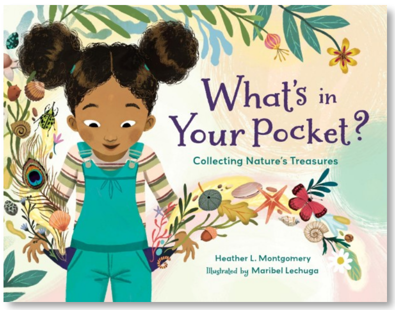
Discussion questions and activities for *What's In Your Pocket: Collecting Nature's Treasures*

By Heather L. Montgomery • Illustrated by Maribel Lechuga
On-Sale Date: September 14, 2021



Charles Darwin, George Washington Carver, and Jane Goodall were once curious kids with pockets full of treasures!
When you find something strange and wonderful, do you put it in your pocket? Meet nine scientists who, as kids, explored the great outdoors and collected "treasures": seedpods, fossils, worms, and more. Observing, sorting, and classifying their finds taught these kids scientific skills—and sometimes led to groundbreaking discoveries.

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Nature

1. *What's In Your Pocket?* takes place in many outdoor locations. What are some of the places you see these young scientists exploring? Have you been to places like this?
2. What is the environment like where you live? (Hint: Many things make up an environment! Weather, wildlife, geography, and plant life can all play a role in shaping the place you call home.)
3. Do you collect things from nature? If so, what and why?
4. If you could collect anything at all, what would you pick?
5. Do you have a favorite illustration in this book? Describe it and explain why it is your favorite.
6. The back of the book includes a list of field guides. Have you used a field guide before? What do you think makes a good field guide? What kind of field guide would you look for to learn more about your collection?

Science & Scientists

1. What is science? What are some of your favorite science topics?
2. What are some jobs that scientists do?
3. How does someone become a scientist?
4. Have you heard of any of the scientists listed in this book? Were there any names that were new to you?
5. Who is your favorite scientist in the book? Why?
6. What does it mean to be a "community/citizen scientist"? Are there community/citizen science projects going on in your area that you can participate in as a class?
7. Read Heather L. Montgomery's "My Rules for Collecting" (page 47) aloud. Have you heard some of these rules before? Why do you think each section of the list begins with respect for something?

Create Your Own Collection

I will collect: ____
(For example: leaves, shells, rocks)

I will find my treasures:____
(For example: in my backyard, at a local beach, on the sidewalk)

To store my treasures, I will use:____
(For example: an mint tin, a shoebox, a blank diary, a jam jar. Depending on what you decide to collect, you may need something waterproof, something flat, or something that can fit in your pocket.)

Once you have chosen your collection container, make it your own with paint, stickers, marker, construction paper, or other decorations!

Get Off the Beaten Path
There are all sorts of ways to enjoy the outdoors! Use this checklist to track your adventures.

☐ **Hike and Bike** State and national parks can offer miles of trails for hiking or biking. Prepare to enjoy the outdoors safely: check the park's website for any hazard alerts, dress appropriately for the weather and terrain, give your bike a tune-up so it's in good shape, and let other people know about your plans.

☐ **Geocache** This modern treasure-hunting pastime is beloved around the world. To play, start online with a geocaching organization that shares GPS coordinates for little stashes located near you. Once you've found the geocache, sign and date the logbook to prove that you found it—and hide it exactly where it was so the next hunter can find it. Larger caches sometimes have small trinkets, toys, or stickers that you can trade!

☐ **Volunteer** Many parks have dedicated clean-up days for volunteers to pick up trash, mend worn-out trails, clean and fix facilities, and generally make the park a safer and more pleasant place to be.

☐ **Walk the Dog** A four-legged buddy can give you a whole new perspective on the outdoors. If your family doesn't have a dog, ask a friend who does if you can join them on a dog walk or offer to walk a neighbor's dog while they're out of town.

☐ **Make a Splash** Your nearest waterfront park may offer boat rentals, which is a great way to get a closer look at whatever swims in the sea, lake, or river! You'll need an adult buddy to help you stay safe on the water.

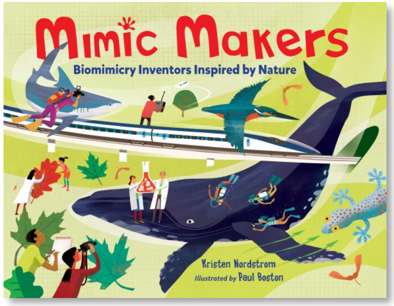
☐ **Look Up** Find an open field near you—in a park, garden, school playground, or backyard—and lie down and look up. What do you see in the sky? Try this on cloudy days, snowy days, near sunrise and sunset, and after dark when the stars are out.

☐ **Get Down** You know your own neighborhood, right? Look again! Get low to the ground—crawling on hands and knees—and see what you can see from this angle.

☐ **Quiet Time** Find a time when you can sit silently in your backyard or another nature space for twenty or thirty minutes. This will feel like forever—but you may get the chance to see wildlife that's easily scared off by noise or movement! See what you notice when everything is still.

