Welcome to Science D!

In this program, your students will analyze their fingerprints, find DNA, explore how animals survive, observe electricity, and so much more.

The 36 experiments in this program will introduce your students to Forces and Interactions, Life Systems and Cycles, Weather and Climate, Physics, and Engineering Design. They are designed to teach your students to think like scientists and use real scientific skills and practices.

What do Students Need to Know?

In the past, science instruction focused on teaching students what we already knew about science. However, as technological growth and development exploded in recent years, we realized that simply teaching students what we know now isn't sufficient—it doesn't adequately prepare them for the future. The technology and scientific developments our students will use when they are adults haven't been invented yet. So how do we prepare them for what they will need to know when it is still unknown to us?

Instead of teaching facts and knowledge, our instructional focus needs to shift. In addition to exposure to familiar science topics, such as Physical Science, Life Science, and Earth and Space Science, today's students also need skills, and scientific practices, that will help them find out what they need to know on their own. They need to become innovators and developers and not just passive consumers of scientific knowledge. By the time your students are ready for further education or to enter the workforce, they need to know how to investigate purposefully, build models, ask useful questions, and be able to report their findings so they can share what they learn with others. They should also be able to develop creative solutions to problems, and build and test their designs to determine how well they work. Once tested, they should be able to improve their designs so they can develop an even better solution. The lessons required to arrive at this destination will need to be hands-on, interactive, and student-driven. They may be a little noisy, and hopefully not too messy, but certainly an adventure like no other.

Introduction

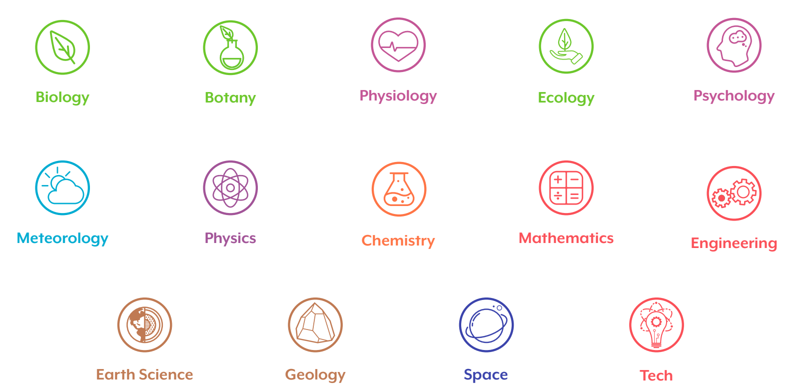
How This Program Works

Through this program, your students will use the Scientific Method to explore their world, not just memorize the steps. Your students will brainstorm solutions to problems, and have space to come up with ways to test them with you. Together, we will begin to prepare them to think for themselves, weigh the claims they encounter around them, and innovate on their own. We will also incorporate key Scientific and Engineering Practices to explore ideas that connect across all subjects, like cause and effect, patterns, structure and function, systems, stability and change, cycles, and more.

In addition to practicing the Scientific Method, you will also begin to teach the process of Engineering Design, in which students investigate a problem they can solve through design. Some lessons will present a challenge or problem which will require your students to design (and build!) a solution, and then they will test their solution's effectiveness in solving the problem. From there, they may also apply what they learned from their tests toward designing an improved solution.

Science D will serve as your roadmap for this year's experiment instruction. We have chosen easy experiments that will fascinate your students and help them begin to develop key scientific skills through exploration. Before you start teaching, take a few minutes to familiarize yourself with this book and the structure of each experiment.

Each lesson begins with an overview of the **Key Concepts**, intended to give you, the instructor, a big-picture view of the goals of the lesson. By the end of the experiment and discussion, your students should have a solid understanding of the lesson's Takeaways (which mirror the Key Concepts), so you know they have mastered the important information. And since each lesson is truly an exploration, your students will often delve into elements of several different scientific disciplines in a single day. You can quickly see which topics you will cover in the icons provided on the Introduction page for each experiment:



Let's Get Started

To help you teach with confidence, we recommend you read through each experiment the night before. You may also use this time to gather the supplies noted on the Materials List under **Additional Items You Will Need**. While you will find some experiment supplies around your home, we have collected a number of materials for your convenience in our **Science Supplies Kit**, listed with a **K** in the Materials List (at the beginning of each experiment). The data charts and templates, listed with a **P**, follow each experiment and are also included in the **Paper Packet**.

We include a complete list of the supplies you will need to provide yourself in the **Appendix**, so you can start collecting those items now so they will be ready when you need them.

A few of the experiments require some early preparation, which we'll warn you about in a **Before You Begin** note at the start of the experiment. Be sure to check the next experiment for this note when you wrap up an experiment so you will be fully prepared to teach the next lesson when you intend to.

When you have gathered the supplies and are ready to teach, head to the experiment's **Introduction** and simply start reading to your students. Our provided instruction helps you pique your students' curiosity about each day's topic, and will challenge them to **Make a Prediction** about what they will experience in the experiment. The **Investigate** section offers step-by-step procedures that walk you through the experiment itself, and includes discussion information to help you explain what's happening along the way. Use the questions under **Draw Conclusions** to bring the concepts and observations together, and close with the thoughts under **Takeaway**.

As you have time, enjoy the information under **See the Bigger Picture** which illustrates how the scientific principles discussed in the lesson apply to the world at large. Also, be sure to check out the **Make Connections** section as you work to add more depth and extend conversation about the experiment's topic. We also include **Tips** to help you know what to expect and complete the investigations with as few bumps as possible. If your students still want more, try out the suggestions under **Go Further** for related activities that will help you extend the exploration.

Plan for your students to take an active role in setting up the experiment and completing the steps (with your help, of course). Give them room

Introduction

to be curious and ask questions. If we don't address something that comes up as you work by the end of the experiment, make a note to help them find the answer later. The more you can support their curiosity and inquisitiveness, the better you will teach them to think like a scientist. And don't forget—they can help you clean up, too!

We can't wait for you to start this grand adventure with your students, helping them to explore their world while learning to think like scientists and design like engineers. Through this journey, you will prepare them to be an active part of a future that we can't even imagine today.

Experiments

1

Do Insects Look the Same at Each Life Cycle Stage?

Key Concepts

A life cycle is made up of four stages: birth, growth, reproduction, and death.

All living things have a life cycle that includes the same four stages, even though each living thing may look very different from one another during each phase.

Reproduction is the process when organisms, like plants and animals, make more new organisms.

Materials

- ¼ cup clay K
- 1 pipe cleaner K
- ping pong ball K
- Week 1 Sheets from Paper Packet P
- scissors
- colored pencils or markers
- ruler

P Indicates the item is in the Experiment Paper Packet

K Indicates the item is in the supply kit.

Introduction

Life cycles describe how plants, animals, insects, and every living thing are born, grow into adults, and continue to make future generations to help each type of organism survive. Cycles are ongoing processes and different stages that are important to guarantee the success of the cycle. The water cycle, for example, is a continuing process of how water is transporting around Earth. Water goes through stages; sometimes, it is in the clouds or is returning to Earth as rain. Sometimes it is even invisible and exists as a gas found in the air. Water may look different during its journey through the water cycle, but some basic facts about water and the water cycle never change. The same ideas are true about life cycles. Life cycles have four stages, and they are continuous, and they are necessary for the survival of living things. The four stages that living things will go through during their life cycles are birth, growth, reproduction, and death. Living things must reproduce or make new organisms, or that particular type of living thing will die out.

