-size dinosaur skeletons and scale models; search Smithsonian, Natural History Museum London, American Museum of Natural History, Science Max, SciShow Kids, and kid-friendly videos on measuring with scale.

KEY TERMS

model

A copy of a real thing that helps us see and study it.

scale

The rule for how much smaller a model is, like “1 inch on my model stands for 1 foot on the real dinosaur.”

life-size

Just as big as the real thing.

measure

To find out how long, tall or heavy something is, using a ruler, a tape or your steps.

CORE IDEAS

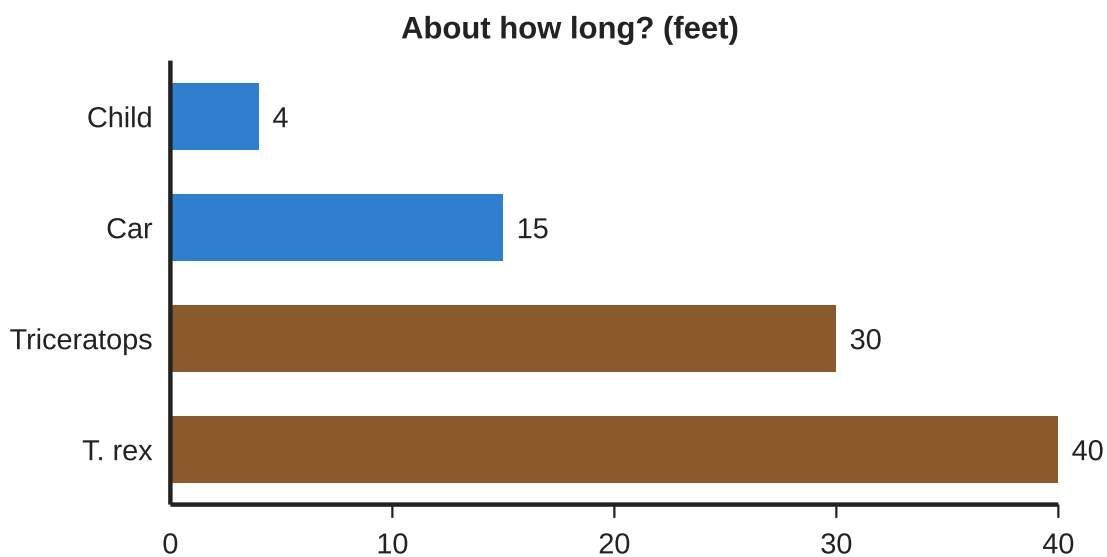
The story. On the last night of the year 1853, about twenty men climbed into a dinosaur and ate dinner! They sat at a long table inside the mold of a huge *Iguanodon* model in Sydenham, near London. The model was built by an artist named Benjamin Waterhouse Hawkins. He made a whole park of life-size dinosaur models with help from the scientist Richard Owen. The models opened to visitors in 1854, and they are still standing there today.

How they figured it out. Hawkins had only a few bones to go on. So he had to guess. He gave *Iguanodon* a spike on its nose like a rhinoceros. Later, people found whole *Iguanodon* skeletons in Belgium. The spike was really on its thumb! Today, model makers start with the

bones. They measure each bone, then make every part smaller by the same amount. That rule is called the **scale**.

The big idea. A **scale model** is a small copy where every part shrinks the same way. Our rule will be: 1 inch on the model stands for 1 foot on the real animal. *Triceratops* was about 30 feet long, so its model is 30 inches long. *Tyrannosaurus rex* was about 40 feet long, about as long as a school bus, so its model is 40 inches. A child about 4 feet tall would be 4 inches. Look at the bar chart to compare them.

Try it and see. First you will go outside and measure 30 feet with a tape measure. You will walk the length of a real *Triceratops*! Then you will make a paper *Triceratops* 30 inches long and a paper you 4 inches tall, and set them side by side. You will see just how big God made this great beast.



About how long? The dinosaur bars are brown. Each line on the bottom is 10 feet.

Thinking About Time

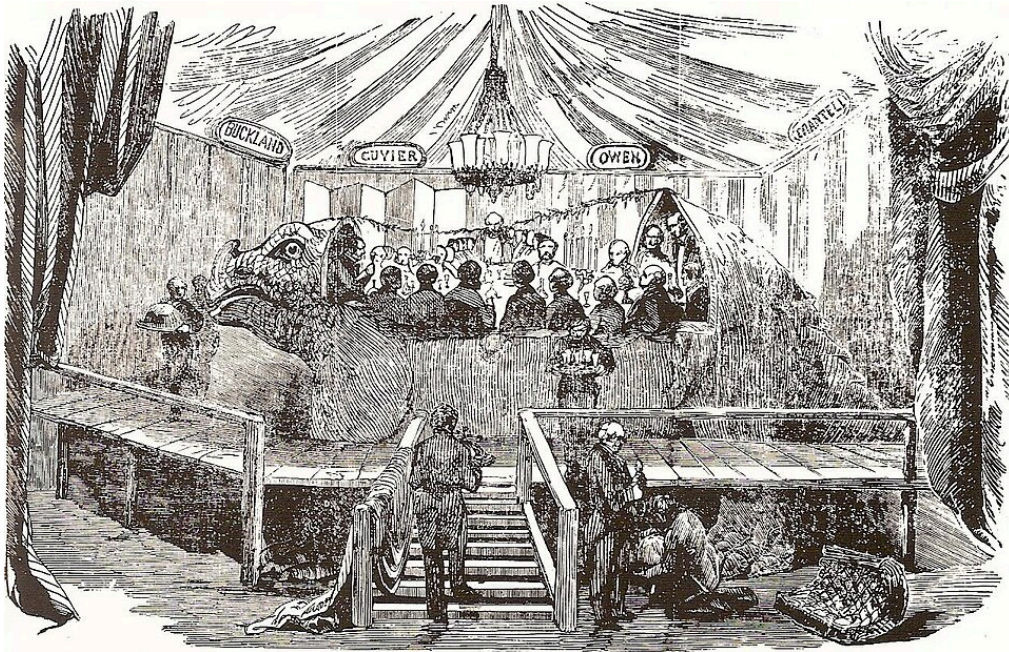
What the sign says. Museum signs say *Iguanodon* and the other dinosaurs lived long, long ago, long before any people.

What we observe. We have the bones. We can measure them and build models from them. But when the bones are missing, a model is partly a guess, like Hawkins' nose spike.

How Christians read it. Many Christians believe dinosaurs were made by God on the sixth day, the same day as Adam, so people and dinosaurs lived on the earth at the same time.

Try it. Point to one part of a dinosaur model and ask: is this from a bone, or is it a guess?

PICTURE STUDY



Dinner in the Iguanodon at the Crystal Palace, Sydenham, Unknown artist for The Illustrated London News, 1854 · Wood engraving printed in a newspaper · The Illustrated London News, January 1854

This picture was printed in a London newspaper a week after the famous dinner. It shows the guests of Benjamin Waterhouse Hawkins eating inside the mold of his *Iguanodon* model. Richard Owen, the man who named the dinosaurs, sat at the head of the table.

Hawkins wanted people to talk about his models, and they did! Thousands of visitors came to see the dinosaurs in the park. The newspaper picture helped people who could not come see how big the models were.

Look closely

- Find the long dinner table. Where is it?
- Count the people you can see. Are there more or fewer than ten?
- Find the shape of the dinosaur model around the table. Can you see its back or its legs?
- Look at the clothes the men wear. How are they different from clothes today?

Talk about it

1. Why would someone want to build a life-size model instead of a small one?
2. How did this picture show people how big the model was?
3. If you could have dinner inside a dinosaur model, which dinosaur would you pick?

Safety first. Measure outdoors in a yard, park or empty driveway, never in a street. A parent helps with scissors.

MAKE AND DO: WALK A TRICERATOPS, THEN MAKE ONE TO SCALE

First you will measure a real *Triceratops* length outside. Then you will make a paper scale model where 1 inch stands for 1 foot.

You will need

- A tape measure at least 30 feet long (or a 10-foot string measured 3 times)
- Sidewalk chalk or two sticks
- A ruler with inches
- A long strip of paper: adding machine tape, a paper grocery bag cut open, or sheets taped end to end
- Crayons, scissors and tape

Steps

1. Outside, put a chalk mark or stick on the ground. With your parent, stretch the tape measure 30 feet and make a second mark. This is how long a *Triceratops* was!
2. Walk from one mark to the other and count your steps. Then lie down at the first mark while your parent marks how tall you are. How many of you would fit?
3. Inside, use the ruler to measure 30 inches on your paper strip. Mark each end.
4. Draw a *Triceratops* from the side between the marks: head and frill at one end, tail at the other. Make it touch both marks.
5. On a scrap, measure 4 inches and draw yourself that tall. (If you are not about 4 feet tall, ask how many feet tall you are and draw yourself that many inches tall.) Cut yourself out.
6. Lay the paper you next to the paper *Triceratops*. You and the dinosaur are shrunk by the same rule, so they compare just like the real ones.

Tips

- Start measuring at the 0 end of the ruler, not at the edge.
- For an extra challenge, make a 40-inch *T. rex* strip too and line all three up.

Check your work

- I measured 30 feet outside and walked it.
- My paper *Triceratops* is 30 inches long.
- I can say our scale rule: 1 inch stands for 1 foot.

NATURE NOTEBOOK

1. Write how many steps it took you to walk the 30-foot *Triceratops*. Draw yourself walking beside it.
2. Draw Hawkins' *Iguanodon* with a spike on its nose. Then draw it again with the spike on its thumb.
3. Copy the bar chart from the lesson and color the dinosaur bars brown.

From history. The Crystal Palace was a giant building of glass and iron. It was rebuilt at Sydenham, and Queen Victoria opened it in June 1854. Hawkins' dinosaurs stood on islands in the lake of the park around it. They were the first life-size dinosaur models in the world, and you can still visit them in Crystal Palace Park in London.

WORKED EXAMPLES

Example 1. Our scale rule is 1 inch for 1 foot. *Triceratops* was about 30 feet long. A child is about 4 feet tall. How long is the model *Triceratops*? How tall is the model child? Which is bigger, and by how many inches?

(Use the map or drawing "Use the bars to compare lengths." shown earlier in this lesson.)

1. Each foot becomes 1 inch. 30 feet becomes 30 inches.
2. 4 feet becomes 4 inches.
3. Compare: 30 is bigger than 4.
4. Count up from 4 to 30: 4 to 10 is 6, and 10 to 30 is 20. $6 + 20 = 26$.

Answer: The model *Triceratops* is 30 inches long. The model child is 4 inches tall. The dinosaur is bigger by 26 inches.

PRACTICE

1. **EASY** Is a toy dinosaur bigger or smaller than the real dinosaur? What is a life-size model?
2. **EASY** Look at the bar chart. Point to the longest bar. Which one is it?
3. **MEDIUM** Our scale is 1 inch for 1 foot. *T. rex* was about 40 feet long. How long is the model?
4. **MEDIUM** Use the bar chart. How many feet longer was *T. rex* than *Triceratops*?
5. **HARD** Hawkins put a spike on the nose of his *Iguanodon*. Where did the spike really go, and how did people find out?

COMMON MISTAKES

- Making only some parts smaller. In a scale model, every part shrinks by the same rule, or the shape comes out wrong.

- Starting to measure from the edge of the ruler instead of the 0 mark.
- Thinking a model in a museum is always exactly right. Models are built from the bones we have, and they get fixed when new bones are found.

Make it a game • Guess and Measure. Your parent names something in the house or yard: a couch, a door, the driveway. You guess how many of your steps (or hands) long it is. Then measure it for real. If your guess is within 2, you score a point. Finish by guessing how many of your steps long a *T. rex* would be!

Scripture. “O LORD, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches.” (Psalm 104:24, KJV)

When you walk the length of a *Triceratops*, you feel how great God’s works are. Measuring His creatures carefully is one way to praise Him.

Practice answers

1. Smaller. A life-size model is just as big as the real thing, like Hawkins’ models.
2. *Tyrannosaurus rex*, about 40 feet.
3. 40 inches.
4. $40 - 30 = 10$ feet longer.
5. On its thumb. People found whole *Iguanodon* skeletons and saw where the spike belonged.

UNIT 7 REVIEW

This is an oral review. The parent reads each question aloud, and the child answers out loud, points or draws. Have the lesson figures and the child's models nearby. The review is worth 20 points.