Discussion questions and activities for *Mimic Makers: Biomimicry Inventors Inspired by Nature*

By Kristen Nordstrom • Illustrated by Paul Boston
On-Sale Date: July 13, 2021



Who's the best teacher for scientists, engineers, AND designers?
Mother nature, of course!
When inventors are inspired by nature for a new creation, they are practicing something called biomimicry. Meet ten real-life scientists, engineers, and designers who imitate plants and animals to create amazing new technology. An engineer shapes the nose of his train like a kingfisher's beak. A scientist models her solar cell on the mighty leaf. Discover how we copy nature's good ideas to solve real-world problems!

ISBN 978-1-58089-947-5 Hardcover

1. Which invention in *Mimic Makers* is your favorite? Why?
2. Which scientist do you want to read more about? Why?
3. What animal or plant features are you curious about? What could you do to find out more about them?
4. Why did Eiji Nakatsu need to redesign the Shinkansen bullet train? What do you think about his design inspiration?
5. What other examples from nature might have been good inspiration for Eiji?
6. Does your house have solar panels? Ask your family: Why do you like using solar energy?
7. How does Yueh-Lin (Lynn) Loo's solar cell mimic a leaf? How is it an improvement on flat rooftop solar panels?
8. Why did Tony Brennan invent Sharklet?
9. Sharklet is used to keep medical devices and cell-phone cases clean. What else would be a good use for Sharklet?
10. Why is an invention like Sharklet important?
11. Kitae Pak was twelve years old when he saw a documentary that later inspired him to create the Dew Bank Bottle. Do you think he knew at twelve that he'd become a scientist and inventor? What kind of scientist would you like to be?
12. Do you have a water bottle? Do you think it's a necessary piece of equipment? Why?
13. Where in the world do you think a Dew Bank Bottle would be a necessary piece of equipment? Why?
14. What does a botanist do? What does a microbiologist do?
15. What are the advantages of the fungus that Rodriguez and Redman discovered?
16. Frank Fish learned from an ocean creature how to improve upon a wind turbine. Why do you think this is an important discovery?
17. Kingsley Fregene is using what he learned from the Samarai to invent new and improved drones. What might be some of the practical applications for robotic drones?
18. What is it about a gecko's feet that help it stick to a surface? What would you do with this ability?
19. Looking around at the plants and animals in your own neighborhood, what abilities do you see? Which abilities do you wish you had? What would you do with them?

Be a Mimic Maker!

Inventions Inspired by Leaves

You are a mimic maker. In this mini-unit, you'll make all the discoveries. Get ready to explore! After your investigations, you'll make a list of leaf ideas (things you found interesting). From your list, you'll create a leaf -inspired invention, draw the invention or build a model out of recycled materials.

Find a Mimic Maker Journal template at kristennordstrom.com

Make your own Mimic Maker Journal

1. Choose an option:
    - Composition notebook
    - Spiral notebook
    - Homemade notebook (papers stapled or taped together)
2. Put your name on the front.
3. Decorate the cover.
4. Suggestion: Write on the front of pages unless noted in the directions.

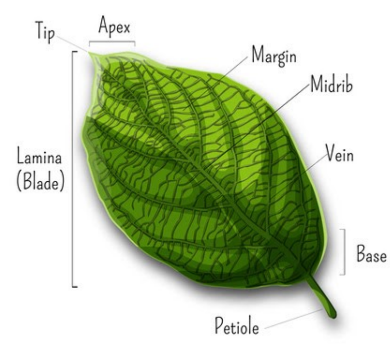
See, Think, Wonder . . .

Go on a collection walk. Start by taking three deeeeep breaths. Feel your feet on the ground. Feel connected to the earth. As you walk, look for leaves. Collect five to ten different leaves. Gently pick leaves from a tree, bush, or from the ground. When you look at your leaf collection, ask yourself:

- What do I see?
- What do I think?
- What do I wonder?

In your Mimic Maker Journal

Write <u>LEAVES</u> on the first page. Write down some of your *see, think, and wonder* observations. After you explore leaves through the following activities, you'll return to these pages in your journal, answer your questions, and write down things you've learned. Remember, there are no right or wrong questions. Just curious you!

Explore Leaf sort Sort your leaves in ways that are interesting to you. For example: Color Size Leaf shape (hand, heart, spear) Texture (rough, smooth, fuzzy) Edge Shape (pointy, rounded, spiky, lobed) Leafe Arrangement (simple, compound)	**Explain** Leaf parts 

Draw

In your journal, draw and color a picture of your favorite kinds of leaves. Write descriptive words around your leaves.

Explore

Leaf rub

In *Mimic Makers* you read about Lynn Loo. Through many investigations, Lynn and her team discovered wrinkles and folds on the surface of a leaf absorb and channel sunlight.

Observe the wrinkles and folds on a leaf using a hand lens. Write in your journal what you see.

Sketch

Sketch a leaf in your journal. Draw a thumbnail sketch (enlargement) of the wrinkles and folds. Measure and record the length and width of your leaf. Identify and record the type of leaf using a guide page like this one.

Explain

Leaf submerge

Take a deep breath. Let it all out. You just helped a plant grow! How? Plants need CO_2 to survive. Each time you exhale, you release this gas into the air. Take another deep breath and hold it. Pretend to jump into a swimming pool. Now that you're underwater, let out all your air. What's the difference between these two breaths?