Although all living things or organisms have a life cycle, the **stages** can look very different for different organisms. For example, both insects and animals lay eggs to reproduce and give birth to their young, but the eggs themselves may look wildly different in size, texture, and even color. Once the organism hatches, the growth stage can also result in physically different young. Let's look at two types of insects: the butterfly and the dragonfly. Both are winged insects that lay eggs. Butterflies lay eggs on plant leaves, in contrast to dragonflies that lay their eggs on water's surface. The larvae for both insects then move to the growth stage of the life cycle.

Make a Prediction

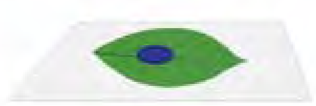
Butterflies and Dragonflies are insects that look similar when they become adults. Do you think they will look the same while going through their life cycles?

1

Investigate

Model the Life Cycle of a Butterfly

1. Cut along the line on the Green Leaf and Blue Water Template page. Roll a small ball of clay about ¼" around to model a butterfly egg. Set the egg on the Green Leaf Template because butter-flies lay their eggs on leaves. Record your observations on the Experiment Sheet.



2. Take a 1" ball of clay and roll it into a tube-like shape to create the larva. Butterfly larva is called a **caterpillar**. Form a caterpillar about 3" long. This part of the model shows the birth stage of the butterfly's life cycle. Record your observations on the Experiment Sheet.

3. As the nymph eats, it grows larger and develops a large hump on its back, forming part of a connected head, neck, and chest structure that is part of its adult body Shape the caterpillar to form a head and smooth body. Caterpillars eat large amounts of leaves as they begin to enter the growth stage of the butterfly life cycle, so add a small amount of clay to fatten up the caterpillar.

4. **An adult is needed to complete this step.** The butterfly has an additional growth stage in their life cycle. The caterpillar spins a protective cocoon to form a protective shell while it grows. Have an adult complete this step. Use scissors to poke a hole in the ping pong ball, then cut an opening large enough to place the clay model inside.

5. Place the clay model inside the ping pong ball to model the caterpillar building a cocoon. The caterpillar model gets a new name and is now called a **pupa**. Record your observations on the Experiment Sheet.

6. Inside the cocoon, the pupa is developing legs, wings, and the things it will need as a young butterfly. Color the butterfly wings from the template, then carefully use scissors to cut them out. Be sure to color both sides of the wings.

Tip

You may need to remold the pupa once removing it from the egg.

1

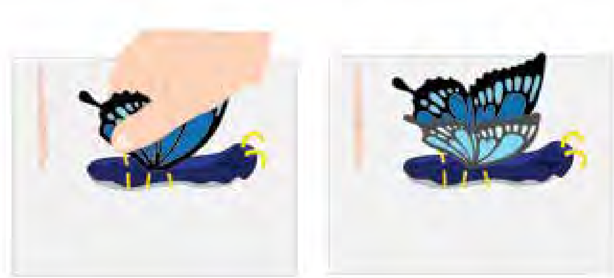
7. Use the pipe cleaner to cut six ¼" long insect legs. Cut two 1" long antennae for the butterfly.

8. **Have an adult complete this step.** Remove the pupa from the cocoon by cutting the ping pong ball open. .

9. Smooth the body of the butterfly to shape it before adding legs. Poke three ¼" pipe cleaner pieces into each side of the lower half of the butterfly to give it legs.

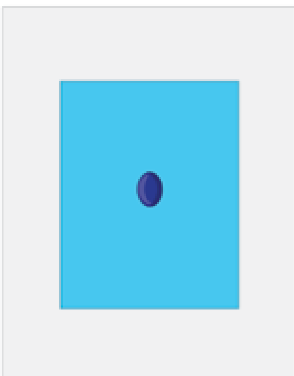
10. Add the antennae by poking a 1" piece of pipe cleaner into each side of the butterfly's head.

11. Give the butterfly wings by gently pushing each wing's small end into the upper part of the butterfly's body. Record your observations on the Experiment Sheet.



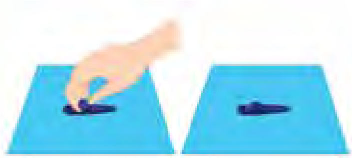
Model the Life Cycle of a Dragonfly

1. Roll a small ball of clay about ¼" around to model a dragonfly egg, like in Step 1. Set the egg aside. Set the egg on the water template because dragonflies lay their eggs on the surface of different bodies of water. Record your observations on the Experiment Sheet.

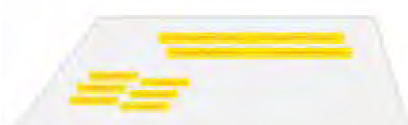


2. Take a 1" ball of clay and roll it into a tube-like shape to create the larva. Dragonfly larva is called a **nymph** and makes its diet on other insects' larva. Form a nymph about 3" long. This part of the model shows the birth stage of the dragonfly's life cycle. Record your observations on the Experiment Sheet.

3. Add a pea-sized amount of clay to form the nymph's head. Add a second pea-sized amount of clay to make a hump on the nymph's upper back. This back structure is one feature that models the growth stage of the dragonfly. Record your observations on the Experiment Sheet.



4. Use the rest of the pipe cleaner to cut six ¼" long insect legs. Cut two 1" long antennae for the dragonfly.



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5. **An adult is needed to complete this step.** Use scissors to trim the pipe cleaner threads from the antennae. Dragonfly antennae are very thin and not easily seen, unlike butterfly antennae.

6. Color the dragonfly wings from the template, then carefully use scissors to cut them out. Be sure to color both sides of the wings.

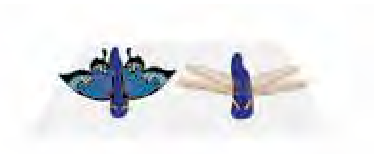
7. Poke three ¼" pipe cleaner pieces into each side of the lower half of the dragonfly to give it legs.

8. Smooth the clay on the back to build the upper body of the dragonfly. Add two seed-sized pieces of clay to make the dragonfly's eyes. Push one pipe cleaner slightly to the side at the top of the dragonfly's head to form the antennae. Then add the second antenna.

9. Add one wing by gently pushing the small end into the upper body on the left side of the dragonfly. Repeat this step using the remaining wings of the dragonfly. The narrower wings should be closer to the head of the dragonfly. Record your observations on the Experiment Sheet.

Test

1. Compare the adult stages of the butterfly and dragonfly by placing the models next to each other.



2. Use remaining clay to build a model of the next stage of the life cycle for both the butterfly and the dragonfly. You may use what you have discovered in this activity and the diagram provided in the Introduction to this activity.

Draw Conclusions

Which three life cycle stages did the models show? (Reproduction [egg], growth, and adult)

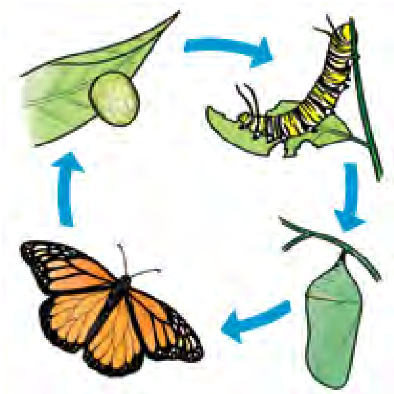
Describe what looked different about the growth stage of the butterfly and dragonfly models. (Possible: The butterfly model showed the larva called a caterpillar at the beginning of its growth stage. Next, the caterpillar became a pupa and formed a cocoon. The dragonfly model showed the larvae called a nymph at the beginning of its growth stage. The nymph becomes larger and gains a hump in the model, but does not change names or make a cocoon.)