1. (3 pts) Harry Seeley sorted dinosaurs into two groups. What part of the skeleton did he look at, and what were the two groups called?
2. (3 pts) Is *T. rex* lizard-hipped or bird-hipped? Is *Triceratops*? Was a bird-hipped dinosaur a bird?
3. (3 pts) Name an armored dinosaur. Tell two ways its body helped keep it safe.
4. (2 pts) A *Stegosaurus* has 4 tail spikes. How many spikes do 2 *Stegosaurus* have?
5. (3 pts) Point to and name three parts of a *Triceratops* head. How many horns did it have?
6. (3 pts) Tell the story of Marsh and the horns. Why did he change his mind?
7. (3 pts) What is a scale model? If 1 inch stands for 1 foot, how long is a model of a 30-foot *Triceratops*?

UNIT PROJECT: MY DINOSAUR MUSEUM SHELF

Set up a small dinosaur museum on a shelf or table. Include your paper hips from Lesson 7.1 with two toy or drawn dinosaurs sorted beside them, your clay *Ankylosaurus* from Lesson 7.2, your *Triceratops* mask from Lesson 7.3, and your 30-inch scale *Triceratops* with the paper you from Lesson 7.4. Make a little label card for each one with its name and one fact. Then give your family a museum tour and tell what each thing shows.

- **Sorting:** Dinosaurs are sorted correctly into lizard-hipped and bird-hipped, and the child can point to the pubis on each paper hip.
- **Models:** The armored dinosaur has plates and a tail club; the mask has three horns, a frill and a beak; the scale model is measured correctly at 30 inches.
- **Labels:** Each object has a label card with its name and one true fact, written by the child or dictated to a parent.
- **Tour:** The child tells about each object clearly in their own words, including one story of a real scientist from the unit.

Answer key

1. The hip bones (which way the pubis pointed). Lizard-hipped (pointing forward) and bird-hipped (pointing backward).
2. *T. rex* is lizard-hipped. *Triceratops* is bird-hipped. No, bird-hipped dinosaurs were not birds; the name tells only the shape of one bone.
3. *Ankylosaurus*: bony armor plates in its skin protected its soft body, and it could swing its tail club. (Or *Stegosaurus*: back plates and tail spikes.)
4. $4 + 4 = 8$ spikes.
5. Any three of: brow horns, nose horn, frill, beak (or eye). It had 3 horns.

6. Marsh got a pair of big horns found near Denver and thought they came from a giant bison. When John Bell Hatcher found whole skulls with a beak and a frill, Marsh saw it was a dinosaur and named it *Triceratops*. More evidence changed his mind.
7. A smaller copy where every part is shrunk by the same rule. The model is 30 inches long.

LIFE CYCLES

Every living thing God made has a story that goes around like a circle. It begins, it grows, it makes new young of its own kind, and the story starts again. In this unit children watch four of these **life cycles** up close: a butterfly, a chicken, a frog and a bean plant. They will hold a real egg, sprout a real bean, and build each cycle with their own hands.

Along the way they meet the careful watchers who first drew these stories: Maria Sibylla Merian with her caterpillars, Aristotle with his eggs, August Rösel von Rosenhof with his jars of tadpoles, and George Washington Carver in his bean fields. Each of them looked at the same living thing again and again and drew what changed. That is what your child will do too. By the end, children can compare the cycles and see that some animals change their whole bodies (metamorphosis) while others simply grow, and that every kind always makes young “after his kind” (Genesis 1:25).

BEFORE YOU BEGIN

- Knows that insects have six legs and that frogs are amphibians (Units 4 and 6)
- Can count to 21 and add small numbers such as $7 + 7 + 7$
- Can draw a simple picture and tell about it out loud
- Can use a ruler to measure in centimeters with help

MASTERY CHECKLIST

- I can name the four stages of a butterfly’s life in order.
- I can point to the shell, white, yolk and air space of an egg and tell what each is for.
- I can tell how a tadpole changes into a frog, and which legs grow first.
- I can tell what a seed needs to sprout and name the stages of a bean plant.
- I can tell which life cycles have a big change (metamorphosis) and which do not.
- I can explain why we call it a life *cycle*.

OPTIONAL BOOKS AND RESOURCES

- **Biodiversity Heritage Library** (<https://www.biodiversitylibrary.org/>): Free. Search for Maria Sibylla Merian or Rösel von Rosenhof to page through scans of their real books of caterpillars, butterflies and frogs (Lessons 8.1 and 8.3). A parent can choose plates to look at together.
- **Monarch Watch** (<https://monarchwatch.org/>): Free information and photos on raising monarch caterpillars at home, including what milkweed to grow (Lesson 8.1).
- **Library of Congress** (<https://www.loc.gov/>): Free. Search “George Washington Carver Tuskegee” to see Frances Benjamin Johnston’s photographs of Carver and his school (Lesson 8.4).

8.1 THE BUTTERFLY'S LIFE CYCLE ★

OBJECTIVES

- Name the four stages of a butterfly's life in order: egg, caterpillar, chrysalis, butterfly.
- Tell how Maria Sibylla Merian watched and painted caterpillars to learn where butterflies come from.
- Explain that a life cycle goes around like a circle, because a butterfly lays eggs that start it again.

Warm-up. Go outside (or open a window) and pick one leaf from a bush or garden plant. Turn it over and look closely. Do you see tiny dots, little holes or chewed edges? Who might have been eating it? Now guess: what do you think a baby butterfly looks like? Does it look like its mother?

Video. Coming soon. Butterfly life cycle for children: egg, caterpillar, chrysalis and a butterfly coming out, time-lapse of a monarch or painted lady; search SciShow Kids, Smithsonian, Homeschool Pop (Alternate), Moody Science classics and nature time-lapse footage.

KEY TERMS

life cycle

The stages a living thing goes through as it begins, grows, and makes new young that start the circle again.

caterpillar (larva)

The baby stage of a butterfly. It hatches from an egg, eats leaves and grows and grows.

chrysalis (pupa)

The hard case a caterpillar makes around itself. Inside, its body changes into a butterfly.

metamorphosis

A big change in body shape as an animal grows up, like a caterpillar becoming a butterfly.

CORE IDEAS

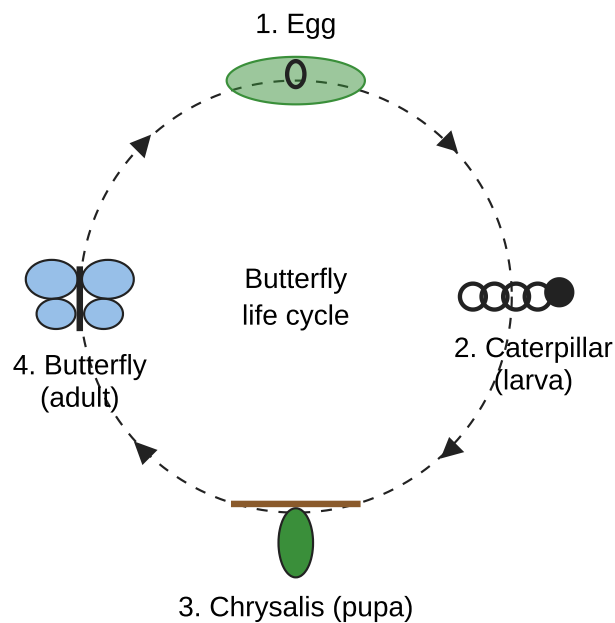
The story. Long ago in the city of Frankfurt, Germany, a girl named Maria Sibylla Merian kept silkworm caterpillars in boxes. She fed them fresh leaves and watched them every day. She saw each one spin a case, rest inside it, and come out as a moth. In those days many grown-ups thought little bugs just popped out of mud or rotten food. Maria knew better. She had watched it happen with her own eyes. In 1679 she printed a book of her drawings about how caterpillars change.

How they figured it out. Merian did not guess. She raised caterpillars, fed each one the plant it liked best, and painted every stage on that plant. In 1699 she sailed across the ocean to Suriname, in South America, with her daughter Dorothea to find new caterpillars. Her big

book of Suriname insects came out in 1705. On one page she would show the caterpillar, the chrysalis and the grown butterfly or moth together. Watching, drawing and writing down what you see is what real scientists do.

The big idea. A butterfly has a four-stage **life cycle**. (1) A mother butterfly lays a tiny **egg** on a leaf. (2) A **caterpillar** hatches and eats and eats. It grows so fast that it splits its skin and crawls out of it several times. (3) Then it hangs very still and makes a **chrysalis**. Inside, its body is being changed. (4) A **butterfly** comes out, pumps up its wet wings, lets them dry and flies away. Later it lays eggs, and the circle starts again. This great change in shape is called **metamorphosis**.

God's handiwork. A caterpillar and a butterfly look like two different animals, but they are the same animal at different times. A monarch egg always makes a monarch, never a moth or a beetle. Living things make young "after their kind" (Genesis 1:25). Each kind of caterpillar even has its own food plant. A monarch caterpillar eats milkweed leaves. God planned every stage before the first egg was ever laid.



The butterfly's life cycle goes around like a circle: egg, caterpillar, chrysalis, butterfly, and back to egg.

PICTURE STUDY



A plate from Metamorphosis of the Insects of Suriname, Maria Sibylla Merian, 1705 · Hand-colored engraving made from her watercolor paintings · Printed in Amsterdam; copies are kept in many great libraries and natural history museums

Maria Sibylla Merian painted from life. She sat with live caterpillars and the plants they ate, and she painted them all together. Then engravers copied her paintings onto copper plates so the pictures could be printed, and the prints were colored by hand.

Most of her pages tell a whole life story on one plant. If you look carefully, you can follow the insect from the leaf it ate to the wings it flew away with.

Look closely

- Find the caterpillar. What is it doing? Is it on a leaf?
- Find the chrysalis or cocoon. Is it hanging, or lying on something?
- Find the grown butterfly or moth. What colors are its wings?
- Look at the plant. Why do you think Merian painted the insect on this plant and not on a plain white page?

Talk about it

1. Can you tell the life story in this picture, starting with the caterpillar?
2. Merian watched her caterpillars every day. Why does watching many times help a scientist?
3. If you could paint one living thing as it grows, what would you choose?

Safety first. Do not touch fuzzy or spiny caterpillars; some can sting or make skin itch. Look at caterpillars and butterflies gently and never rub a butterfly's wings. Wash hands

after handling leaves or insects. Little children should not put rice or pasta in their mouths, noses or ears.

MAKE AND DO: PASTA LIFE CYCLE PLATE

You will build the whole butterfly life cycle on a paper plate using things from the kitchen. When you are done, you can turn the plate and tell the story around the circle.

You will need

- One paper plate
- A green crayon or marker and a pencil
- A few grains of rice (eggs)
- One spiral pasta, such as rotini (caterpillar)
- One shell pasta (chrysalis)
- One bow-tie pasta (butterfly)
- White glue
- Optional: a butterfly-raising kit or a caterpillar found on a garden plant, kept in a jar with air holes and its own food leaves

Steps

1. Draw a cross on the plate to split it into four parts, like slices of a pie.
2. Draw an arrow around the edge of the plate, going from part to part, so the story goes in a circle.
3. In part 1, draw a green leaf and glue on a few grains of rice. Write “egg.”
4. In part 2, draw a leaf with bites out of it and glue on the spiral pasta. Write “caterpillar.”
5. In part 3, draw a twig and glue the shell pasta hanging from it. Write “chrysalis.”
6. In part 4, glue the bow-tie pasta and color it with bright wings. Write “butterfly.”
7. Turn the plate slowly and tell the story out loud: “The egg hatches into a caterpillar. The caterpillar makes a chrysalis. A butterfly comes out. The butterfly lays eggs.”
8. If you have live caterpillars, look at them each day and draw what you see. Let the grown butterflies go outside on a warm day.

Tips

- Let the glue dry flat before you hold the plate up.
- If you raise a real caterpillar, give it fresh leaves from the same kind of plant you found it on, and do not shake the chrysalis.

Check your work

- I can name the four stages in order.
- I can tell what happens inside the chrysalis.
- I can explain why the arrow goes all the way around.

NATURE NOTEBOOK

1. Draw a caterpillar on its leaf, like Merian did. Add chewed edges to the leaf.
2. Draw a butterfly and count its legs. Write the number beside it. (An insect has six.)
3. Draw the four stages in a circle with arrows, and label each one.

From history. In 1668, in Amsterdam, a Dutch scientist named Jan Swammerdam showed a visiting prince from Italy something amazing. Using tiny tools, he carefully opened a big caterpillar that was almost ready to change, and inside he found the beginnings of wings, folded up small. The butterfly's parts were already being prepared inside the caterpillar. Swammerdam, like Merian, believed that studying even the smallest creature shows the wisdom of God.