Explore

(Leaf submerge continued)

- Get an active leaf (one from a tree). Fill a glass bowl with lukewarm water.
- Place the leaf in the bowl of water, and place a small rock on top so it the leaf is fully submerged.
- Place the bowl in a sunny spot inside or outside.
- Now wait for few hours. Write down what you think will change or happen and why.
- Share your ideas with your fellow classmates.
- A few hours later, observe the leaf. What do you see? Use a hand lens if needed. Draw a picture of the leaf in the bowl. Write down your observations.

Explain

Plants making food

What did you discover? Yes, bubbles! But why? Let your brain think as you draw your experiment in your journal.

Even though your leaf is under water, it is still using sunlight to make food. The leaf is creating energy through the process of photosynthesis. It is also getting rid of stuff it no longer needs. The leaf releases extra oxygen and water. This release creates bubbles of oxygen in the water. Oxygen is lighter than water. Keep watching. What happens to the bubbles?

Draw

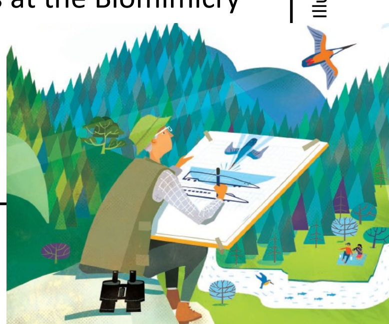
Draw a picture of your leaf submerge exploration. How can you show the process?

- Sunlight being absorbed into the leaf.
- Light moving along the wrinkles and folds on the surface.
- Oxygen and water being released.
- Bubbles forming and rising to the surface.

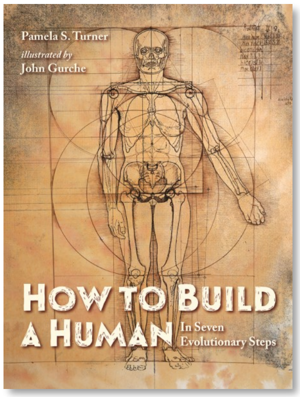
Read and question

Reread the questions and thoughts you had about leaves when you started. Did your explorations answer any questions? Write those new ideas and facts down. Still have unanswered questions? Go on a reading investigation. Find interesting facts about leaves and recommended books at the Biomimicry Institute's Ask Nature website.

www.asknature.org



Discussion questions and activities for *How To Build a Human: In Seven Evolutionary Steps*



By Pamela S. Turner • Art by John Gurche
On-Sale Date: April 12, 2022

The epic story of our evolution in seven big steps!
How did we become who we are? With trademark wit, acclaimed science writer Pamela S. Turner breaks down human evolution into the seven most important steps leading to *Homo sapiens*.

ISBN 978-1-62354-250-4 Hardcover

Among animal behavior scientists, the definition of a tool is "an unattached object used to **manipulate** something else."

Make a list of every tool you use during the course of a day. For example, your toothbrush is a tool, and so is the toothpaste tube. The toothpaste isn't. How many tools can you identify? Deciding what meets the scientific definition of a "tool" can be tricky—others may disagree with what you label a tool. Discuss.

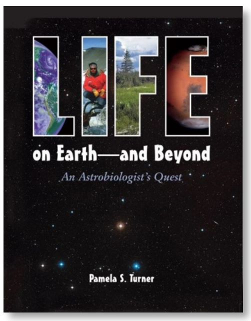
Early human ancestors had chimp-like hands with long fingers, long palms and short thumbs. The individuals in any population vary slightly. During the process of evolution through natural selection, those early human ancestors with hands that were slightly better at using tools—hands with slightly shorter palms, shorter fingers, and a longer, stronger thumb—were better able to use tools to survive. They passed these helpful traits to their offspring. Scientists think that over a long period of time, these traits spread, eventually producing a new population with handier hands. We inherited these hands from our ancient ancestors. Yes, we humans make tools. But tools also helped make us.

Using medical tape (designed not to hurt your skin when it's peeled off), tape your thumbs to your hands. Then try doing your normal daily activities. Humans have hands with a very precise grip. What happens when you lose that ability? How many of the tools you use on a daily basis require your specially evolved hands?

1. How are humans like other primates?
2. Define natural selection. Can you give an example of how natural selection has influenced human evolution?
3. What is the one lesson about evolution the author urges you to remember? Why is it important?
4. Why do some species go extinct? Why do other species survive?
5. One of the reasons our ancestors survived was because they were not picky eaters. How would our survival skills compare today? If you had to eat worms, how do you think you'd do?
6. What is the advantage of being able to stand upright and walk on two legs?
7. Can you find in the book examples of traits or body parts that were altered during the course of human evolution?
8. The author says that evolution's motto might be, "Yeah. Good Enough." What other mottos might describe evolution?
9. What is the significance of the Makapansgat Pebble?
10. Why is tool use and tool-making considered an important step in human revolution?

11. Sharing is caring. Evidence points to Handy People sharing their food with each other. How is this like the social skills and bonds we're familiar with today?
12. Do you play team sports? How is a team like an Australopith or *Homo habilis* social group?
13. Why do scientists think humans have sclera (the white part of the eyeball)?
14. In Step 7, the author discusses how a flip-flopping climate may have driven our ancestors close to extinction. Consider the period of climate change we are currently experiencing. What species may be endangered today because of climate change?
15. When did our ancestors finally beat dolphins in the brains department?
16. Which evolutionary step do you think is the most important? Why?
17. The author says we humans are the dominant species on Earth because our mental abilities are paired with a high degree of cooperation. Working together, list the ways in which cooperation contributes to human survival and cultural evolution.