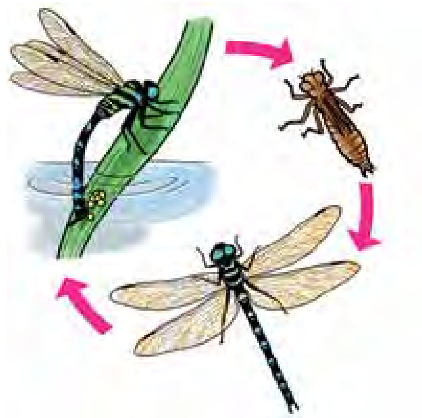
1

Make Connections

Life cycles are ongoing loops and form a recognizable pattern. The pattern is the repeated flow from birth to growth to reproduction to death that continues. A particular plant or animal could fail to exist if this pattern is broken. For example, the growth stage may be affected by a lack of good food and proper nutrition, which can cause not enough of a species to reach adulthood. When too few of a type of animal reach the adult stage or reproduce, there are not enough new animals born to make up for the number of animals that die each year. Sometimes animals are forced to move in search of more food, or they will not survive.

- What did the adult butterfly and the adult dragonfly look like in the model? (Possible: The adult butterfly had two large wings, six legs, and two antennae. The adult dragonfly had two long, thin wings, six legs, and two thin antennae.)
- List the four stages of a life cycle. (Birth, growth, reproduction, and death)
- What structure did the ping pong ball represent in the butterfly model? (The cocoon)
- Which part of the butterfly life cycle is the dragonfly nymph most like? (Possible: The dragonfly nymph is most like the caterpillar.)
- Where do dragonflies begin their life cycles? Where do butterflies begin their life cycles? (Dragonflies begin their life cycles on the surface of a body of water. Butterflies begin their life cycle on plant leaves.)





Takeaway

In this activity, you modeled parts of the butterfly and dragonfly life cycles. You learned that both insects undergo the same four stages: birth, growth, reproduction, and death. However, in your model, you observed that these stages could look very different depending on the type of organism studied. Although the butterfly and dragonfly both started as eggs, the similarities disappeared shortly after birth. The butterfly egg hatched into a tube-shaped larva called a caterpillar. The caterpillar lives on land, eats green plants as it stores food, and develops the specialized structures an adult butterfly needs, like wings and legs. The dragonfly egg hatches into a larva, called a nymph, that lives on the water's surface. The nymph grows healthy on a diet of smaller insect larva and other water organisms. You built a cocoon from a ping pong ball. The caterpillar was placed inside to become a pupa as it continued in its growth stage. The nymph did not require a cocoon, which was another important physical difference between the butterfly and dragonfly's life cycle. Wings, legs, antennae were added to complete the adult butterfly and the adult dragonfly. You modeled reproduction by forming two small clay eggs for the butterfly and dragonfly.

Go Further

You compared the life cycle of two insects: the butterfly and the dragonfly. Research the life cycle of two different animals. Draw a picture of each animal's life cycle and label each stage. Identify the parts where they look alike and the parts where they look different.

Research an extinct animal and answer the following questions.

- What is your animal called? Where did it live?
- What caused it to go extinct?
- What parts of its life cycle were affected by the events that made it go extinct?
- Was there any way to prevent its extinction? If so, how do you think it could have been prevented?

See the Bigger Picture

When the last of a certain type of plant or animal dies, scientists say that that plant or animal is extinct. Plants or animals become **extinct** for many reasons. The basic reason is that there are not enough animals left to reproduce and make new animals. Sometimes natural disasters can kill large numbers of animals in a single event, like an asteroid impact. Other events can take place over time, such as when a specific type of animal is overhunted. Animals like the buffalo were hunted for their meat in this country, causing their population to decrease. The buffalo were nearly extinct until laws were passed to stop the hunting, and special programs were created to protect buffalos. These programs allowed buffalos to reproduce, which has helped increase the number of buffalo.

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Do Insects Look the Same at Each Life Cycle Stage?

1. Draw a picture of the butterfly and dragonfly from your model that represents **reproduction**?

Butterfly	Dragonfly

2. Draw a picture of the butterfly and dragonfly from your model at **birth**. Label each picture with the name of the butterfly and dragonfly at birth.

Butterfly	Dragonfly
Name at Birth Stage	**Name at Birth Stage**

1

3. Draw a picture of the butterfly and the dragonfly from the model at the **growth stage**. Label the picture with the name of the butterfly and dragonfly at the growth stage.

Butterfly	Dragonfly
Name at Growth Stage	Name at Growth Stage

4. Draw a picture of the butterfly and dragonfly from the model at the **adult stage**.

Butterfly	Dragonfly
Adult Stage	Adult Stage

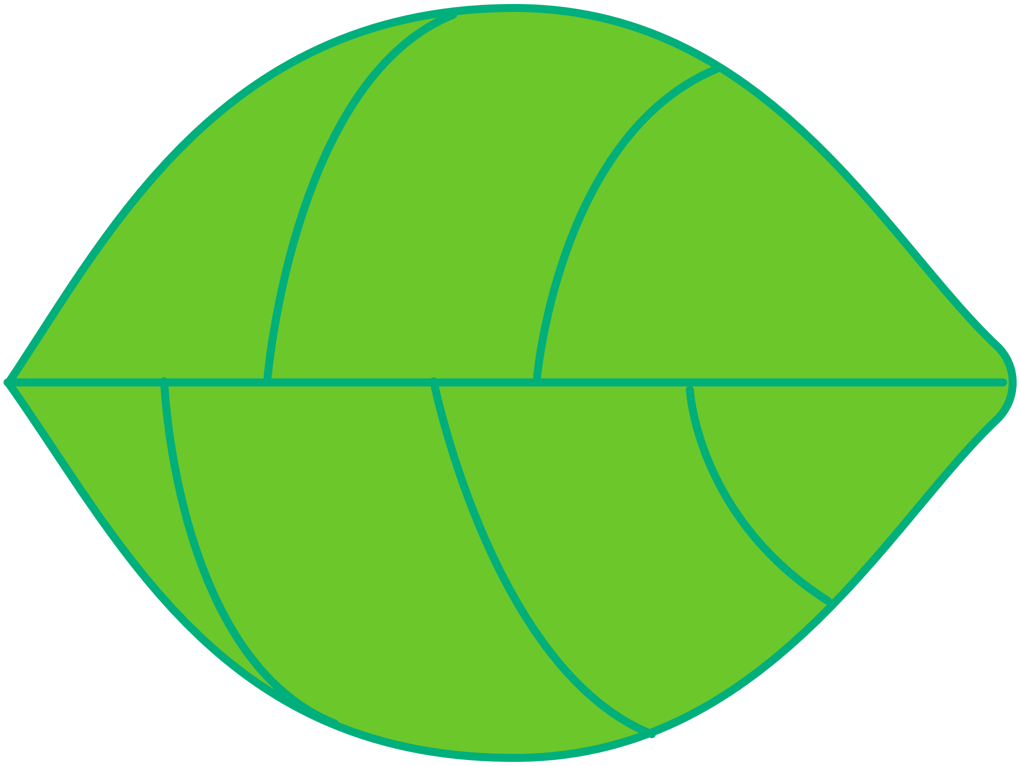
Circle the correct answer.