WORKED EXAMPLES

Example 1. Look at the life cycle picture. How many stages does a butterfly have? Which stage comes right after the caterpillar?

(Use the map or drawing "Count the stages by following the arrows." shown earlier in this lesson.)

1. Put your finger on the egg at the top and count: egg is 1.
2. Follow the arrow to the caterpillar: 2.
3. Follow the next arrow to the chrysalis: 3.
4. Follow the next arrow to the butterfly: 4. The next arrow takes you back to the egg, so there are no more new stages.
5. Go back to the caterpillar and follow its arrow. It points to the chrysalis.

Answer: A butterfly has 4 stages. The chrysalis comes right after the caterpillar.

PRACTICE

1. **EASY** Point to the egg in the life cycle picture. What comes out of a butterfly egg?
2. **EASY** Put these in order: butterfly, egg, chrysalis, caterpillar.
3. **MEDIUM** A monarch caterpillar has 6 pointy legs near its head and 10 stubby legs farther back. How many legs does it have in all?
4. **MEDIUM** Sort the stages. Which stage eats leaves? Which stage flies and sips sweet nectar from flowers? Which two stages do not eat at all?
5. **HARD** Tell in your own words why we call it a life *cycle* and not a life *line*.

COMMON MISTAKES

- Thinking a caterpillar and a butterfly are two different animals. They are the same animal at two stages of its life.

- Thinking a butterfly keeps growing bigger. A grown butterfly does not grow; all the growing happens while it is a caterpillar.
- Thinking insects come from mud or rotten food. Every insect hatches from an egg laid by a mother of its own kind.

Make it a game · Life Cycle Freeze. The parent calls out a stage and the child acts it out: curl up tiny and still for an egg, crawl and munch for a caterpillar, stand wrapped in your own arms for a chrysalis, and flap your arms for a butterfly. Then the parent says “Next!” and the child must act out the stage that comes after. Mix up the order to keep it tricky. After butterfly, “Next!” means curl up as an egg again.

Scripture. “Therefore if any man be in Christ, he is a new creature: old things are passed away; behold, all things are become new.” (2 Corinthians 5:17, KJV)

A caterpillar crawls and a butterfly flies. Christians have long seen in this change a little picture of the new life God gives to people who trust in Christ.

Practice answers

1. A tiny caterpillar.
2. Egg, caterpillar, chrysalis, butterfly.
3. $6 + 10 = 16$ legs. (When it becomes a butterfly, it has only the 6 legs that every insect has.)
4. The caterpillar eats leaves. The butterfly flies and sips nectar. The egg and the chrysalis do not eat.
5. A cycle goes around like a circle. The butterfly lays eggs, and each egg starts the same stages over again, so the story never just stops at the end.

8.2 THE CHICKEN'S LIFE CYCLE

OBJECTIVES

- Name the stages of a chicken's life cycle: egg, chick growing inside the egg, chick, and grown hen or rooster.
- Find the parts of an egg (shell, white, yolk and air space) and tell how each one helps a growing chick.
- Count the days a hen sits on her eggs before they hatch: about three weeks, or 21 days.

Warm-up. Hold a raw egg gently in your hand over a folded towel. Is it heavy or light? Smooth or bumpy? Find the big round end and the narrower end. Now think: if a baby bird grew inside this closed box, how would it get food, water and air?

Video. Coming soon. Chick hatching from an egg and egg candling for children, chicken life cycle; search SciShow Kids, Homeschool Pop (Alternate), Smithsonian, university poultry extension videos, and farm nature footage of a hen with chicks.

KEY TERMS

shell

The hard outside of an egg. It keeps the chick safe, and tiny holes in it let air in.

yolk

The round yellow part of an egg. It is food for a growing chick.

hatch

To break out of an egg.

chick

A baby chicken.

CORE IDEAS

The story. Long, long ago in Greece, before Jesus was born, a teacher named Aristotle wanted to know how a chick grows. He opened eggs that hens had been sitting on for different numbers of days and looked inside. After only a few days of sitting, he saw a tiny red spot in the egg, and it was moving. It was the little chick's heart, already beating!

How they figured it out. Aristotle used a good plan. He compared eggs from early to late, in order, so he could see what changed as the days went by. He wrote it all down. Today farmers can see inside an egg without breaking it. In a dark room they shine a bright light through the shell. This is called *candling*. They can see the shadow of the chick and the thin red lines that carry its blood.

The big idea. A chicken's life cycle goes around in a circle. (1) A hen lays an **egg**. (2) If the hen lives with a rooster and she sits on the egg to keep it warm, a chick begins to grow

inside. The **yolk** is its food. The white gives it water and a soft cushion. Air comes in through tiny holes in the **shell**. (3) After about three weeks, the **chick** pecks its way out. It has a little hard point on the tip of its beak, called an egg tooth, just for this job. Soon after it **hatches**, the egg tooth falls off. (4) The fluffy chick grows feathers and becomes a grown hen or rooster. The hen lays eggs, and the circle goes around again. Eggs from the store are not kept warm, and almost all of them never had a chick started in them, so they will not hatch.

God's handiwork. Think how much God packed into one egg: food, water, air and a strong wall, all in a shape you can hold in one hand. A chick does not need a chrysalis like a butterfly. When it hatches, it already looks like a small bird, and it just grows bigger. A mother hen keeps her chicks warm under her wings. The Bible uses that picture to show how God cares for His people.

PICTURE STUDY



Rooster and Hen with Hydrangeas, Itō Jakuchū, about the 1750s · Hanging scroll, ink and color on silk · Long kept in the Etsuko and Joe Price Collection (Shin'enkan)

Itō Jakuchū was a painter in Kyoto, Japan. The story is told that he kept chickens in his own garden and watched them for a long time before he painted them. He also painted a famous set of thirty scrolls of birds, fish, insects and flowers, and chickens were some of his favorite subjects. This rooster and hen is a separate scroll of his.

Look closely and you will see that he painted each feather one by one, the way a scientist would draw them.

Look closely

- Find the rooster. Look at his tall red comb and his long, curving tail feathers.
- Find the hen. How is she different from the rooster?

- Look at the feathers. Can you find a pattern that repeats?
- Find the flowers. What color are they?

Talk about it

1. Which of these two birds lays eggs?
2. Jakuchū watched his chickens for a long time. What might you notice about a chicken if you watched it for a whole day?
3. Where in your life cycle drawing would these two birds go?

Safety first. Raw eggs can carry germs. Wash hands with soap after touching raw egg, and wipe the table clean. A grown-up does all of the boiling and handles the hot egg. Do not eat the raw egg.

MAKE AND DO: LOOK INSIDE AN EGG

You will open one raw egg and one hard-boiled egg and find every part a chick would use. Then you will draw a labeled egg in your notebook.

You will need

- One raw egg and a clear glass bowl
- One hard-boiled egg, cooled (a grown-up boils it ahead of time)
- A spoon and a paper towel
- A magnifying glass if you have one
- Notebook and crayons

Steps

1. With a grown-up's help, crack the raw egg gently into the clear bowl.
2. Find the yellow yolk. This is the chick's food.
3. Find the clear white around it. This gives the chick water and a soft cushion.
4. Look for two twisty white strings on each side of the yolk. They are like little ropes that hold the yolk in the middle of the egg.
5. Look on top of the yolk for a tiny pale spot. In an egg that a hen keeps warm, this is the place where a chick would begin to grow. Store eggs have only the spot, with no chick started.
6. Look at the inside of the empty shell. Feel the thin, papery skin on it.
7. Now take the cooled hard-boiled egg. Gently peel the big round end. Do you see a flat dent? That was the air space. Just before hatching, the chick pokes its beak into this space and takes its first breath of air.
8. Draw an egg cut in half and label: shell, white, yolk, air space.

Tips

- Crack the egg on the flat table, not the edge of the bowl, so the shell does not fall in.

- Save the raw egg for scrambled eggs at breakfast so nothing is wasted.

Check your work

- I can point to the shell, white, yolk and air space.
- I can tell what the yolk is for.
- I can tell how a chick gets out of its egg.

NATURE NOTEBOOK

1. Draw a mother hen with chicks peeking out from under her wings.
2. Draw an egg cut in half and label the shell, white, yolk and air space.
3. Draw the chicken life cycle in a circle: egg, chick inside the egg, chick, hen. Add arrows.

From history. William Harvey, the English doctor who showed that the heart pumps blood all around the body, also loved to study chicks growing in eggs. He watched them day after day, as Aristotle had done, and in 1651 he wrote a book about how animals begin. At the front of the book is a picture of an egg with the Latin words that mean “everything comes from an egg.”

WORKED EXAMPLES

Example 1. A hen sits on her eggs for 1 week, then another week, then one more week. Each week has 7 days. How many days does she sit before the chicks hatch? Use the calendar picture.

Days a hen sits on her eggs

Week 1	1	2	3	4	5	6	7
Week 2	8	9	10	11	12	13	14
Week 3	15	16	17	18	19	20	21

Day 21: the chicks hatch!

$$7 + 7 + 7 = 21 \text{ days}$$

A hen sits on her eggs for about 21 days, or 3 weeks.

1. Count the boxes in the first row: 7 days. That is week 1.
2. The second row has 7 more days. $7 + 7 = 14$.
3. The third row has 7 more days. $14 + 7 = 21$.
4. Look at the last box. It is day 21, the day the chicks hatch.

Answer: $7 + 7 + 7 = 21$ days, which is 3 weeks.

PRACTICE

1. **EASY** Point to the yolk in your bowl (or in your drawing). What is it for?
2. **EASY** Put these in order: grown hen, egg, chick.
3. **MEDIUM** A hen sits on 12 eggs. 9 of them hatch. How many eggs did not hatch?
4. **MEDIUM** Match each part with its job: shell, yolk, egg tooth. Jobs: helps the chick break out; keeps the chick safe and lets air in; food for the chick.
5. **HARD** A butterfly has a chrysalis stage, but a chicken does not. Tell why in your own words.

COMMON MISTAKES

- Thinking every egg from the store could hatch if you kept it warm. Almost all store eggs never had a chick started in them.
- Thinking the yolk is the baby chick. The yolk is the chick's food; the chick grows from a tiny spot and uses up the yolk as it grows.
- Thinking the mother hen breaks the shell to let her chick out. The chick does the work itself with its egg tooth.

Make it a game · Hen and Chicks. The parent is the hen and holds out both arms like wings. The child is the chick. The parent asks a question from the lesson, such as "What is the yolk for?" or "How many days does a hen sit on her eggs?" A right answer lets the chick run and pick up one paper egg from across the room. When the hen calls "Hawk!" the chick must run back under her wings. Collect five eggs to win, then switch places.

Scripture. "He shall cover thee with his feathers, and under his wings shalt thou trust: his truth shall be thy shield and buckler." (Psalm 91:4, KJV)

When a hawk flies over, a mother hen calls her chicks, and they run under her wings to hide. The Bible uses this picture to show that God keeps His children safe.

Practice answers

1. The yolk is food for the growing chick.
2. Egg, chick, grown hen. (Then the hen lays more eggs.)
3. $12 - 9 = 3$ eggs did not hatch.
4. Shell: keeps the chick safe and lets air in. Yolk: food for the chick. Egg tooth: helps the chick break out.
5. A chick already looks like a little bird when it hatches, with a beak, legs and wings. It only needs to grow bigger and get feathers. A caterpillar looks nothing like a butterfly, so it needs a chrysalis to change its whole body.

8.3 THE FROG'S LIFE CYCLE

OBJECTIVES

- Name and put in order the stages of a frog's life cycle: egg, tadpole, tadpole with legs, froglet, frog.
- Compare the frog's life cycle with the butterfly's and the chicken's.
- Tell how August Rösel von Rosenhof kept frogs and drew every stage of their growth.

Warm-up. Put a spoonful of chia seeds into a clear glass of water and stir. Wait five minutes and look closely. Each little dark seed now wears a clear coat of jelly. Frog eggs look a lot like this: a dark dot inside a ball of clear jelly. Why might jelly be a good wrapper for an egg that sits in a pond?

Video. Coming soon. Frog life cycle for children: frogspawn, tadpoles growing legs, froglet leaving the water, time-lapse; search SciShow Kids, Homeschool Pop (Alternate), Smithsonian, and pond nature footage.

KEY TERMS

frogspawn

A clump of frog eggs inside clear jelly, laid in the water.

tadpole

A baby frog that lives in the water. It swims with its tail and breathes with gills.

gills

Body parts that let an animal breathe under water.

froglet

A young frog with four legs and a short bit of tail left. It is ready to climb out onto land.