Also by Pamela S. Turner



Is there life beyond Earth?
NASA astrobiologist Dr. Chris McKay has searched the Earth's most extreme environments on his quest to understand what factors are necessary to sustain life.

ISBN 978-1-58089-133-2 • HC • 112 pages • 2008

Pre-Reading Activities

- Take a poll with your class. Who thinks that there is life on other planets? What do your students This this life might look like? Create a bar graph to see which opinion has the most supporters.
- Have your students free write their own definitions of the word *life*. Ask them to consider what qualities something must have in order to be considered living.

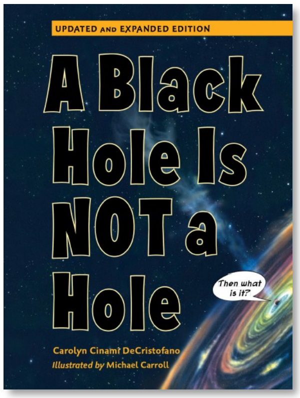
Reading Comprehension Questions

- What characteristics must something have in order to be considered living?
- How do viruses complicate a simple definition of life?
- List four surprising locations scientists have found microbes on Earth.
- Where do scientists think life might exist on Mars? Why?
- What is the driest desert in the world? Why was Chris McKay interested in doing research in such a dry place?
- How do microbes help make Earth habitable for other life forms?

Interdisciplinary Activities

- Take your class outside and have them look under rocks What do they find? Have your students keep note of *what* they find and *how much* of each item they find (living or otherwise). When you get back to your class, have your students take a look at their data and create bar graphs to see what were the most, and least, common findings.
- Go on a hike with your class. Is there desert nearby? Wetlands? A path behind your school? A walk around the block? Encourage students to observe the wildlife they see, both *big* and *small.* Are they surprised by how much they find when they really take the time to look?

Discussion questions and activities for *A Black Hole Is NOT a Hole*



By Carolyn Cinami DeCristofano • Illustrated by Michael Carroll
On-Sale Date: September 7, 2021

A black hole isn't really a hole . . . is it? Get ready to S-T-R-E-T-C-H your mind with this beloved and best-selling science book. Updated with an all-new chapter about the first black-hole image ever!

What are black holes, what causes them, and how the heck did scientists discover them? Acclaimed STEM writer Carolyn DeCristofano's playful text shares how astronomers find black holes, introduces our nearest black-hole neighbors, and provides an excellent introduction to an extremely complex scientific topic. Gorgeous space paintings supplement real telescopic images, and funny doodles and speech bubbles keep the content light and fun.

ISBN 978-1-62354-308-2 Hardcover • ISBN 978-1-62354-309-9 Paperback

1. Before reading, what do you already know about black holes? Make a list.
2. What does the author mean when she uses the word "pull"? What examples does she use? Can you think of any other examples?
3. Try this gravity experiment called: Racing Gravity
    - Toss a ball up in the air at three different speeds--slow, medium, and fast. What similarities and differences did you notice across the tosses?
    - How is this experiment like the fish, the boat, and the whirlpool (Page 8)?
    - The faster the object moves away from the Earth, the farther it can go before Earth's gravity pulls it back. If a launcher tossed the ball much faster, it would escape the Earth's gravity zone. Only black holes have utterly irresistible gravity zones.
4. In Chapter 3 we learn how a black hole begins. Try drawing a storyboard of the beginning, middle, and end of a black hole's life.
5. What is it that ultimately ends a star's life? What needs to happen to create a black hole?
6. Do you think our own Sun could become a black hole?
7. Why is a black hole black? Why can't you see light coming from inside of a black hole?
8. Try this experiment:
    - Run 20 feet. How long did it take you?
    - Run 40 feet. Did it take twice the time?
    - Calculate the time it would take you to run1,250,000,000, which is one and one-fourth billion feet. That's the distance from Earth to the Moon.
    - How long would it take you to get to Earth's nearest black hole?

10. If you cannot see a black hole, how do you know it's there? Visit the Event Horizon Telescope page to see a telescopic image of a black hole. List the evidence you would need to declare a black hole's existence.
11. The author includes a joke in the book: "If it looks like a duck, and quacks like a duck, then we can safely state it is likely to have its identity as a duck confirmed at some point in the future, pending additional evidence." It's funny, but is it true? Why do you think science moves so slowly?
12. Many of the images in this book are created by artists. Since you cannot travel to a black hole, take what you've learned in the book to create your own black hole picture.

Can Do! Exploring the Unknown

Science is all about being curious—and what we do to satisfy our curiosity. Most of that doing comes down to making observations and inferences. When we add in actions like conducting a field study, digging up artifacts and fossils, or running an experiment, we are essentially structuring our observations so we can make good inferences.

This activity brings all of this into concrete and engaging reality for students. While it can be run with different variations, the basics are simple. Students are invited to explore the contents of a sealed container in an effort to describe (and possibly identify) what's inside. It's best if you, as the teacher, also don't know what's inside, so try to get a partner to set up the cans.

The key in the facilitation is to add just enough structure so students feel curious but not too stymied. This is a fun—and educational—experience. This lesson plan should help you find, and keep, the sweet spot.