5. Where does the butterfly live during its birth and growth stage?

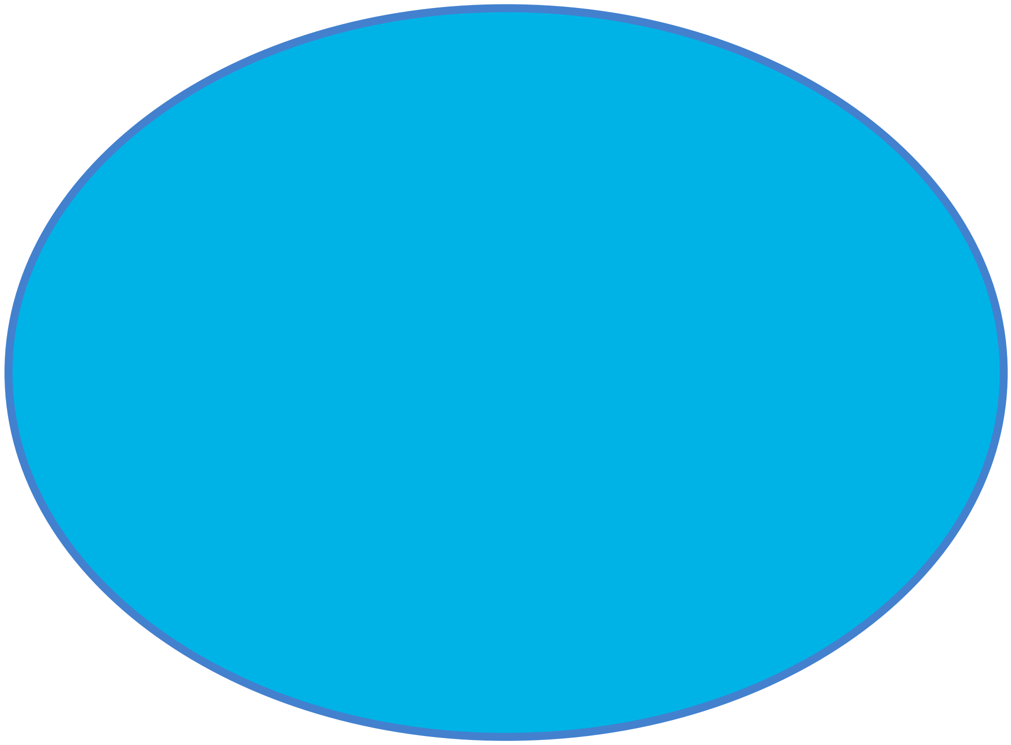
a. on leaves   **b.** in water

6. Where does the dragonfly live during its birth and growth stage?

a. on leaves   **b.** in water



Green Leaf Template



Blue Water Template

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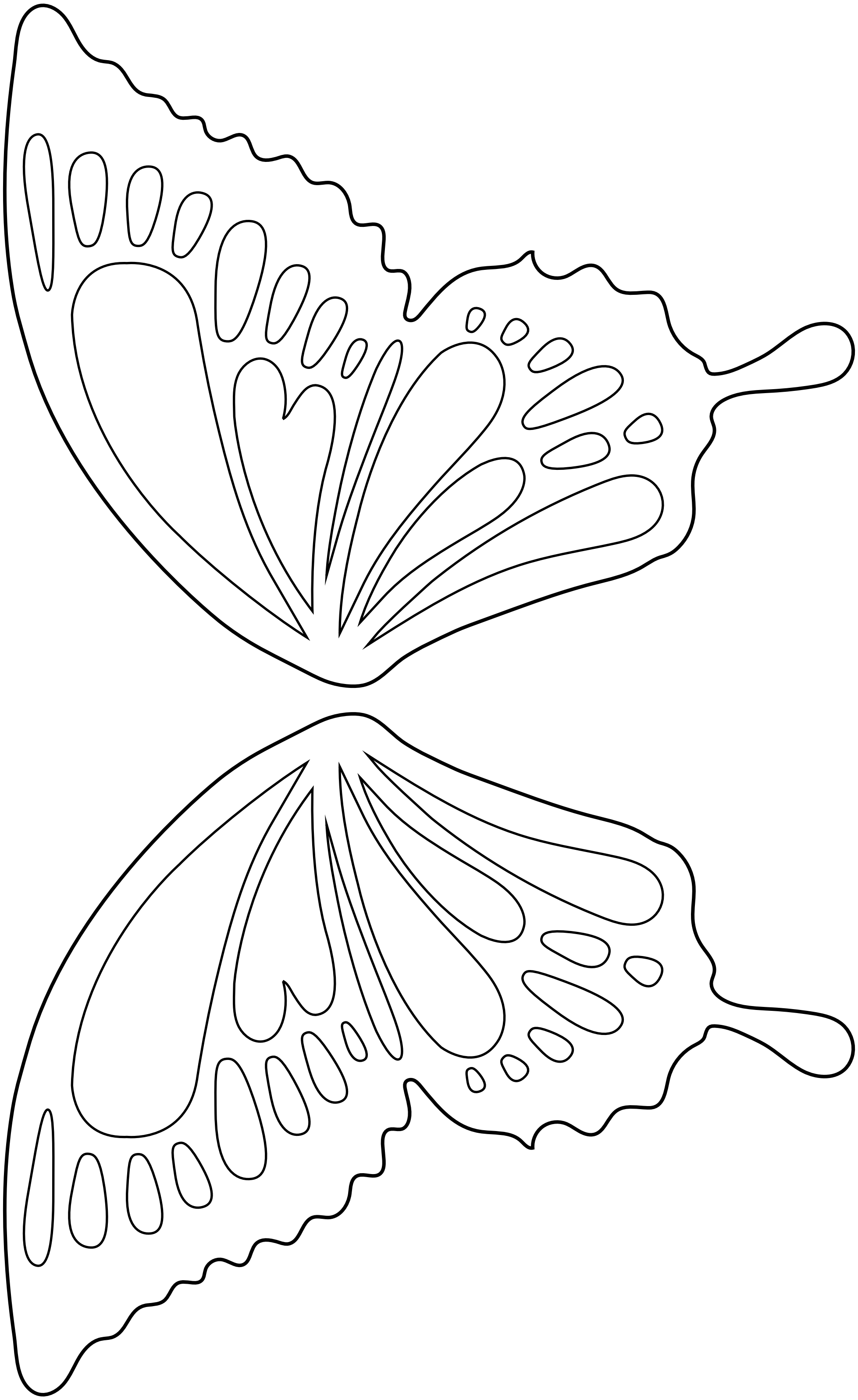
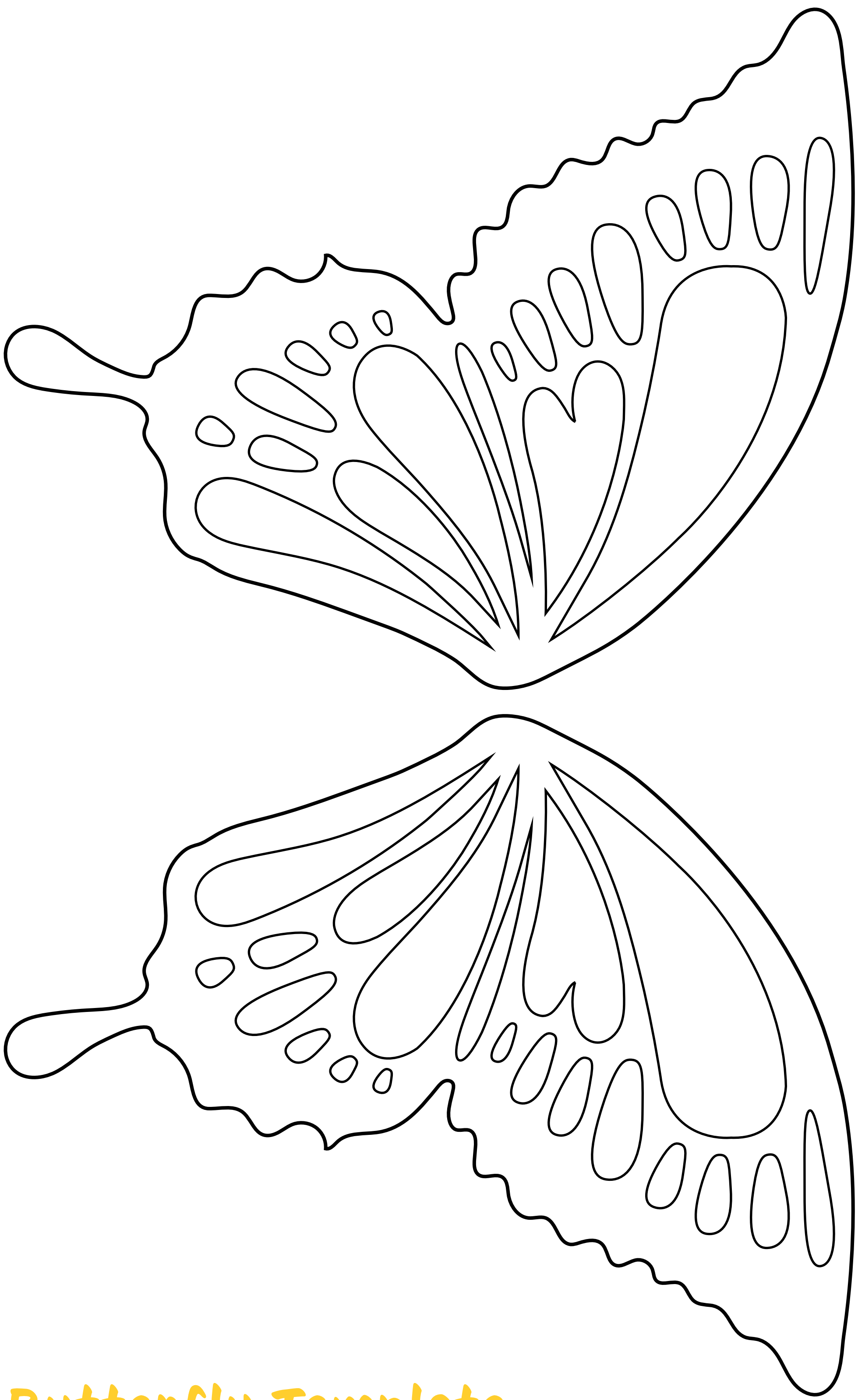
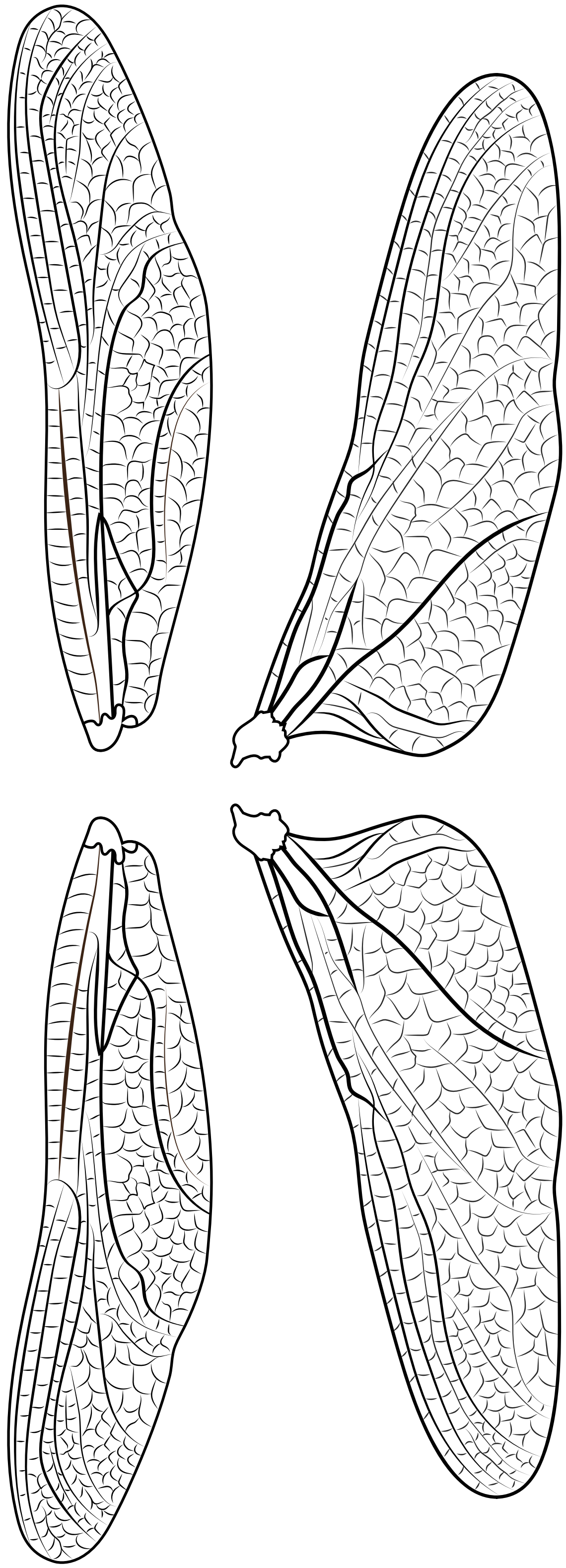