CORE IDEAS

The story. In 1758, in the city of Nuremberg, Germany, a painter named August Johann Rösel von Rosenhof finished a whole book about frogs. For years he had kept frogs and frog eggs in tubs and glass jars of water. He watched them every day. He drew the clumps of eggs, the tiny tadpoles, the tadpoles with little legs, and the young frogs. His pictures were so careful and so beautiful that scientists still admire them today.

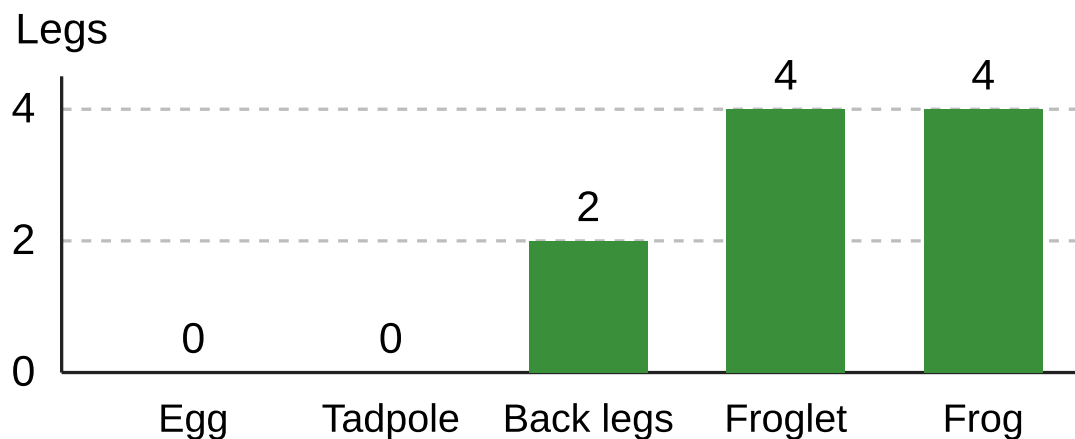
How they figured it out. Rösel did what you can do too. He looked at the same animals many times and drew what he saw each time. When he laid all his drawings side by side, in order, they showed the whole story of how a frog grows. You met tadpoles in the Amphibians unit. Now we will put the frog's whole circle next to the butterfly's and the chicken's.

The big idea. (1) In spring a mother frog lays many eggs in a pond. They float in a clump of clear jelly called **frogspawn**. (Toads usually lay their eggs in long strings instead.) (2) A

tadpole wiggles out. It has a tail and **gills**, lives in the water like a little fish, and nibbles soft green plants. (3) The tadpole grows two back legs first. Then two front legs pop out. Inside, it grows lungs for breathing air. (4) Its tail gets shorter and shorter as its body uses it up. Now it is a **froglet**, and it climbs out onto land. (5) It grows into a frog that breathes air and catches insects. In spring it goes back to the water to lay eggs, and the circle goes around again.

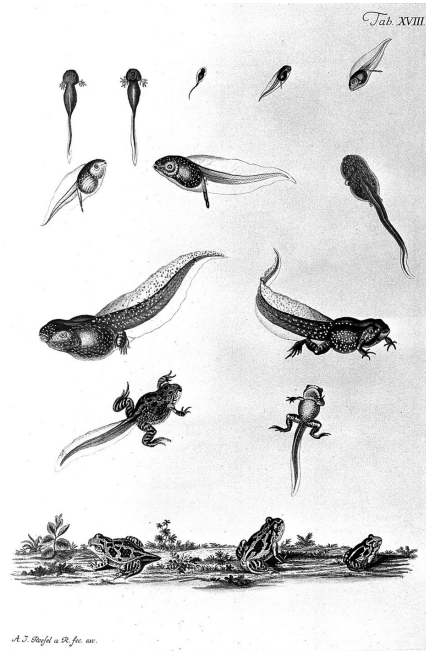
Try it and see. Put the three life cycles side by side. A butterfly changes its whole body, and so does a frog. That big change is metamorphosis. A chicken does not change its shape; a chick already looks like a little bird and just grows. God made each kind with its own way of growing up, and a frog egg always becomes a frog.

How many legs at each stage?



A frog's legs grow in a set order: back legs first, then front legs.

PICTURE STUDY



A plate of the growth of the frog, from Natural History of Our Native Frogs, August Johann Rösel von Rosenhof, 1758 · Hand-colored engraving · Printed in Nuremberg; copies are kept in many natural history libraries

Photo: Wellcome Collection · CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0>) · via Wikimedia Commons

Rösel von Rosenhof was a painter of tiny portraits who loved to study small animals. His frog book has a long Latin title that means “natural history of our native frogs.” Its plates show frogs and toads, and some pages show every step of how a frog grows, from egg to adult.

He drew each stage many times bigger or at true size so readers could see the smallest parts, the way you might look through a magnifying glass.

Look closely

- Find the frog eggs. Can you see the dark dot in each one?
- Find the smallest tadpole and the biggest tadpole. What has changed?
- Find a tadpole with legs. Which legs does it have?
- Find a young frog. Does it still have any tail?

Talk about it

1. Can you point to the stages in order, from egg to frog?
2. Why do you think Rösel drew so many tadpoles instead of just one?
3. How is this picture like Merian’s butterfly pictures?

Safety first. Visit ponds and streams only with a grown-up, and stay back from the edge. Look at frogspawn, tadpoles and frogs where they live, and leave them there unless your parent has checked that it is allowed where you live. A frog’s skin is delicate, so do not

squeeze it. Wash hands with soap after touching pond water, frogs or toads. Do not eat the chia seed model.

MAKE AND DO: CHIA FROGSPAWN AND A LILY PAD LIFE CYCLE

You will make a model of frogspawn in a cup, and then lay out the frog's life cycle on paper lily pads in a pond on the floor.

You will need

- Two spoonfuls of chia seeds and a clear cup of water
- A large sheet of blue paper (or a blue towel) for the pond
- Five paper circles cut from green paper for lily pads
- Crayons or markers

Steps

1. Stir the chia seeds into the cup of water. Wait ten minutes. Each seed is now a dark dot in clear jelly, like frogspawn. Draw what you see.
2. Lay the blue paper on the floor. This is the pond.
3. On the first lily pad, draw a clump of frog eggs.
4. On the second, draw a tadpole with a long tail and no legs.
5. On the third, draw a tadpole with two back legs.
6. On the fourth, draw a froglet with four legs and a short tail.
7. On the fifth, draw a grown frog with no tail.
8. Lay the lily pads in a circle on the pond. Hop your fingers from pad to pad and tell the story out loud. After the frog, hop back to the eggs.

Tips

- Count the legs on each drawing to check: 0, 0, 2, 4, 4.
- Draw the frog's back legs long and bent, because frogs use them for big jumps.

Check your work

- I can name the five stages in order.
- I can tell which legs grow first.
- I can tell what happens to the tadpole's tail.

NATURE NOTEBOOK

1. Draw your chia frogspawn model and label "egg" and "jelly."
2. Draw a tadpole and a frog side by side. Circle the parts that are different.
3. Draw the butterfly, chicken and frog life cycles as three small circles on one page.

From history. The people of ancient Egypt saw the mud along the Nile River fill with wriggling tadpoles every year, more than anyone could count. In their picture writing, called hieroglyphs, the sign of a tadpole stood for a very big number: one hundred thousand.

WORKED EXAMPLES

Example 1. Read the leg chart. How many legs does a tadpole with back legs have? How many does a froglet have? How many more legs does the froglet have?

(Use the map or drawing “Read the top of each bar to find the number of legs.” shown earlier in this lesson.)

1. Find the bar marked “Back legs.” Its top lines up with 2. A tadpole with back legs has 2 legs.
2. Find the bar marked “Froglet.” Its top lines up with 4. A froglet has 4 legs.
3. Subtract to find how many more: $4 - 2 = 2$.

Answer: The tadpole with back legs has 2 legs, the froglet has 4, and the froglet has 2 more legs (its front legs).

PRACTICE

1. **EASY** What do we call a clump of frog eggs in jelly?
2. **EASY** Put these in order: froglet, frogspawn, frog, tadpole.
3. **MEDIUM** Which legs grow first on a tadpole, the back legs or the front legs?
4. **MEDIUM** Three frogs sit on a log. Each frog has 4 legs. How many frog legs are on the log?
5. **HARD** Sort these three into two groups, “big change” and “no big change”: butterfly, chicken, frog. Then tell why.

COMMON MISTAKES

- Thinking tadpoles are fish. A tadpole is a baby frog, an amphibian, even though it lives in water and has gills for a while.
- Thinking the tadpole’s tail falls off. It does not drop off; it shrinks little by little as the body uses it up.
- Thinking a grown frog can breathe under water with gills like a tadpole. A grown frog has lungs and must come up for air, though it can also take in some air through its wet skin.

Make it a game • Lily Pad Hop. Lay the five lily pads from the project on the floor in a big circle, far enough apart to hop between. The child hops from pad to pad and names each stage as they land. Then the parent mixes up the pads, and the child must put them

back in order before hopping again. For a harder round, the parent calls out a stage, and the child jumps to the pad that comes next.

Scripture. “To every thing there is a season, and a time to every purpose under the heaven:” (Ecclesiastes 3:1, KJV)

A frog has a time to be an egg, a time to swim as a tadpole, and a time to hop on land. God set the seasons, and every living thing grows on His timetable.

Practice answers

1. Frogspawn.
2. Frogspawn, tadpole, froglet, frog.
3. The back legs grow first.
4. $4 + 4 + 4 = 12$ legs.
5. Big change: butterfly and frog. No big change: chicken. The caterpillar and the tadpole look very different from the grown animal and must change their whole bodies (metamorphosis). A chick already looks like a small chicken and just grows.

8.4 THE BEAN PLANT'S LIFE CYCLE

OBJECTIVES

- Name the stages of a bean plant's life cycle: seed, sprout, seedling, and grown plant with flowers and pods.
- Tell what a seed needs to sprout: water, air and warmth.
- Tell how George Washington Carver taught farmers to grow beans and peas to make their soil better.

Warm-up. The night before, a parent soaks a few large dry beans (lima beans work best) in water. In the morning, hold one dry bean and one soaked bean. Which is bigger? Gently rub the skin off the soaked bean and open it like a book. Look closely, with a magnifying glass if you have one. Can you find the tiny baby plant tucked inside?

Video. Coming soon. Bean seed germination time-lapse, root and shoot growing, bean plant life cycle for children; search SciShow Kids, Homeschool Pop (Alternate), Science Max, university extension garden videos, and plant time-lapse footage.

KEY TERMS

seed

A little package that holds a baby plant and its food, wrapped in a seed coat.

sprout

To start growing. When a seed sprouts, its first root and shoot push out. (Scientists call this germinating.)

seedling

A young plant with its first leaves.

pod

The long case on a bean plant that holds the new seeds.

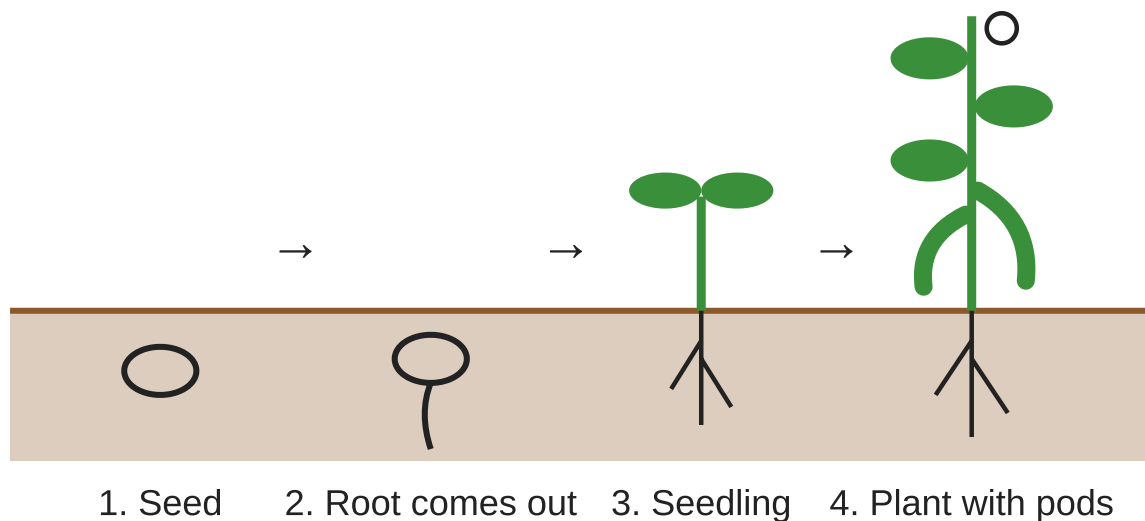
CORE IDEAS

The story. In 1896 George Washington Carver came to Tuskegee Institute in Alabama to teach farming. Many farms near there had grown cotton year after year, and the soil was worn out. Carver told the farmers to plant cowpeas (also called black-eyed peas), peanuts and sweet potatoes. Cowpeas and peanuts belong to the bean family. Their roots help put good food back into the soil, and the family gets beans to eat too! Carver even sent a farm wagon full of lessons and tools out on the country roads to teach families at their own farms.