> ***Why have someone else prep the cans?***
>
> Being able to honestly tell your students that you don't know what is inside the cans drives home the idea that, in general, scientists can't go to a Grand Teacher when they are done exploring and ask if they got the answers to their questions right. Instead, they rely on whether an answer truly makes sense, and whether there are other equally good explanations. They progressively work to narrow down the possible explanations for what they observe, and test these ideas continuously.

What you need:

- Easel sheets or chalkboard/whiteboard
- 6–10 metal containers for the Mystery Cans
  Notes:
  - Coffee cans or inexpensive metal paint cans (purchased at a hardware store) work well.
  - Try if possible to have identical cans (don't mix and match paint cans with coffee cans, or different styles/sizes of coffee cans).
  - If necessary, you can run this activity with just one can, but having 6–10 allows you to pass the cans around the class. For COVID-related conditions, either have students wear gloves or provide 1 can per student or acceptably sized team.
- 2-3 everyday objects to put in each container
  Notes:
  - The exact choices don't matter. But at least one item in each container should be hard so it makes a noise that can be explored through shaking.
  - Choose something that will survive a lot of shaking. Still, even when objects break, that is of interest during the exploration.
  - A mix of objects works well.
  - Here are suggested objects to choose from. They work well to hold students' attention (especially when mixed or when multiples are in the can):
    - ◊ Washers, nuts
    - ◊ Coins
    - ◊ Marbles or metal balls
    - ◊ Wooden spheres and/or cubes
    - ◊ Cylindrical objects: batteries (of different sizes), wooden cylinders, spools, nails, screws, bolts, pencils
    - ◊ Chains
    - ◊ Paper clips (metal and rubberized)
    - ◊ Plastic buttons
    - ◊ Pompoms, small bean bags, rubber balls
    - ◊ Rubber or gel snakes
    - ◊ Erasers
    - ◊ Felt

    - ◊ Craft foam
    - ◊ Crumpled-up paper

- **Duct tape for sealing container lids**

- **Optional** materials:
    - Additional empty cans (so students can model and test what they think is inside their cans)
    - A diverse array of objects and materials to allow students to test their ideas about what might be inside their mystery cans
    - Items for an extended activity that can help students experiment with their cans in a variety of ways; for example:
        - ◊ Magnets (to test whether the contents are magnetic, by placing on the outside)
        - ◊ Balance (to help compare different cans, including students' models and the mystery can they are investigating)
        - ◊ Ramp (in case students think that rolling the cans would help them investigate)
        - ◊ Large sinks or containers of water (in case they want to test for buoyancy)

Preparation:
If at all possible, enlist someone else to create the mystery cans (Steps 1 and 2) while you are not around, so that you will not know or guess the cans' contents.

1. To make the cans, fill each can with the same contents as all the others. Put 2–3 items in each can.
   Note: For older students (perhaps Grades 4 and up), consider making two sets of cans. All the cans within a set should have the same contents. The contents of each set should be similar enough for students to start out assuming their can is identical to any other can, but different enough to allow observant students to begin to realize that there are/may be differences.

2. Seal each container well.
   Coffee cans will need duct tape. Metal paint cans can be hammered shut, but added duct tape is a good way to emphasize that the can is sealed and should remain so. Working neatly, add enough duct tape around the top of the can so that it would be difficult for someone to remove it and peer inside the can.

3. To prepare to lead this activity, *before students arrive*, place one can on a table or stool so that every student will be able to see. You will begin by pointing to the can but not handling it.

4. If you are implementing this activity as part of a literacy extension for *A Black Hole is NOT a Hole*, decide if you want students to complete the book before the lesson or to use this lesson to frame their reading of the book.

Procedure:
This procedure includes a lot of notes to help you facilitate this experience, but the key is to introduce the activity, allow students to explore the contents of the can by observing the effect the contents have on the can, and then lead the class through a discussion that helps connect their observations to inferences. Optionally, this can be extended over another session to allow students to experiment in more elaborate ways to gather more information.

> Scientists operate on the edge of what they know already and what they can determine from observation and inference. And they argue (in professional ways, we hope!) about the details, even though some ideas have broad consensus. For example, everyone can agree right away that a large object—a car, a textbook, etc.—is not in the can because it cannot fit. In a can that makes a loud, clanging sound when it is shaken, everyone might agree with the idea that something hard is inside—ruling out, say, a rubber ball—but they may disagree on the object's shape or material.

1. **Begin with a question that many students can relate to:**
   Have you ever received a gift and tried to guess what's inside?
   How is this like a mystery?
   How is science like trying to guess what's inside a package?

   (We are curious about the contents of the gift package. The contents are mysterious—unknown to us. Detectives and scientists alike act on their curiosity, trying to find out more by making observations.)

2. **Connect to black holes (or other science topics):**
   Say something like:
   Black holes are a great mystery. Scientists weren't even sure they existed, but by making observations and connecting that to other information, they were able to find them. But scientists didn't just point telescopes to the sky and see them. They inferred (figured out) the existence of black holes by the effects they have on their surroundings—just as you can sometimes infer (figure out) the contents of a gift by the effect the gift has on the package, your ears when you listen as you shake the gift, your hands as you hold the package and possibly probe it.

   Science is really about exploring things that make us curious, and finding out more about the unknown.