Butterfly Template

1

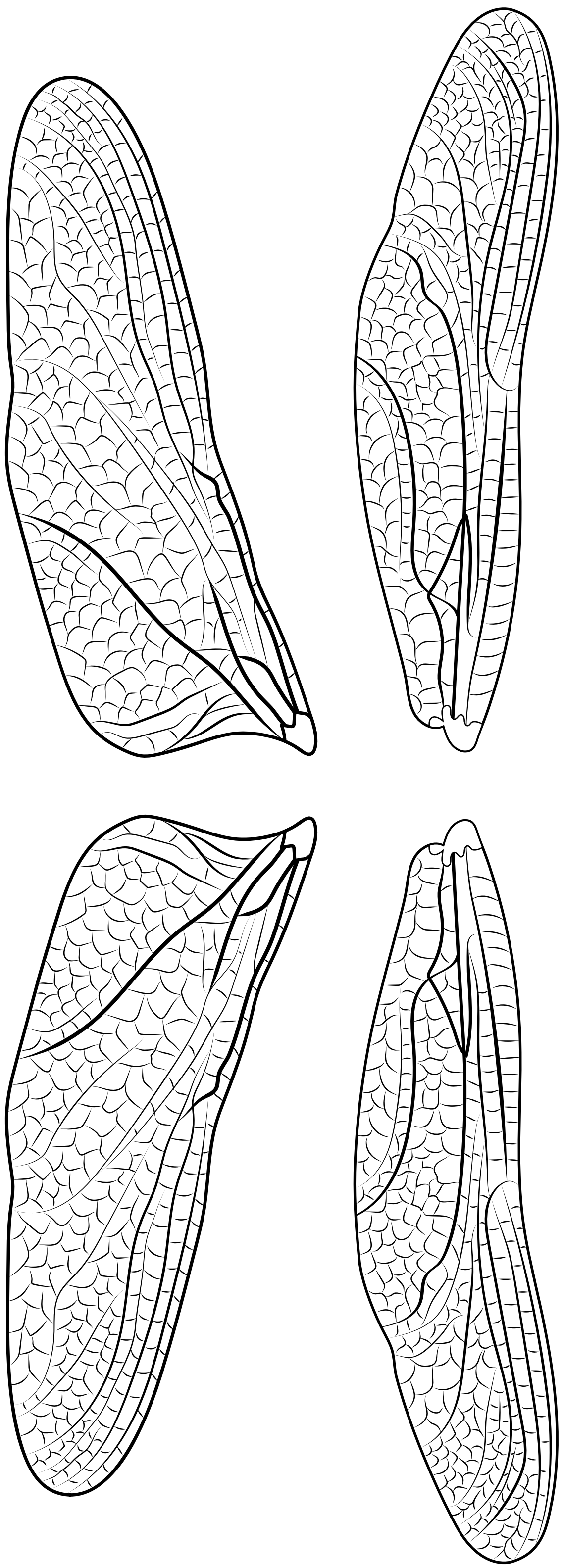


Butterfly Template



Dragonfly Template

1



Dragonfly Template

2

Which Beak Works Best?