How they figured it out. Carver loved plants from the time he was a boy in Missouri. Neighbors called him “the plant doctor.” At Tuskegee he grew crops in test fields, watched them closely and wrote down which ones grew best and which ones helped the soil. You can be a plant watcher too, with one bean in a jar.

The big idea. Plants have life cycles too. (1) It starts with a **seed**. When the seed gets water, air and warmth, it swells up and **sprouts**. (2) A root pushes out first and grows down. Then a shoot bends up like a hook and pulls up toward the light. (3) The shoot straightens and opens its first leaves. Now it is a **seedling**, and it needs sunlight to make its own food. (4) The plant grows tall and makes flowers. (5) Each flower can turn into a **pod**, and inside the pod are new seeds. When the pods dry, the seeds can be planted, and the circle starts again. A seed does not need light or even soil to sprout, because it carries its own food inside.

God's handiwork. On the third day of creation, God made plants "yielding seed after his kind" (Genesis 1:12). A bean seed always grows a bean plant, never a sunflower or an oak tree. And a whole plant, with roots, leaves, flowers and new seeds, was packed inside that one small bean you held in your hand.



A bean grows from seed, to root, to seedling, to a plant with pods full of new seeds.

PICTURE STUDY



George Washington Carver in a field at Tuskegee, Frances Benjamin Johnston, 1906 · Black-and-white photograph · Library of Congress, Washington, D.C.

Frances Benjamin Johnston was one of the first well-known women photographers in America. In 1906 she visited Tuskegee Institute and took many pictures of the school, its students and its teachers. One of them shows Professor Carver out in a field, where he liked best to be.

In those days a camera was big and heavy, and the person in the picture had to stand very still. Look at how carefully dressed Carver is, even out among the plants.

Look closely

- Find Carver. Where is he standing?
- Look at the ground and the plants around him. Are they tall or short?
- Look at his hands. What do you think he is doing?
- Look at his clothes. Would you wear those clothes to work in a garden?

Talk about it

1. Why do you think a plant scientist would want his picture taken in a field instead of in a room?
2. Carver helped farmers make worn-out soil good again. How did beans and peas help?
3. If someone took your picture as a scientist, where would you want to stand?

Safety first. Do not eat dry or raw beans; some kinds, like red kidney beans, can make you sick unless they are well cooked. Keep beans away from babies and little children, who could choke on them or push them into a nose or ear. Wash hands after handling soil.

MAKE AND DO: BEAN IN A JAR WINDOW

You will sprout beans against the side of a clear jar so you can watch the root and shoot grow every day, like a little window into the soil.

You will need

- A clear glass jar or clear plastic cup
- Two or three paper towels
- Three or four dry beans (lima, pinto or bush beans)
- Water
- A ruler
- Later: a small pot or cup of potting soil and a sunny window

Steps

1. Fold the paper towels and push them inside the jar so they press against the glass all the way around.
2. Slide the beans between the paper towel and the glass, about halfway down, so you can see them from the outside.
3. Pour a little water into the bottom of the jar so the towel stays damp but the beans are not under water. Beans need air too.
4. Set the jar in a warm place. Check it every day and add a little water if the towel feels dry.
5. Each day, draw what you see. Which comes out first, the root or the shoot?
6. When a root is about as long as your finger, turn the jar on its side for a day. Watch what the root does. (It will bend and grow down again.)
7. Measure the root or the shoot with a ruler every few days and write the number in your notebook.
8. When the seedling has opened its first leaves, plant it gently in a pot of soil by a sunny window. Keep watching for flowers and pods.

Tips

- Use beans from a seed packet or the grocery store; dry beans from the soup aisle usually sprout well.
- If a bean turns soft and smelly, it had too much water. Take it out and try again with less.

Check your work

- I can tell what a seed needs to sprout.
- I can tell which comes out first, the root or the shoot.
- I can name the stages of a bean plant in order.

NATURE NOTEBOOK

1. Draw the inside of your opened bean. Label the baby plant and the seed's food.
2. Draw your bean jar each day for a week. Write the day under each drawing.
3. Draw the whole bean life cycle as a circle: seed, sprout, seedling, plant with flowers, pod with seeds.

From history. Beans have a cousin that made science history: the garden pea. In the monastery garden in Brno, a monk named Gregor Mendel grew thousands of pea plants in the 1850s and 1860s. He counted how many had tall or short stems and smooth or wrinkled seeds, and he found that the plants passed these traits to their young in a regular pattern. You will learn his discoveries when you are older.

WORKED EXAMPLES

Example 1. On Monday you measure your bean's root with a ruler. It is 2 centimeters long. On Friday it is 7 centimeters long. How much did the root grow?

1. Write the Friday length: 7 centimeters.
2. Write the Monday length: 2 centimeters.
3. Subtract the smaller number from the bigger one: $7 - 2 = 5$.
4. Check with your ruler: start at 2 and count up to 7. That is 5 steps: 3, 4, 5, 6, 7.

Answer: The root grew 5 centimeters from Monday to Friday.

PRACTICE

1. **EASY** When a bean sprouts, what comes out first, the root or the shoot? Which way does the root grow?
2. **EASY** Put these in order: plant with pods, seed, seedling, sprouting seed.
3. **MEDIUM** Each bean pod holds 5 seeds. You pick 4 pods. How many seeds do you have?
4. **MEDIUM** Which of these does a bean seed need to sprout? Water, warmth, air, soil, candy.
5. **HARD** Tell in your own words why a bean plant's life is a cycle.

COMMON MISTAKES

- Thinking a seed must be planted in soil to sprout. A seed needs water, air and warmth; it can sprout on a damp paper towel because it carries its own food.
- Thinking plants eat soil for food. Green plants make their own food in their leaves using sunlight, air and water; the soil holds water and gives a few helpful minerals.
- Thinking a seed planted upside down will send its root up. Roots always turn and grow down, and shoots turn and grow up.

Make it a game · Grow, Little Bean. The child curls up small on the floor as a seed. The parent “waters” the seed by wiggling fingers like rain and says “Warm sun!” The child pokes out one foot (the root), then slowly raises arms (the shoot), opens hands (the first leaves), stands tall (the grown plant), makes fists that pop open (flowers), and holds arms out long (pods). Then the parent asks, “What is inside the pod?” The child says “Seeds!” and curls back down to start again. For a harder round, the parent calls the stages out of order.

Scripture. “And God said, Let the earth bring forth grass, the herb yielding seed, and the fruit tree yielding fruit after his kind, whose seed is in itself, upon the earth: and it was so.” (Genesis 1:11, KJV)

God made plants with their seed “in itself.” Every bean pod holds the beginning of the next bean plant, just as God planned.

Practice answers

1. The root comes out first, and it grows down.
2. Seed, sprouting seed, seedling, plant with pods.
3. $5 + 5 + 5 + 5 = 20$ seeds.
4. Water, warmth and air. It does not need soil to sprout (your beans sprouted on a paper towel), and it certainly does not need candy.
5. The bean plant grows from a seed and makes flowers, and the flowers turn into pods full of new seeds. When those seeds are planted, they grow into new bean plants, so the story goes around again like a circle.

UNIT 8 REVIEW

This is an oral review. Ask each question aloud and let your child answer in their own words, pointing to drawings or the project pieces if they like. Give full points for answers that show understanding, even if the words are simple. The review is worth 20 points.

1. (3 pts) Tell me the four stages of a butterfly's life, in order.
2. (3 pts) Who was Maria Sibylla Merian, and how did she learn where butterflies come from?
3. (3 pts) Name two parts of an egg and tell what each one does for the chick.
4. (3 pts) How does a chick get out of its egg? About how long does the hen sit on her eggs first?
5. (3 pts) Tell how a frog grows, from egg to frog. Which legs grow first?
6. (3 pts) What does a bean seed need to sprout? What comes out of the seed first?
7. (2 pts) Which two animals in this unit change their whole bodies as they grow, and which one does not?

UNIT PROJECT: MY BOOK OF LIFE CYCLES

Make a small book with one page for each life cycle in this unit: butterfly, chicken, frog and bean plant. On each page, draw the stages in a circle with arrows and label every stage. Add one real thing you made or kept, such as a photo of your pasta plate, your egg drawing, a chia frogspawn sketch, or a dried bean pod. On the last page, draw the butterfly, frog and chicken side by side and circle the two that go through metamorphosis. Read your book aloud to someone in your family.

- **Stages in order:** Each page shows every stage of the life cycle in the right order, with arrows that go all the way around.
- **Labels:** The stages are labeled with the right words (for example egg, caterpillar, chrysalis, butterfly; seed, seedling, pod).
- **Observation:** The book includes things the child really saw or made: the opened egg, the sprouting bean, the frogspawn model or a live caterpillar.
- **Telling:** The child reads or tells the book aloud and can explain why each story is a cycle and which animals go through metamorphosis.

Answer key

1. Egg, caterpillar (larva), chrysalis (pupa), butterfly (adult). Then the butterfly lays eggs and it starts again.
2. She was an artist and scientist who raised caterpillars, fed them their plants, watched them every day and painted every stage. She saw for herself that butterflies and moths come from caterpillars, not from mud.
3. Any two: the shell keeps the chick safe and lets air in through tiny holes; the yolk is food; the white gives water and a soft cushion; the air space gives the chick its first breath before hatching.

4. The chick pecks its way out using the egg tooth on the tip of its beak. The hen sits for about three weeks, or 21 days.
5. Frogspawn (eggs in jelly), tadpole with a tail and gills, tadpole with legs, froglet with a short tail, grown frog. The back legs grow first.
6. Water, air and warmth. The root comes out first and grows down.
7. The butterfly and the frog change their whole bodies (metamorphosis). The chicken does not; a chick already looks like a small bird and just grows.

BONUS: NATURE LAB

This bonus unit takes everything your child has learned about animal families and carries it outdoors. There are no new big ideas to master here. Instead, your child will practice the habits of a real naturalist: walking slowly, looking closely, drawing what they see, counting, sorting and labeling. Each lesson is short and playful, and most of the work happens outside or on a trip.

Your child will make a nature journal and fill the first page, the way Anna Botsford Comstock taught children to do. They will count the creatures in a hula hoop on the lawn, as Audubon kept track of his phoebes. They will visit a zoo, farm or museum with an explorer card and hear how Charles Willson Peale dug up a mastodon on a New York farm. Last, they will gather a few safe specimens and build an egg carton museum, like Ferrante Imperato's collection room in Naples.

Use these lessons any time of year, in any order, whenever the weather is good or a trip comes up. Keep the journal, the tally charts, the explorer card and the egg carton museum together. They make the unit's capstone, a Nature Lab notebook.

BEFORE YOU BEGIN

- Can count to 100 and add and subtract small numbers
- Knows the animal families from Units 1 to 6: mammals, birds, reptiles, amphibians, fish and insects
- Can use a ruler with a grown-up's help
- Can follow simple safety rules outdoors with a grown-up

MASTERY CHECKLIST

- I can take a slow nature walk and make a journal page with the date, place, weather, a labeled drawing, "I notice" and "I wonder."
- I can count living things with tally marks and read a tally chart.
- I can sort animals I see into their families by what covers their bodies.
- I can collect safe, non-living specimens, leave living things alone, and label each specimen with what, where and when.
- I can tell one story about a real naturalist from this unit.

OPTIONAL BOOKS AND RESOURCES

- **All About Birds, from the Cornell Lab of Ornithology** (<https://www.allaboutbirds.org/>): Free. Look up any bird you see on your walks and surveys, with photos and recordings of its song. Search "Eastern Phoebe" to hear the bird from Lesson 9.2 say its name.

- **Great Backyard Bird Count** (<https://www.birdcount.org/>): Free. Each February, families count the birds they see and share their tallies with bird scientists. A real-world way to use the survey skills from Lesson 9.2.
- **Smithsonian National Museum of Natural History** (<https://naturalhistory.si.edu/>): Free. If you cannot visit a museum in person for Lesson 9.3, explore the museum's online exhibits and virtual tour of its halls together. Preview first and choose the animal and bird halls.