3. **Introduce the Mystery Can.**
   Call students' attention to the Mystery Can that is already set up in front of the classroom, without moving it. If you can't have it set up ahead of time, and have to instead pick it up, be very careful not to let any of the contents make any noise. If you are inclined, you can also act as though the can is heavier than it is.

   Tell students that you want them to get a feeling for this exploration of the unknown, and use the same skills as scientists, to try to figure out everything they can about the contents of the can. Try to emphasize that their challenge is not just about answering, "What's inside?" but also about describing the contents. In fact, they may not be able to say exactly what is inside, but they will collect lots of information.

   Students may begin to start guessing right away. Let them enjoy this a little, but also chime in and point out that these guesses are based on some observations they are making and knowledge that they already have. If students don't start calling out, ask them:

   What do we already know about what's inside the can?

   You might get stumped silence. You can follow up with questions to point out the obvious, such as: "Do you think there's a car inside? A text book? Why (not)?" On the other hand, students might readily realize that it's something small, or make other conjectures, which you can field. Keep asking students to justify their statements. As they do so, note what's an observed fact, and what's an inference (something they've figured out by using the fact/observation).

   <u>*For example*</u>:
   The can is small, so whatever is inside has to be smaller than, or exactly the same size as, the can (even if it is folded up).
   Fact/observation: The can is small.
   Inference: Whatever is inside is also small.

4. **Lead students to think about how they could collect new observations that would help them explore/ discover more about what's inside the can.**
   Ask: What could we do to find out more about what's inside the can?

   One important, obvious response is that we could open it and look inside. If students don't bring this up, mention it. Tell them that often, science can be straightforward—like when students dissect a flower, watch fish in a fish tank, etc.

   Tell students that sometimes science is not that straightforward, so they will NOT be able to open the cans and just look inside. Ask them to suggest other things they could do, and encourage them to state what these actions would reveal, or how they would help students make more observations.

   Examples:
   "We could hold it." —*What would that tell you?* "How heavy it is."
   "We could smell it."—*What would that tell you?* "It might tell us if there's coffee inside, or we might smell something else that we recognize."
   "We could shake it."—*What would that tell you?* "We might hear if there's anything in there —and tell if it sounds like a liquid, gas, or solid, or a mix, or if solids, if there's anything loose."

   Give the can one, little shake, enough to tantalize students. Ask them to share their observations. They may start guessing; gently redirect their attention to describing and noting their observations. Point out that their guesses about what's inside are inferences based on their observations.

5. **Allow students to explore the contents of cans.**
   Invite students to explore cans of their own and collect as many observations as they can in a few minutes.

   Establish rules: This is exciting and noisy! Tell students how you will call their attention, and be clear on the fact that when you do so, you expect them to place the can on a surface, with no one touching it during the discussion. Also set the expectation that students will share the cans with each other (in their small teams). You can allow/encourage cross-team sharing and comparing as well.

   Distribute cans to small groups of students. Allow them to try whatever (safe, reasonable) manipulations of the can they think of. Circulate among the groups asking them to share their observations. Ask for detail and for their thoughts/inferences, continuing to emphasize the difference between observations and inferences.

6. **After several minutes, call the class's attention and discuss their findings.**
   During the discussion, allow one student at a time to demonstrate with the can, if that seems appropriate. For example, if a student says, "It made a clinky noise," you might ask the student to re-create that noise so the rest of the class can hear it.

   As you collect observations, ask other groups to comment on whether they made the same observation/ heard or felt the same thing. As needed, you can invite student teams to pick up their cans and try whatever a speaker demonstrates.

   Point out observations that are the same and those that don't seem to be universal. Ask students why they think that might be. (Possible answers: The test was not exactly the same; this is an opportunity to remind students about "fair tests"/controlled experiments. The contents may not be the same. Students observe differently.)

Treat the possibility of the contents of the cans being different across (at least some) cans as a major discovery. Encourage students to probe that possibility. (You can have teams with potentially different cans demonstrate some shaking/rolling/movements/other tests for comparison.)

Consider scribing student observations on a T-chart.
Sum up the observations before moving on to Step 7.

7. **Give students a few minutes to talk to each other about what they think they can confidently say about the contents of the can.**
   Encourage them to both describe the contents ("There are multiple objects, some made of metal") and try to identify the contents ("I think they are coins."). Group members do not have to agree but should help each other think through their responses .

8. **Ask students to share their ideas. Focus on the descriptions and the conclusions.**
   Ask students to explain why they think what they think. Which observations are they drawing from? Point out that ideally, a good inference about the contents of the can is that it should account for all observations. Which observations might be unaccounted for by any inference?

   Note that in real-world science, some leading ideas don't account for, or explain, all of the observations. The strongest, and most broadly accepted, ideas do account for all or the vast majority of observations. They also allow for predictions that can be tested. The predictions should allow the idea to be eliminated or strengthened.

9. **Make a connection to real-world science.**
   Refer back *to A Black Hole is NOT a Hole* (or other science content) and ask students to identify any observations and inferences that helped to build the idea of black holes and identify specific black holes.

   Also focus on any science experiences that the class has engaged in, connecting their science to real-world science. They both (should) focus on the discovery of the unknown.

   Now would be a perfect time to discuss Item 11 in the Black Hole Discussion Guide (above), referencing the joke that begins "If it looks like a duck and acts like a duck..."