Key Concepts

Each type of bird has a unique beak that is adapted to help it find food in its environment.

A population is a group of organisms of the same kind, such as a group of goldfinch birds.

When an environment changes, the organisms that live in the environment must change, or adapt, in order to survive in the new conditions.

2

Materials

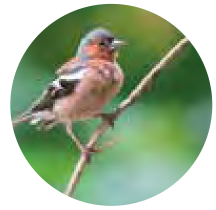
- toothpicks K
- tweezers K
- 10 marbles K
- 3 feet of yarn (cut into 10 3" pieces) K
- Week 2 Sheets from Paper Packet P
- 1 drinking glass or cup
- timer
- 1 spoon
- pencil
- dinner plate
- 8 to 10 small cereal pieces

Introduction

There are many different types of birds across the world that live in a variety of environments. Birds come in different shapes and sizes and have various characteristics. Their bodies are adapted to the places in which they live. Think about the birds you have seen outside your window. Think about other birds you might have seen when visiting the zoo, aviary, beach, desert, or other locations. Were the birds all the same in size and shape? Chances are, you have noticed differences among the birds you have seen.

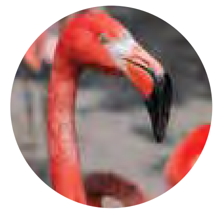
The shape of a bird's beak is very important because it helps the bird get food. Birds with short, strong beaks like the Chafflich are able to crack open nuts and seed casings. Long, pointed beaks help birds the **woodcock** find little critters like earthworms and insects and pluck them from the ground. Some birds have a beak that acts like a strainer. For example, **flamingos** lower their head so that their beak is upside down in the water. Then, they move their head from side to side. The top part of their beak has a fringe that filters food particles from the water. Meat-eating birds, like **hawks**, have beaks that look like a sharp hook. The hook helps the bird tear their prey into pieces. Birds that eat fruit and seeds need a beak that can help pull fruit apart and also be strong enough to crack open seeds. **Parrots** are an excellent example of a bird with a beak that can do both. Some birds, like **ducks**, have tooth-like notches on the sides of their beaks. These notches help them catch fish.

As you can see, there are a great variety of beak shapes. Populations of birds have developed these diverse shapes because they needed to adapt to the food that was available to them. Since birds can fly, they can move to different places to find food. Imagine a population of birds that has moved to an island with a new food source. The birds with the beaks that can eat the food on the island will survive. Over many generations of birds, the beak will become adapted to the type of food on the island. All over the world, we see that the shapes of bird beaks have adapted to take advantage of different sources of food.

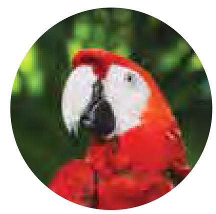


chaffinch

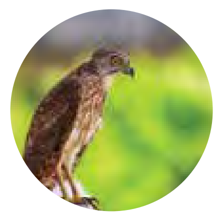
woodcock



flamingo



parrot



red-tailed hawk

duck

2

In this activity, you will investigate how different bird beaks function best at eating different types of food. You will attempt to pick up "food" using various tools, just as a bird would do with its beak.

Make a Prediction

How does the shape of a bird's beak help it gather food?

Investigate

1. Gather the tools you will use to "eat" the food:

   - **Toothpicks** represent the seed-eaters, like finches
   - **Spoons** represent birds that eat fish, like pelicans
   - **Tweezers** represent birds that eat worms and insects, like warblers

2. Organize the "food" onto a plate. Mix up 8-10 pieces of each "food" on the plate. Then, set an empty cup next to the plate.

   - **Cereal** represents seeds
   - **Marbles** represent fish
   - **Yarn** represents worms

3. Look at **the tables on Experiment Sheet #2** below and choose the first "beak" (tool) to begin "eating" like a bird.

4. Set your timer for one minute.

5. For one minute, use the "beak" and pick up as many pieces of "food" as possible. Each piece must go into the cup, which represents the bird's "stomach."

6. At the end of one minute, count each food piece, by type, and record the amount in the data table as a bar graph.

7. Return the food to the plate.

8. Repeat the process for each "beak" type. Record your data at the end of each minute.

9. When you have tried each one, look at your data.

Make Connections

While their beak types are critically important to birds and their ability to consume food, their senses also play a large role in capturing prey and locating berries and plants to eat. Birds primarily rely on their sense of sight and hearing to find the foods that are most suited for them. Their sense of touch is also important as it allows them to travel in the air, adjusting their travel paths as needed. Smell and taste are their two least used and most underdevel- oped senses, although they still play a critical role in their survival.

Draw Conclusions

- Which tools might be most difficult to use? Why? (Possible: The beaks that were not designed for a particular food were difficult to use.)
- Which objects might be the most difficult to pick up? Why? (Possible: It was difficult to pick up objects with the "wrong" beak.)
- Which "beak" led to the most "food" in the bird's stomach? (Possible: The food that was picked up with the correct beak.)
- How does a bird's beak play an important role in its survival? (Possible: Birds with beaks that are adapted to pick up food in their environment will have a better chance of survival.)
- What type of beak is beneficial to a bird that eats seeds? (The toothpick beak.)
- What type of beak is beneficial to a bird that eats fish or small animals? (The spoon beak.)

Takeaway

While traveling to the Galapagos Islands in Ecuador, Charles Darwin observed that the finches living there had different types of beaks. Each population of finch had a beak that was adapted to eat a different type of food. This activity is inspired by Darwin's observations and research. As you can see, the shape and the way the bird beak works affects the amount of food the bird eats. It was difficult to pick up marbles with toothpicks, and yarn with spoons. However, if you used a spoon to pick up the marble and tweezers to pick up the yarn, it was much easier. In the same way, beaks are specially adapted to pick up the type of food a bird eats in its environment.

See the Bigger Picture

All over the planet, it is easy to find examples of how the environment influences the characteristics of an organism. Over long periods of time, populations' organisms can adapt to an environment by slowly changing the characteristics within the species of organism. In addition to birds' beaks, bird have additional features to help them thrive in their environment. Some birds have long legs to enable them to wade easily into the ocean shoreline. Ducks have webbed feet to help them swim with ease. Birds of prey like hawks and owls have feet with long talons to help them grab their food, whereas songbirds use their feet to help them perch on branches. Birds of prey have eyes that face forward, whereas birds that are predators, have eyes on the sides of their heads to watch for danger. This is called **natural selection**. In other words, nature "selects" the best traits for a population of organisms to survive in an environment.

Go Further

Try the experiment again using different tools and food sources. Suggestions for beaks: straws, small cups, and clothespins. Suggestions for food: gold-fish crackers, sprinkles, marshmallows, raisins, and sunflowers seeds. What changes occurred? Were you able to collect more pieces of "food?" If so, why might that be?