9.1 NATURE JOURNAL WALK

OBJECTIVES

- Take a slow nature walk and use my eyes, ears and nose to notice living things.
- Make a nature journal page with the date, the place, the weather, a drawing and labels.
- Tell one thing I noticed and one thing I wonder.

Warm-up. Put one leaf (or an apple) on the table. Look at it for one whole minute without talking. Then tell your parent three things you saw: a color, a shape and one tiny detail. Did you see more the longer you looked?

Video. Coming soon. Nature journaling for children and drawing leaves, bugs and birds from life; search the Cornell Lab of Ornithology, John Muir Laws nature journaling, SciShow Kids, Homeschool Pop (Alternate) and calm outdoor nature footage.

KEY TERMS

nature journal

A notebook where you draw and write about the living things you see outside.

observe

To look closely and carefully, using your eyes, ears, nose and hands.

label

A word you write next to a drawing to name a part, like “stem” or “wing.”

I wonder

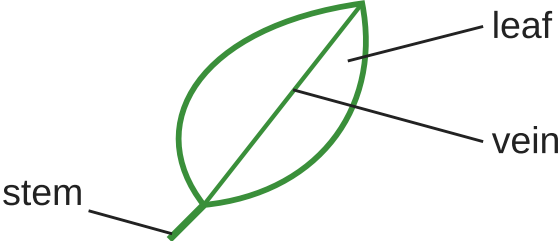
A question you write about something you saw. Scientists begin with questions.

CORE IDEAS

The story. Anna Botsford Comstock lived in New York and taught at Cornell University. She was an artist, too. She drew insects so carefully that you could count the tiny lines on their wings. Anna wanted every child to go outside and look. In 1911 she wrote a big book for parents and teachers called the *Handbook of Nature Study*. It tells how to watch a robin, a toad, a dandelion or a pebble. Her idea was simple: a child does not need a fancy lab. The backyard is the lab, and a notebook is the best tool.

The big idea. A scientist is a careful looker. On a nature walk, go slowly. Stop often. Look up into the trees. Look down at the ground. Look under a leaf. Listen for birds and buzzing. Then pick one thing and draw it. Drawing makes you look harder, because you cannot draw what you did not see. A good journal page has the **date**, the **place** and the **weather** at the top. It has a drawing with **labels**. At the bottom it has two lines: “I notice...” and “I wonder...” Your drawing does not have to be pretty. It has to be true.

God's handiwork. The Bible says the animals and the earth can teach us (Job 12:7-8). When you look closely, you find that God did not make anything sloppy. A tiny ant has a head, a middle and a back part. A leaf has veins like little roads. Every page of your journal is a thank-you note for something God made.

Date: _____	Place: _____
Weather: ☀	
	
I notice ... _____	
I wonder ... _____	

A nature journal page: date, place, weather, a labeled drawing, "I notice" and "I wonder."

PICTURE STUDY



The Great Piece of Turf, Albrecht Dürer, 1503 · Watercolor and gouache on paper · Albertina, Vienna, Austria

Albrecht Dürer was a German artist who lived in the town of Nuremberg. Most painters of his day painted kings and saints. One day Dürer did something new. He looked down at a little clump of weeds and painted it as carefully as if it were a king.

There are no animals or people in this picture. There is just grass, a few wild plants and some dirt. Dürer shows us that the plain things by our feet are worth a long, slow look. That is what a nature journal walk is all about.

Look closely

- Find the dandelion leaves. Their edges are jagged, like teeth.
- Look at the bottom of the picture. Can you see the dark soil and a few roots?
- Count how many tall grass stems you can find with seed heads at the top.
- Is there any sky or tree in the picture? Why do you think Dürer left them out?

Talk about it

1. Why do you think Dürer chose to paint weeds instead of a big beautiful garden?
2. If you made your own “piece of turf” drawing, what plants from your yard would be in it?

Safety first. Walk with a grown-up. Look at wild animals but do not touch or chase them, and stay away from bees and wasp nests. Do not touch or taste wild mushrooms or berries. Learn “leaves of three, let it be” so you stay away from poison ivy. Stay back from deep or fast water. Never look at the sun. Wash your hands when you come home.

MAKE AND DO: MAKE A NATURE JOURNAL AND TAKE IT FOR A WALK

Today you will make your very own nature journal, then take it outside on a slow walk. You will fill your first page like a real naturalist.

You will need

- Four or five sheets of plain paper and one sheet of colored paper or thin cardboard for the cover
- A stapler, or yarn and a hole punch
- A pencil, an eraser and a few colored pencils
- A clipboard or a piece of stiff cardboard to press on
- A small bag to carry everything (optional: a hand lens)

Steps

1. Stack the plain paper on top of the cover paper. Fold them in half like a book.
2. Staple the fold (or punch two holes and tie it with yarn). Write “My Nature Journal” and your name on the cover.
3. On the first page, write the date and the place. Draw a little sun, cloud or raindrop to show the weather.

4. Go outside with your grown-up. Walk slowly. Stop three times and be very still for a short while each time. What do you see? What do you hear?
5. Choose one thing to draw: a leaf, a flower, a bug, a bird or a stone. Draw it big, filling most of the page.
6. Add two or three labels with little lines pointing to the parts.
7. At the bottom, finish two sentences: "I notice..." and "I wonder...." Your parent can write the words while you tell them.

Tips

- Sit down to draw. It is much easier than drawing while standing.
- If a bug walks away, draw what you remember and write "it ran off!" Real scientists do that too.
- Use colored pencils only after the pencil drawing is done.

Check your work

- My page has the date, the place and the weather.
- I drew one living (or once-living) thing large, with at least two labels.
- I wrote or told one "I notice" and one "I wonder."

NATURE NOTEBOOK

1. Draw one leaf from your walk as large as the page. Label the stem and one vein.
2. Draw a "sound map": put an X in the middle for you, then draw a little picture for each sound you heard and where it came from.
3. Look at the sky and draw the clouds you see. Write one word about the weather.

From history. Anna Botsford Comstock drew and made wood engravings of insects for books her husband, John Henry Comstock, wrote about bugs. She became a leader of the "nature study" movement, which brought children outdoors to learn by looking. Her *Handbook of Nature Study* is still printed and used by many homeschool families today.

WORKED EXAMPLES

Example 1. On your walk you find two leaves. You measure them with a ruler. Leaf A is 5 inches long. Leaf B is 3 inches long. Which leaf is longer, and by how much?

1. Lay each leaf on the ruler with the bottom of the leaf at the 0 mark. Read the number at the tip.
2. Leaf A reaches 5. Leaf B reaches 3.
3. 5 is bigger than 3, so Leaf A is longer.
4. Count up from 3 to 5: 4, 5. That is 2 more. (Or $5 - 3 = 2$.)

Answer: Leaf A is longer, by 2 inches.

PRACTICE

1. **EASY** Name three things that go at the top of a nature journal page.
2. **EASY** Close your eyes outside for a little while. Then tell how many different sounds you heard and what made them.
3. **MEDIUM** Point to the leaf drawing in the journal page picture. Which label points to the little line that runs down the middle of the leaf?
(Use the map or drawing “Find the labels on the leaf.” shown earlier in this lesson.)
4. **MEDIUM** Measure a leaf with paper clips laid end to end. Then measure a different leaf. Which one is longer, and how many paper clips longer?
5. **HARD** Tell your parent one “I notice” and one “I wonder” about something you saw on your walk.

COMMON MISTAKES

- Thinking a nature drawing has to be beautiful. It only has to be true and careful.
- Thinking nature is only far away in a big forest. Living things grow in a sidewalk crack and under a backyard rock.
- Walking fast and talking loudly. Animals hide from noise. If you sit still and quiet, many creatures come back out.

Make it a game • Tiny Detail I Spy. Outside, one player picks something small and gives a clue about one tiny detail: “I spy something with a jagged edge” or “I spy something with six legs.” The others look until they find it. The finder gives the next clue. Play until each person has found three things, then draw your favorite one in your journal.

Scripture. “But ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee: Or speak to the earth, and it shall teach thee: and the fishes of the sea shall declare unto thee.” (Job 12:7-8, KJV)

God made the creatures so that, when we look closely, they teach us about Him. A nature walk is a way of “asking the beasts.”

Practice answers

1. The date, the place and the weather.
2. Answers will vary, for example: 4 sounds, a bird singing, the wind, a dog barking and a car.
3. The label “vein.”
4. Answers will vary. Example: the first leaf is 4 paper clips, the second is 6 paper clips, so the second is 2 paper clips longer.
5. Answers will vary. Example: “I notice the ant was carrying a crumb bigger than its head. I wonder where it was taking it.”

9.2 BACKYARD SURVEY

OBJECTIVES

- Count the living things in one small patch of ground and record them with tally marks.
- Read a tally chart to tell which living thing was seen most and which was seen least.
- Sort what I found into groups, such as insects, spiders, birds and worms.

Warm-up. Dump a handful of mixed dry beans, buttons or cereal on the table. Sort them into piles by kind. Now count each pile and make one little line on paper for each one. You just did a survey of your table!

Video. Coming soon. Backyard bug and bird surveys for kids, counting with tally marks and the Great Backyard Bird Count; search the Cornell Lab of Ornithology, Audubon, SciShow Kids, Homeschool Pop (Alternate) and close-up backyard nature footage.

KEY TERMS

survey

Counting and listing the living things in one place.

tally mark

A little line you draw for each thing you count. The fifth line goes across the first four, so you can count by fives.

habitat

The home place where a plant or animal finds food, water and shelter.

CORE IDEAS

The story. When John James Audubon was a young man, he lived on a farm called Mill Grove in Pennsylvania. Near the creek was a little cave. Every spring a pair of small gray birds called phoebes built a mud nest there. Audubon wondered: do the same birds come back each year? So he tied a soft, light silver thread around a leg of each baby bird. The next spring he watched the phoebes near the farm. Some of them still had his threads! The same birds had come home. Audubon found the answer by watching and keeping track.

The big idea. A **survey** is a careful count of what lives in one place. Scientists do not try to count a whole forest. They mark off a small patch and count everything in it. You can lay a hula hoop or a loop of string on the grass. Get down low. Count every ant, beetle, spider, worm and snail inside the loop. Look up for birds, too. Make one **tally mark** for each one. When you get to five, draw the fifth line across the other four. Then you can count your marks by fives. At the end, your tally chart tells you who lives in that little **habitat**.

In the world today. Every February, families all over the world count the birds in their yards for the Great Backyard Bird Count. They send their tallies to bird scientists at the

Cornell Lab of Ornithology and the Audubon Society. Children help, too, and all those counts show scientists where the birds are. Jesus said, “Behold the fowls of the air” (Matthew 6:26). Counting them is one good way to behold them.

Living thing	Tally	Total
Ants		12
Birds		7
Bees		5
Worms		3

A backyard survey tally chart. Each bundle of five marks has a line across it.

PICTURE STUDY



Pewee Flycatcher (Plate 120 of The Birds of America), John James Audubon (engraved by Robert Havell), Printed in The Birds of America, 1827-1838 · Hand-colored engraving and aquatint · Audubon’s original watercolors are kept at the New-York Historical Society; printed copies are in many libraries and museums.

“Pewit Flycatcher” was Audubon’s name for the Eastern Phoebe, the little gray bird he banded with silver thread at Mill Grove. The phoebe says its own name: “fee-bee, fee-bee.” It sits on a low branch, wags its tail, and darts out to snatch flying insects.

Audubon wanted every bird in his great book to be painted life-size, so the small birds look just as big on the page as they would in your hand. He wrote about his phoebes and their threads in the words that go with this picture.

Look closely

- Find the bird’s beak. Is it long and thin, or short and flat? (A flat beak helps catch bugs in the air.)
- What colors are the bird’s back and belly?
- Look at the feet. How is the bird holding on?
- What plant is the bird perched on? Find the leaves and stems.

Talk about it

1. Why do you think Audubon painted birds the same size as they are in real life?
2. Have you ever seen a small gray bird wag its tail on a fence or porch? Where might phoebes like to build nests near your house?

Safety first. Do your survey with a grown-up nearby. Look at bugs but do not grab them; some bees, wasps, ants and spiders can sting or bite. Do not touch birds, nests or eggs. Check for ticks after kneeling in tall grass. Never look at the sun. Wash your hands when you are done.

MAKE AND DO: HULA HOOP SURVEY

You will choose one small patch of your yard (or a park) and count every living creature you can find in it. You will record your count on a tally chart, then do it again on a different day to compare.