10. **Collect the cans.**
    Students may groan—why can't they open the cans now? Also, they may ask you if they are right about the contents of the can.

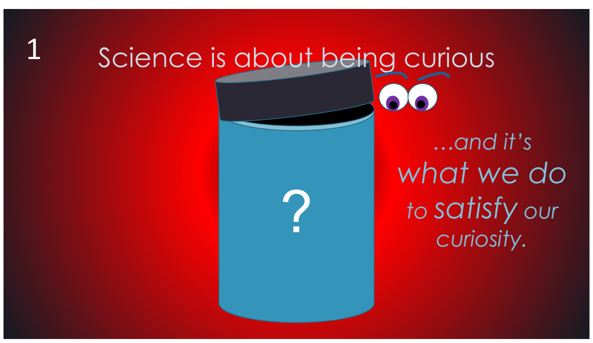
    If you have elected not to know what's inside the cans, consider NOT opening the cans. Tell students that to be fair, you also made sure you do not know the contents, and that this is the way science is sometimes. There's nobody who will tell scientists if they are correct or not with their ideas. Only the world/universe can tell them, by revealing more information that scientists can observe. (Scientists can think of new ways to get that information, like, say, modeling—taking an empty can and filling it with known objects representing what they think might be inside the mystery can, and comparing observations.)

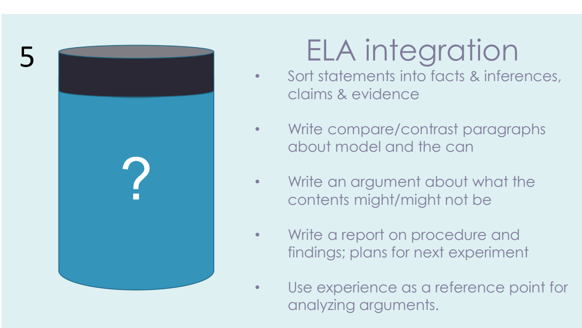
    Or, depending on the age of students, you can try opening the cans. For educational value, compare observations to the contents: How does knowing what's inside help explain the observations?

Optional Extensions:
These extensions could be implemented as formal lessons or on an activity table.

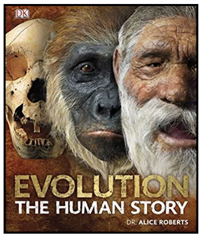
- **If you have not opened the can(s):**
  - You can offer students the opportunity to model their inferences and ideas about what's inside the can, by providing an array of materials and empty cans. Students should fill the cans with objects that are as similar to what they think is inside the mystery can as possible, seal the can, and compare observations. They should feel free to continue to revise the contents of their model cans/revise their model, based on results.
    - You might want to encourage this to be a more systematic process by asking students to track their models, experiments, results, and what they will try next (and why).
  - You might offer students the opportunity to try experimenting with new approaches, such as using magnets on the outside of the can, rolling cans down a ramp, testing for buoyancy, etc., to help eliminate or confirm their ideas about the mystery can's contents.

- **If you have opened the can(s):**
  - Encourage students to continue to practice their skills by creating new mystery cans to share with each other.
  - Consider using these new cans over time, but telling students that there will be one master mystery can that they won't open. Introduce that can after a few weeks and conduct the exploration as in the main activity.

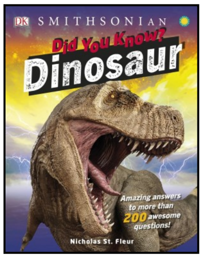




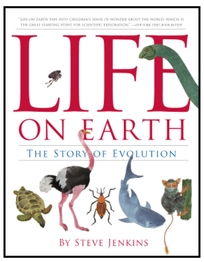
Suggested further reading and resources



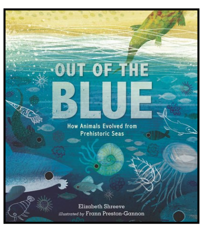
Evolution: The Human Story
Edited by Dr. Alice Roberts • Illustrated by the Kennis Brothers
DK Publishing • 978-1-465-47401-8 • HC • 2018 • 256 pages



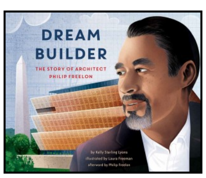
Did You Know? Dinosaurs
Nicholas St. Fleur
DK Publishing • 978-1-46549-068-1 • PB • 2020 • 144 pages



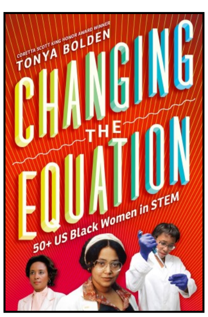
Life on Earth: The Story of Evolution
Steve Jenkins
Clarion • 978-0-35810-844-3• PB • 2020 • 40 pages



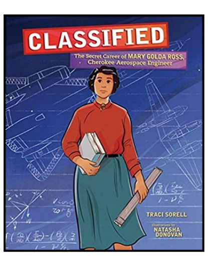
Out of the Blue: How Animals Evolved from Prehistoric Seas
Elizabeth Shreeve • Illustrated by Frann Preston-Gannon
Candlewick • 978-1-53621-410-9 • HC • 2021 • 32 pages