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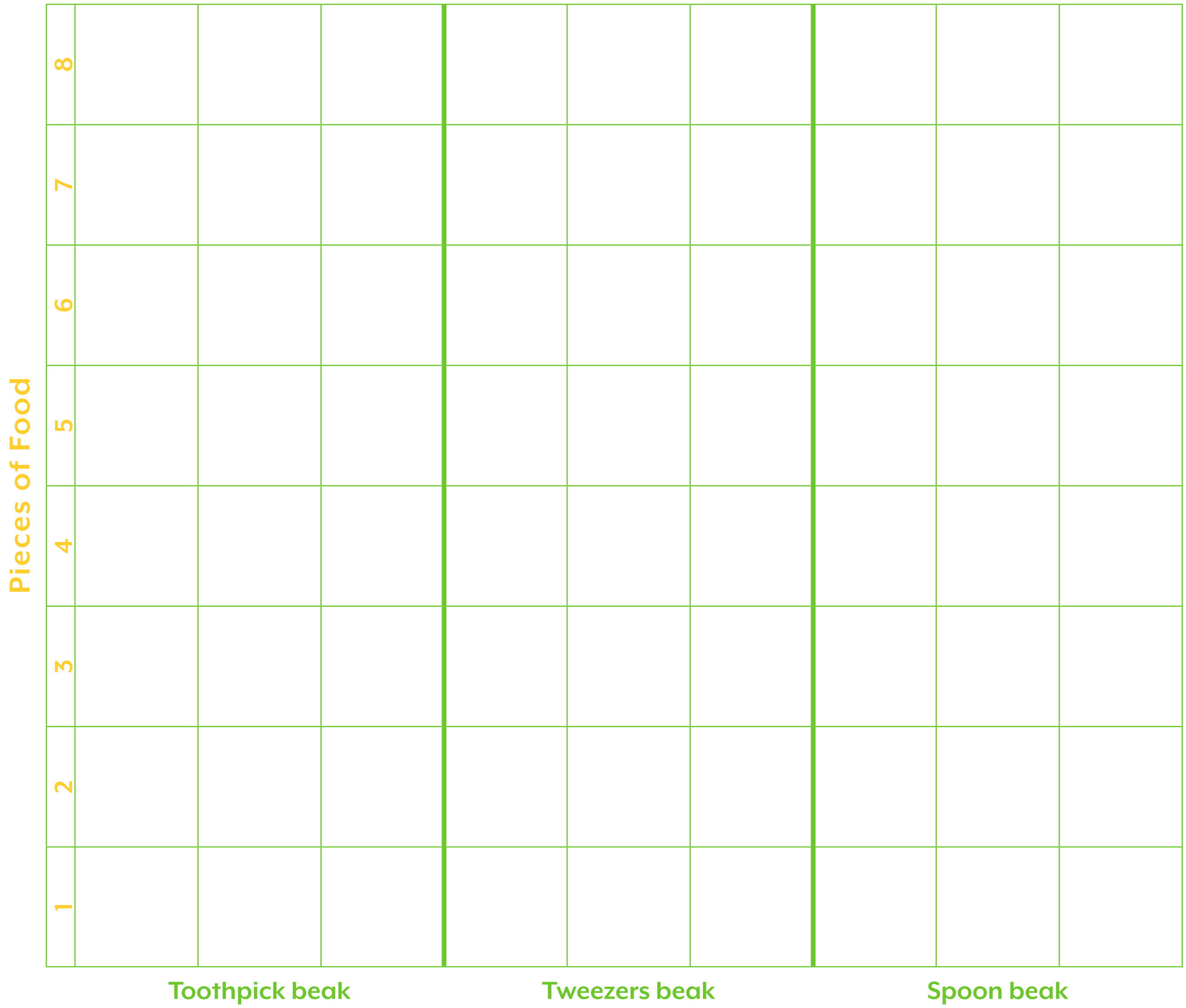
Which Beak Works Best?



Instructions for graph

1. Choose one color to represent each food type (cereal, yarn, marbles).

2. Fill in the bar graph to show how many pieces of food you were able to pick up using each tool (toothpick, tweezers, spoon).

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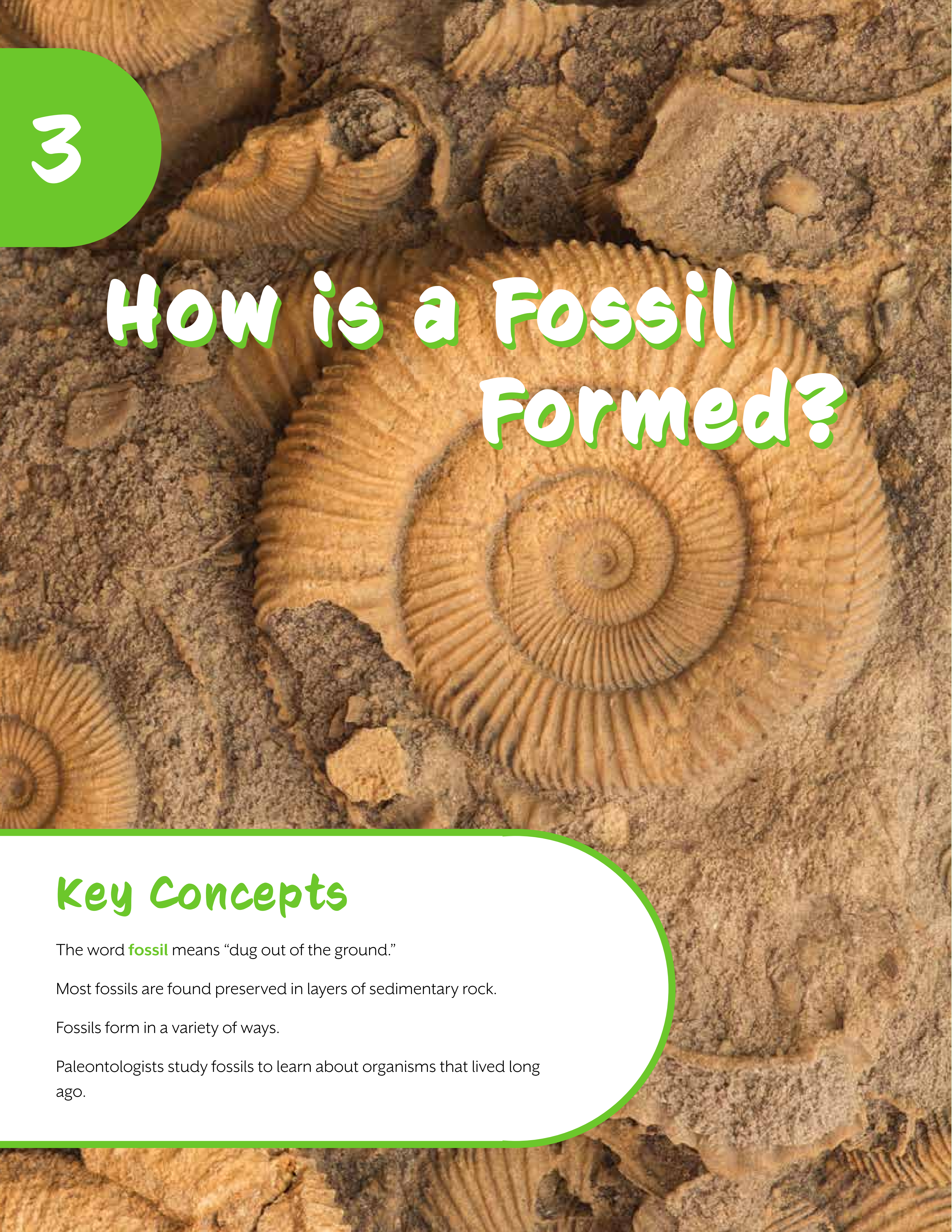

3

How is a Fossil Formed?