You will need

- A hula hoop, or a long string tied into a loop
- Your nature journal and a pencil
- A hand lens if you have one
- A craft stick or twig for gently moving grass

Steps

1. Before you go out, make a tally chart in your journal. Write three column titles: Living thing, Tally, Total.
2. Lay your hoop on the ground. A spot with grass, weeds or leaves will have more to find than bare dirt.
3. Kneel down and look slowly. Gently part the grass with your stick. Look under a leaf.

4. Each time you see a new kind of creature, write its name (or draw it) in the first column. Make a tally mark each time you see one.
5. Stand up and look at the sky and trees for a little while. Tally any birds you see.
6. Count your tally marks by fives and ones. Write the total for each row.
7. Circle the creature you found the most of. Put a star by the one you found the fewest of.
8. Do your survey again in the same spot on another day, or at a different time of day. Did you find the same creatures?

Tips

- Count each creature only once. If the same beetle walks in a circle, it is still one beetle.
- If you do not know a creature's name, draw it and give it a name like "tiny red bug." Look it up later.
- Morning, after a rain, is a great time to find worms and snails.

Check your work

- I made a tally chart with names, tally marks and totals.
- I bundled my tally marks in fives.
- I can tell which creature I found most and which I found least.

NATURE NOTEBOOK

1. Draw your hoop as a big circle and draw where you found each creature inside it.
2. Draw the creature you found the most of. Count its legs and write the number beside it.
3. Draw a bird you saw (or heard) and write where it was: in a tree, on the ground or in the air.

From history. Audubon went on to paint the birds of America life-size. His great book, *The Birds of America*, has 435 large hand-colored plates. Today scientists still put tiny numbered bands on birds' legs, as Audubon did with his threads, to learn where birds travel and when they come home.

WORKED EXAMPLES

Example 1. Look at the tally chart from a backyard survey. Which living thing was seen the most? Which was seen the fewest? How many living things were counted in all?

(Use the map or drawing “Count the bundles of five first, then the ones.” shown earlier in this lesson.)

1. Count each row. Each bundle with a line across it is 5.
2. Ants: $5 + 5 + 2 = 12$. Birds: $5 + 2 = 7$. Bees: 5. Worms: 3.
3. The biggest number is 12, so ants were seen the most. The smallest number is 3, so worms were seen the fewest.
4. Add them up: $12 + 7 = 19$. $19 + 5 = 24$. $24 + 3 = 27$.

Answer: Ants were seen the most (12). Worms were seen the fewest (3). There were 27 living things in all.

PRACTICE

1. **EASY** Your parent draws one bundle of five tally marks and 3 more marks. How many is that?
2. **EASY** Sort these into animal families: ant, robin, bee, sparrow, ladybug. Which are birds? Which are insects?
3. **MEDIUM** On the tally chart, how many more ants than birds were counted?
(Use the map or drawing “Compare the ants row and the birds row.” shown earlier in this lesson.)
4. **MEDIUM** You found a spider in your hoop. Is it an insect? Count its legs to decide.
5. **HARD** Tell how Audubon found out that the same phoebes came back to Mill Grove.

COMMON MISTAKES

- Counting the same creature two or three times as it moves around. Watch carefully and count each one once.
- Thinking a patch of lawn is empty. Many small creatures hide down low, under leaves and in the soil.
- Calling every small crawling thing an insect. Insects have 6 legs. Spiders have 8 legs, and worms have none.

Make it a game • Tally Race. Sit by a window or on the porch for a short time. Each player picks one thing to count: birds, cars, bugs or leaves falling. Every time you see yours, make a tally mark. When time is up, bundle your marks in fives and count. The player with the most marks reads their total out loud and gets to choose the next round's things.

Scripture. “Behold the fowls of the air: for they sow not, neither do they reap, nor gather into barns; yet your heavenly Father feedeth them. Are ye not much better than they?”

(Matthew 6:26, KJV)

Every bird in your backyard is fed by God. When you count them, remember that He knows and cares for each one, and He cares for you even more.

Practice answers

1. 8 ($5 + 3$).
2. Birds: robin and sparrow. Insects: ant, bee and ladybug.
3. 5 more ($12 - 7 = 5$).
4. No. A spider has 8 legs. Insects have 6 legs, so a spider is not an insect.
5. He tied a light silver thread around a leg of each baby bird. The next spring he saw phoebes near the farm still wearing the threads, so he knew the same birds had come back.

9.3 ZOO, FARM OR MUSEUM VISIT

OBJECTIVES

- Visit a zoo, farm or natural history museum and look closely at real animals or skeletons.
- Sort the animals I see into families: mammals, birds, reptiles, amphibians, fish and insects.
- Read one museum sign with my parent and tell what it said.

Warm-up. Gather six toy animals (or animal pictures). Sort them into piles: fur, feathers, scales, and “other.” Tell why each one goes in its pile. You will do the same thing with real animals on your trip.

Video. Coming soon. Virtual tours of a natural history museum, zoo animals and farm animals for kids, and the story of Charles Willson Peale’s mastodon; search the Smithsonian National Museum of Natural History, zoo and farm channels, SciShow Kids, Homeschool Pop (Alternate) and nature footage.

KEY TERMS

zoo

A park where wild animals from many places are cared for so people can see and study them.

museum

A building that keeps and shows real things, like skeletons, shells and stuffed animals, so people can learn from them.

skeleton

All the bones of an animal, fitted together. The skeleton holds the body up.

animal family

A big group of animals with bodies that are alike, such as birds (feathers) or mammals (fur and milk).

CORE IDEAS

The story. In 1801 a painter named Charles Willson Peale heard exciting news. Farmers in New York had found giant bones in a muddy pit on a farm. Peale ran a museum in Philadelphia, and he wanted those bones! He hurried to the farm. The pit kept filling with water, so his helpers built a huge wooden wheel. Men walked inside it to turn it, and the wheel lifted buckets of water out of the pit. Bone by bone, they dug up a giant animal called a **mastodon**. It looked a bit like a big elephant. Back home, Peale and his helpers fitted the bones together into a tall **skeleton**. Where bones were missing, they carved new ones from wood. People lined up to see it in his **museum**.

The big idea. Pictures in books are good, but nothing beats seeing a real animal. At a **zoo** or a farm, look at how each animal moves, eats and covers its body. Is it fur, feathers, dry scales, wet skin or fins? That tells you its **animal family**. At a museum, look at skeletons. Find the skull, the backbone and the ribs. Read the signs with your parent. Some skeletons are real bones. Some are copies called casts. The sign will often tell you which.

God's handiwork. In the garden of Eden, God brought the animals to Adam "to see what he would call them" (Genesis 2:19). Adam looked at each one and gave it a name. When you visit animals and learn their names, you are doing the very first job God gave a man to do.

My Explorer Card

Fur ☐ mammal 	Feathers ☐ bird 	Dry scales ☐ reptile
Wet skin ☐ amphibian 	Fins, gills ☐ fish 	Six legs ☐ insect

An explorer card for your trip. Check a box and draw an animal each time you find one.

Thinking About Time

What the sign says. Museum signs often say mastodons lived a very, very long time ago, in a time they call the Ice Age. "Ice Age" is a museum word.

What we observe. We can see real mastodon bones and teeth. Many were dug out of mud and bogs. The bones do not come with dates written on them.

How Christians read it. Many Christians believe God made the world not so very long ago. They think the Ice Age came after Noah's Flood, and that mastodons lived in those days.

Try it. Find one sign with a museum word on it and read it aloud with your parent.

Genesis 7:11

PICTURE STUDY



The Exhumation of the Mastodon, Charles Willson Peale, 1806–1808 · Oil on canvas · Maryland Center for History and Culture, Baltimore, Maryland

Charles Willson Peale was a painter, an inventor and a museum keeper. After his great dig on the farm in New York, he painted this picture to remember it. “Exhumation” is a long word that means digging something up out of the ground.

Peale put himself in the painting, along with many people from his family. He is holding up a big drawing of one of the mastodon’s bones. Look for the giant wheel that lifted the water out of the pit.

Look closely

- Find the huge wooden wheel. Can you see the buckets that carried water out of the pit?
- Look for the men down in the pit. What are they doing?
- Find the man holding up a large drawing of a bone. That is Peale.
- Look at the sky. What kind of weather is coming?

Talk about it

1. Why did the workers need a big wheel to dig up the bones?
2. If you found a giant bone on your farm, what would you do with it?

Safety first. Stay with your grown-up the whole time. At the zoo, never reach into a cage or over a fence, and do not tap on glass. At a farm, only pet or feed animals when the farmer says yes, and stand away from the back legs of horses and cows. Wash your hands with soap after touching any farm animal. At the museum, look with your eyes and only touch where a sign says you may.

MAKE AND DO: FIELD TRIP EXPLORER CARD

You will make an explorer card to carry on your trip. Each time you find an animal from a new family, you will check its box and draw it.

You will need

- A sheet of cardstock or a paper on a clipboard
- A pencil and a few colored pencils
- A ruler for drawing lines
- A plan with your parent: a zoo, a farm, a petting zoo, a pet store, an aquarium or a natural history museum

Steps

1. Draw lines to make six boxes on your card, three on top and three on the bottom.
2. Write a heading in each box: Fur (mammal), Feathers (bird), Dry scales (reptile), Wet skin (amphibian), Fins and gills (fish), Six legs (insect). Draw a small check box in each corner.
3. On your trip, stop at each animal and ask, "What covers its body?" Find the right box.
4. Check the box and draw a quick sketch of the animal. Write its name if you can.
5. At a museum, find one skeleton. Draw it on the back of your card. Label the skull, the backbone and the ribs.
6. With your parent, read one sign out loud. Tell your parent one thing the sign taught you.
7. At home, count your checked boxes. Did you find all six animal families?

Tips

- Quick drawings are fine. Draw the shape first, then add one or two details like ears, a beak or a tail.
- Bats are mammals, not birds. Whales are mammals, not fish. Look for fur and ask how the babies are fed.
- If you visit a farm, ask the farmer one question about how they care for the animals.

Check your work

- I checked at least four of the six animal family boxes.
- I drew and named at least four animals.
- I can tell my parent one thing I learned from a sign or a farmer.

NATURE NOTEBOOK

1. Draw your favorite animal from the trip. Write which animal family it belongs to and why.
2. Draw an animal skeleton you saw, or the skeleton of a chicken or a fish from a picture. Label the skull and the backbone.

3. Draw Peale's giant wheel lifting buckets of water out of the muddy pit.

From history. Peale's museum in Philadelphia was one of the first museums in America. He set his stuffed birds and animals in front of painted backgrounds, so they looked as if they were at home in the woods or by the water. He also sorted them into groups using the names given by the Swedish scientist Carl Linnaeus, so visitors could learn which animals were alike.

WORKED EXAMPLES

Example 1. At the farm you see 2 chickens and 3 goats. How many legs is that in all?

1. A chicken is a bird. Birds have 2 legs. 2 chickens have $2 + 2 = 4$ legs.
2. A goat is a mammal with 4 legs. 3 goats have $4 + 4 + 4 = 12$ legs.
3. Add them together: $4 + 12 = 16$.

Answer: 16 legs in all.

PRACTICE

1. **EASY** Point to the box on the explorer card where a duck goes. Why?
(Use the map or drawing "Find the right box for a duck." shown earlier in this lesson.)
2. **EASY** Match each animal to its family: cow, snake, goldfish, frog, butterfly.
3. **MEDIUM** In a museum you see a skeleton. Name three bones or parts you could look for.
4. **MEDIUM** At the zoo you count 4 flamingos. How many legs do they have together?
5. **HARD** Tell the story of how Peale got the mastodon bones out of the muddy pit.

COMMON MISTAKES

- Thinking every museum skeleton is made of real bones. Many are casts, which are careful copies. The sign usually tells you.
- Putting a bat with the birds or a whale with the fish. Bats and whales are mammals.
- Thinking the zoo is the only place to see animals up close. A farm, a pet store, a pond or your own yard is full of creatures to study.

Make it a game • Animal Family Charades. One player acts out an animal you saw on your trip without making any words, just moves and sounds. The others guess the animal and then name its family: mammal, bird, reptile, amphibian, fish or insect. Guess the animal for one point and the family for one more point. Take turns until everyone has acted three animals.

Scripture. "And out of the ground the LORD God formed every beast of the field, and every fowl of the air; and brought them unto Adam to see what he would call them: and

whatsoever Adam called every living creature, that was the name thereof.” (Genesis 2:19, KJV)

God gave Adam the job of looking at the animals and naming them. Learning animal names and families is part of that same good work.