Key Concepts

The word **fossil** means “dug out of the ground.”

Most fossils are found preserved in layers of sedimentary rock.

Fossils form in a variety of ways.

Paleontologists study fossils to learn about organisms that lived long ago.

Materials

- 1 cup plaster of Paris K
- 4 Styrofoam cups K
- 1/2 cup of clay K
- Week 3 Sheets from Paper Packet P
- water
- 4 or more objects from nature (seashell, dead bug, leaf, small animal toy, etc.)
- Vaseline, Aquaphor, or cooking oil
- a bowl for mixing

Introduction

Almost everything we know about the history of life on Earth has come from studying fossils found in rocks. You could think of each fossil as a postcard sent forward in time from plants and animals that lived long ago. **Fossils** are the preserved remains of plants and animals that once living on Earth.

Fossils form in a variety of ways. Two man in types of fossils exist: trace fossils. **Trace fossils** are signs of once-living organisms, such as a footprint. Trace fossils help paleontologists (people who study fossils) understand how extinct animals moved. **Body fossils** are the remains of plants or animals that once lived.

Mold fossils, cast fossils, and true form fossils are types of body fossils. **Mold fossils** are formed when a plant or animal dies and decays and leaves its impression behind. Mold fossils typically form in sand or clay. **Cast fossils** are formed when tiny pieces of minerals deposit in a mold fossil. Over time, the entire area in the mold becomes solid rock. The most common example of cast fossils are dinosaur bones. **True form fossils** are formed when animals or plants are trapped within ice, tree sap, or tar, and remain there for many years. The original features of the organism remain intact, keeping them preserved as they were when they died.

In this activity, you will make two different types of fossils: mold fossils and cast fossils. Then, just like a paleontologist, you will use the fossils to gather clues about the organism.

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Preparation

Before you begin the experiment, collect objects from nature in advance to use in creating fossils. Suggestions include feathers, dead insects, twigs, nuts, seashells, etc., depending on your location and natural resources. Alternatively, you can collect objects outside together, weather pending.

When searching for objects together, your students might be inclined to choose a wide variety of objects. Some may form fossils better than others. That is a great part of the learning process. Allow the students to choose an assortment so they can better understand by the end of the experiment which ones made fossils, and which ones did not. This will match what scientists have discovered about fossils found in nature.

Also, consider creating a few fossils on your own ahead of time. Keep these until it is time for the experiment. Allow your students to make observations and guesses as to what each fossil was created from.

In this activity, you will be learning about fossils and the information that fossils can provide to scientists.

? What is a fossil? (Fossils are preserved casts or molds left from previous organisms or objects.)

? What types of fossils have you seen? (Answers will vary.)

? Why are fossils important for scientists? (Possible: Fossils give information about various species, time periods, geology, climates, etc.)

Make a Prediction

Which objects will form the best fossils? Which kind of fossil do you think provides more scientific information? A cast fossil or a mold fossil? Complete questions 1–3 on the Week 3 pages of the Paper Packet.

Investigate

Day 1

1. Set out each object that will become fossilized.

2. Cut the Styrofoam cups to approximately 1 ½–2" tall.

3. Carefully press a small amount of flattened clay into the bottom of a cup. The clay should be about a half an inch thick.

4. Apply a light layer of Vaseline over the clay.

5. Apply a light layer of Vaseline over the object you intend to use for the fossil.

6. Press an object, such as a seashell, into the clay to make an imprint. Press the side you wish to have an imprint, facing downward.

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Tip

Use your knuckles to press the clay down smoothly so you do not leave fingerprints or other indents in your fossil.

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7. Carefully remove the object.

8. Mix the Plaster of Paris, 2 parts Plaster of Paris to 1 part water.

9. Pour a small amount of the plaster mixture into the cup to cover the imprint. Gently move the cup side to side until the Plaster of Paris makes an even layer on top of the clay.

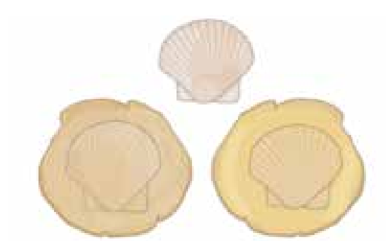
10. Set aside the clay and plaster to dry and form overnight.

Day 2

1. Gather the clay and Plaster of Paris mold.

2. Slowly peel off the Styrofoam cup.

3. Carefully pull the layer of plaster and clay apart. The clay acts as the mold fossil and the plaster acts as the cast fossil.



4. Allow the air-driedy clay to continue drying for another day.

5. Observe. Discuss the similarities and differences between the mold fossil and the cast fossil. Complete questions 4–5 on the Week 3 pages of the Paper Packet.

Draw Conclusions

How does the cast fossil differ from the mold fossil for the same object? (Possible: The cast fossil is more like the actual object that was used to make a fossil. The mold is just the imprint.)

Examine the mold and cast fossils you made. If it was an actual fossil, what type of information could a paleontologist learn about the organism that made the fossil? (Possible: They can learn how the plant or animal looked based on its body structure, where it lived, and how it died.)

Why did certain fossils form better than others? (Possible: Items that are hard made better fossils.)

What types of animals or other living organisms would lend themselves to make good fossils? Which ones would NOT become fossils and why? (Possible: Animals with skeletons, trees—anything with hard parts would make good fossils. Animals without skeletons would not make good fossils because the layers of sediment would flatten the body and nothing would be left to make an impression.)

Make Connections

The study of fossils is also closely connected to engineering. Engineers look at ways to improve objects and processes. By focusing on various dinosaur fossils, engineers can learn more about the ways in which they moved. For example, by studying the bones of a pterodactyl, an engineer may gain new knowledge about how it was able to fly, and the efficiency of its flight process. By studying pterodactyls, engineers can improve current technologies. This is known as biomimicry. Biomimicry occurs when engineers use nature to improve modern objects or processes.

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See the Bigger Picture

Fossils allow scientists to learn more about the world we live in. Paleontologists have an important role. They find, carefully excavate, study, and then share information. Paleontologists can study the physical structure of extinct organisms. They can also work with other scientists who may focus on other important scientific studies in our world. One example is climatologists, because climate also plays an important role in how our world has changed, and information can be learned by studying both related disciplines. The study of paleontology also uses concepts in geology, archaeology, chemistry, biology, archaeology, and anthropology.

Takeaway

Fossils are rare to find. Their formation is a long and complicated process. Animals must die in a location that will become buried by sand or mud. Then, its bones must be covered quickly before it completely decays. After a long time, the remains of the animal becomes buried in layer after layer of sediment. In order for the fossil to be discovered, it must be raised through the movement of the earth's crust. Erosion and weathering must then wear away the layers of earth to reveal the fossil.

Fossils can be formed in various ways. There are different types of fossils, and each is helpful to the science community. Fossils teach us about organisms of the past as well as provide clues into what our world was once like. Scientists can learn about ancient climates, ecosystems, and landforms by studying fossils.

Go Further

Which areas in our world might produce the best fossils and why? What materials are needed to create fossils in nature?

Research various fossils found locally. What is surprising to you? What is the biggest fossil that has been found? How might scientists use this information to find and piece together more fossils?

How is a Fossil Formed?

1. What objects have you chosen to fossilize? List them here.

2. Predict: What will each fossil look like?

3. Which objects might create the best fossils and why?

3. **Observe.** Sketch your fossils in the boxes below and label them.

4. Which objects formed the best fossils?

5. How does the cast fossil differ from the mold fossil for the same object?