Practice answers

1. Feathers (bird). A duck has feathers, so it is a bird.
2. Cow: mammal. Snake: reptile. Goldfish: fish. Frog: amphibian. Butterfly: insect.
3. The skull, the backbone and the ribs (also the leg bones).
4. 8 legs ($2 + 2 + 2 + 2 = 8$). Even when a flamingo stands on one leg, it still has 2!
5. The pit kept filling with water, so his helpers built a huge wooden wheel. Men walked inside it to turn it, and it lifted buckets of water out. Then the workers could dig out the bones, and Peale put them together as a skeleton in his museum.

9.4 SPECIMEN COLLECTION

OBJECTIVES

- Collect a few safe, non-living specimens from nature and leave living creatures where they belong.
- Sort my specimens into groups and label each one with what it is, where I found it and when.
- Make a small nature museum in an egg carton or box.

Warm-up. Empty a junk drawer or a box of toys onto a towel. Sort the things into groups any way you like: by color, by size or by what they are made of. Tell your parent your rule. Collectors sort their things too!

Video. Coming soon. Starting a nature collection for kids: leaves, seeds, shells and rocks, cabinets of curiosities and museum collections; search the Smithsonian National Museum of Natural History, SciShow Kids, Homeschool Pop (Alternate), Science Max and nature footage.

KEY TERMS

specimen

One thing from nature that you keep so you can study it, like a pine cone, a shell or a rock.

collection

A group of specimens kept together and put in order.

sort

To put things into groups that are alike.

label

A small card that tells what a specimen is, where it was found and when.

CORE IDEAS

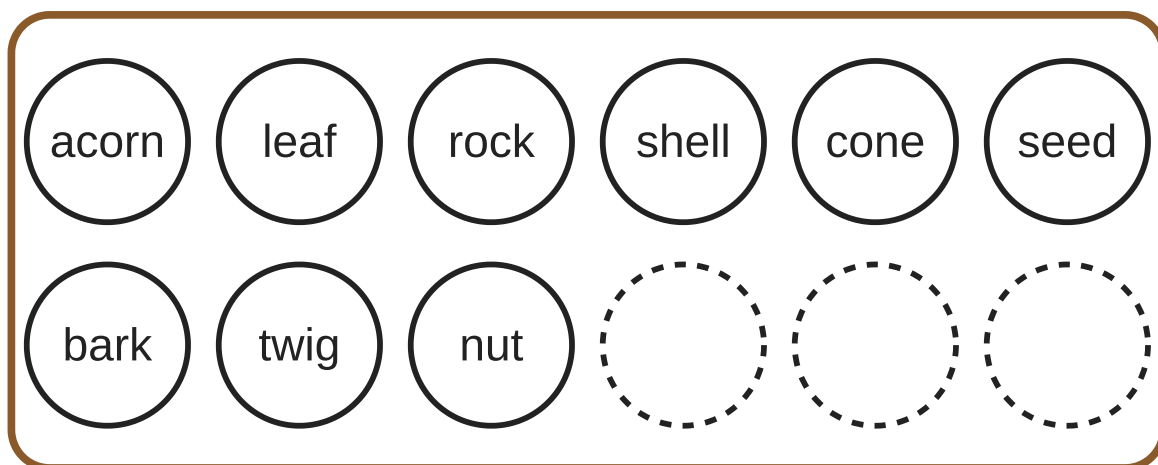
The story. Long ago in the city of Naples, Italy, lived a man named Ferrante Imperato. He made medicines from plants and minerals. He also loved to collect things from nature. He gathered shells, rocks, crystals, dried plants, starfish and even a stuffed crocodile! He filled one big room from floor to ceiling. In 1599 he wrote a book about nature, and it had a picture of his room. Shelves and little drawers line the walls. Fish and sea creatures cover the ceiling, and the crocodile hangs in the middle. Visitors came to look and learn. His room was one of the first natural history museums.

The big idea. A **specimen** is one thing from nature that you keep and study. A good collector takes only things that are not alive and are already on the ground: fallen leaves, acorns, seeds, pine cones, bits of bark, rocks and empty shells. Living creatures stay where God put them. Take just one or two of a kind, and leave the rest. Then **sort** your specimens

into groups, like “from a plant” and “not from a plant.” Last, give each one a **label**: what it is, where you found it and the date. A label turns a pile of stuff into a real scientific **collection**.

God’s handiwork. When you line up your specimens, look at how many different kinds there are. Smooth stones, bumpy acorns, spiky seed pods, curly shells. The psalm says, “O LORD, how manifold are thy works!” (Psalm 104:24). “Manifold” means many and all different. Your little museum is a small picture of that big truth.

My Nature Museum



9 cups full, 3 cups empty

An egg carton nature museum: one specimen in each cup.

PICTURE STUDY



The Museum of Ferrante Imperato, from Dell'Historia Naturale, Unknown engraver, made for Ferrante Imperato's book, 1599 · Engraving · Printed in Naples, Italy; copies of the book are kept in old libraries in many countries.

This picture shows Ferrante Imperato's own collection room in Naples. It was printed in his book about nature in 1599. It is one of the oldest pictures we have of a natural history museum.

Imperato did not just pile things up. He put them in order on shelves and in rows of little drawers, so he and his visitors could find them and study them. That is what you will do with your own collection.

Look closely

- Find the crocodile on the ceiling. What other sea creatures can you find around it?
- Look at the walls. Can you see rows of little drawers and shelves?
- Find the man who is pointing. What do you think he wants the visitors to see?
- Count how many people are in the room. Are they looking up or down?

Talk about it

1. Why do you think Imperato kept his specimens in rows of drawers instead of in one big pile?
2. If you had a whole room for a nature museum, what would you hang on the ceiling?

Safety first. Collect with a grown-up. Never pick or touch wild mushrooms, and never put berries, seeds or plants in your mouth. Learn “leaves of three, let it be” to stay away from poison ivy. Leave living creatures, birds’ nests and eggs alone. In the United States

the law protects the feathers of most wild birds, so draw wild feathers instead of taking them (feathers from farm chickens and ducks are fine). Do not pick up broken glass or sharp metal. Ask before collecting in a park, because many parks do not allow it. Wash your hands when you are done.

MAKE AND DO: EGG CARTON NATURE MUSEUM

You will gather a few safe specimens, sort them, label them and set them out in an egg carton like a tiny museum. Then you will give your family a tour.

You will need

- A clean, empty cardboard egg carton (12 cups)
- A paper bag or small basket for collecting
- Small slips of paper, a pencil and a glue stick or tape
- A hand lens if you have one
- Your nature journal

Steps

1. Go on a collecting walk with your grown-up. Pick up only things that are not alive and are already on the ground, such as leaves, acorns, seeds, pine cones, bark, twigs, rocks and empty shells.
2. Take only one or two of each kind. Leave the rest for the squirrels, the birds and the next person.
3. At home, lay your specimens on a towel. Sort them into two groups: “from a plant” and “not from a plant.”
4. Put one specimen in each cup of the egg carton.
5. Write a tiny label for each cup: what it is, where you found it, and the date. Tape or glue the label inside the lid or beside the cup.
6. Look at three specimens with your hand lens. Draw one in your journal.
7. Write “My Nature Museum” on the lid. Give your family a tour and tell one thing about each specimen.

Tips

- Press leaves flat inside a heavy book for a few days so they do not curl up.
- Shake pine cones and check acorns for little bugs before you bring them inside.
- If you do not know a specimen’s name, write a good describing name like “bumpy gray rock” and look it up later.

Check your work

- Every specimen I kept was not alive and was found on the ground.
- I sorted my specimens into groups and can tell my rule.
- Each specimen has a label with what, where and when.

NATURE NOTEBOOK

1. Draw your egg carton museum from the top. Write the name of the specimen in each cup.
2. Pick your favorite specimen. Draw it large, then draw it again from the other side.
3. Draw a “leave it here” page: something alive you saw but did not take, like a snail, a nest or a flower.

From history. Collections like Imperato’s were sometimes called “cabinets of curiosities.” Over time, some of the biggest collections grew into the great natural history museums we can visit today. Museums still keep drawers full of labeled specimens, and every label tells what the specimen is, where it was found and when, just like yours.

WORKED EXAMPLES

Example 1. An egg carton has 12 cups. You put one specimen in 9 of them. How many cups are still empty?

(Use the map or drawing “Count the full cups, then the empty ones.” shown earlier in this lesson.)

1. Count the cups in the carton: 6 on top and 6 on the bottom. $6 + 6 = 12$.
2. Count the cups with specimens: 9.
3. Take away the full cups: $12 - 9 = 3$. (Or count up from 9: 10, 11, 12. That is 3.)

Answer: 3 cups are still empty.

PRACTICE

1. **EASY** Which of these are good specimens to collect? A fallen acorn, a live caterpillar, an empty snail shell, a bird’s nest with eggs, a smooth rock.
2. **EASY** Sort these into “from a plant” and “not from a plant”: pine cone, rock, leaf, seashell, acorn.
3. **MEDIUM** Name the three things a specimen label should tell.
4. **MEDIUM** You have 2 egg cartons with 12 cups each. You fill 15 cups. How many cups are empty?
5. **HARD** Tell what was hanging on the ceiling of Ferrante Imperato’s museum, and why he kept his specimens on shelves and in drawers.

COMMON MISTAKES

- Taking living creatures home for a collection. Watch them, draw them, and leave them where they live.
- Forgetting labels. A specimen without a label cannot tell anyone where or when it was found.

- Thinking more is better. A good collector takes one or two of a kind and leaves the rest.

Make it a game • Mystery Specimen Bag. One player secretly puts a specimen from the collection into a paper bag. The other player reaches in without looking and feels it. Is it smooth or bumpy? Heavy or light? Hard or soft? They describe what they feel and guess the specimen. A right guess earns a point. Switch places and play until every specimen has been in the bag.

Scripture. “O LORD, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches.” (Psalm 104:24, KJV)

Every acorn, shell and stone in your collection is one of God’s “manifold” works. The earth really is full of His riches, and we only borrow a few to study.

Practice answers

1. The fallen acorn, the empty snail shell and the smooth rock. The caterpillar is alive, and the nest with eggs belongs to the birds, so leave them.
2. From a plant: pine cone, leaf and acorn. Not from a plant: rock and seashell.
3. What it is, where it was found and when it was found (the date).
4. 9 cups. $12 + 12 = 24$ cups in all, and $24 - 15 = 9$.
5. A big stuffed crocodile, with fish and other sea creatures around it. He kept specimens in order on shelves and in drawers so he and his visitors could find them and study them.

UNIT 9 REVIEW

Oral review. Read each question aloud and let your child answer in their own words, point or draw. Give full points for a clear answer with the main idea. The review is worth 20 points.

1. (4 pts) What goes on a nature journal page? Name at least four things.
2. (3 pts) Why does drawing something help you see it better?
3. (3 pts) Your parent draws two bundles of five tally marks and 4 more marks. How many is that?
4. (4 pts) Tell how Audubon found out that the same phoebes came back each spring.
5. (3 pts) Name the animal family for each: a goat, a duck, a turtle.
6. (3 pts) What kinds of things are good specimens to collect, and what should you leave alone? What three things go on a specimen label?

UNIT PROJECT: MY NATURE LAB NOTEBOOK

Gather your nature journal pages, your hula hoop tally charts, your field trip explorer card and a drawing or photo of your egg carton museum into one folder or notebook. Make a cover called “My Nature Lab Notebook” with your name and a drawing of your favorite creature. Then give your family a short tour: show each page and tell one thing you noticed and one thing you still wonder.

- **Careful looking:** Drawings are large and true to life, with labels on the main parts.
- **Records:** Pages have dates and places; tally charts are bundled in fives and totaled correctly; specimens are labeled with what, where and when.
- **Sorting:** Animals and specimens are sorted into sensible groups, and the child can tell the rule for each group.
- **Telling:** The child gives a clear tour, sharing at least one “I notice” and one “I wonder.”

Answer key

1. The date, the place, the weather, a drawing with labels, an “I notice” sentence and an “I wonder” question (any four).
2. You cannot draw what you did not look at, so drawing makes you look slowly and carefully and notice small details.
3. 14 ($5 + 5 + 4$).
4. He tied a light silver thread around a leg of each baby bird. The next spring he saw phoebes near his farm still wearing the threads.
5. Goat: mammal (fur). Duck: bird (feathers). Turtle: reptile (dry scales).
6. Collect only things that are not alive and are already on the ground, like fallen leaves, acorns, pine cones, rocks and empty shells. Leave living creatures, nests, eggs and wild birds’ feathers alone. A label tells what it is, where it was found and when.