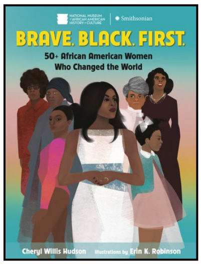
Dream Builder: The Story of Architect Philip Freelon
Kelly Starling Lyons • Illustrated by Laura Freeman
Lee & Low • 978-1-62014-955-3 • HC • 2020 • 40 pages



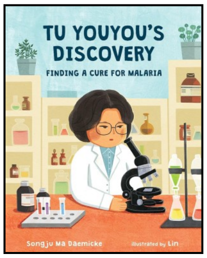
Changing the Equation: 50+ US Black Women in STEM
Kelly Starling Lyons • Illustrated by Laura Freeman
Abrams • 978-1-4197-0734-6 • HC • 2020 • 208 pages



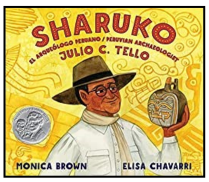
Classified: The Secret Career of Mary Golda Ross, Cherokee Aerospace Engineer
Traci Sorell • Illustrated by Natasha Donovan
Lerner/Millbrook • 978-1-5415-7914-9 • HC • 2021 • 32pages



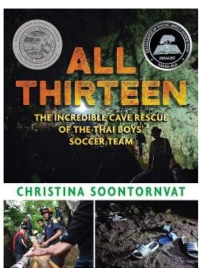
Brave. Black. First. 50+ African American Women Who Changed the World
Cheryl Hudson • Illustrated by Erin K. Robinson
Crown Books for Young Readers • 978-0-52564-581-8 • HC • 2020 • 128 pages



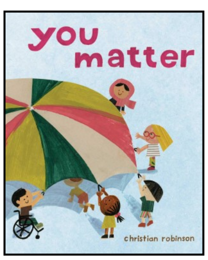
Tu Youyou's Discovery: Finding a Cure for Malaria
Songju Ma Daemicke • Illustrated by Lin
Albert Whitman & Co. • 978-0-80758-111-7 • HC • 2021 • 32 pages



Sharuko: El arqueólogo peruano Julio C. Tello/Peruvian Archaeologist Julio C. Tello
Monica Brown • Illustrated by Elisa Chavarri
Lee & Low • 978-0-89239-423-4 • HC • 2020 • 40 pages

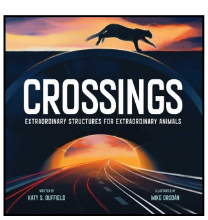


All Thirteen: The Incredible Cave Rescue of the Thai Boys' Soccer Team
Christina Soontornvat
Candlewick • 978-1-53620-945-7 • HC • 2020 • 288 pages

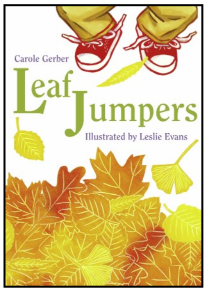


You Matter
Christian Robinson
Atheneum Books for Young Readers • 978-1-53442-169-1 • HC • 2020 • 40 pages

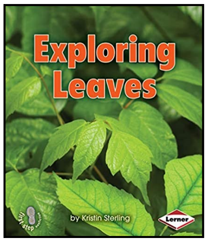
The Leaf Detective: How Margaret Lowman Uncovered Secrets in the Rainforest
Heather Lang • Illustrated by Jana Christy
Calkins Creek • 978-1-68437-177-8 • HC • 2021 • 48 pages



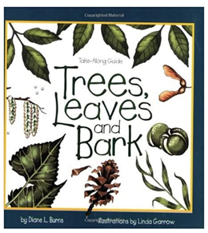
Crossings: Extraordinary Structures for Extraordinary Animals
Katy S. Duffield • Illustrated by Mike Orodán
Beach Lane Books • 978-1-53446-579-4 • HC • 2020 • 48 pages



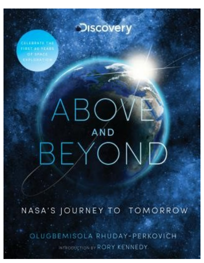
Leaf Jumpers
Carole Gerber • Illustrated by Leslie Evans
Charlesbridge • 978-1-57091-498-0 • PB • 2006 • 32 pages



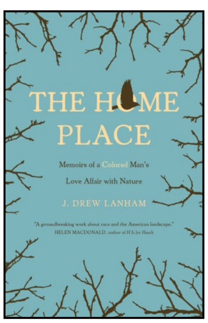
Exploring Leaves
Kristin Sterling • Illustrated by Leslie Evans
Charlesbridge • 978-0-76137-833-4 • PB • 2011• 24 pages



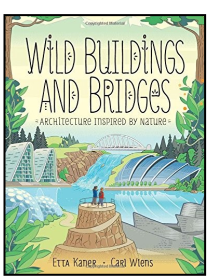
Trees, Leaves, and Bark
Diane L. Barnes • Illustrated by Linda Garrow
NorthWord • 978-1-55971-628-4 • PB • 1995 • 48 pages



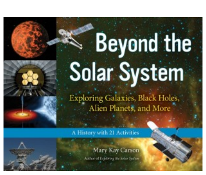
Above and Beyond: NASA's Journey to Tomorrow
Olugbemisola Rhuday-Perkovich
Feiwel & Friends • 978-1-25030-846-7 • HC • 2018 • 160 pages



The Home Place: Memoirs of a Colored Man's Love Affair with Nature
J. Drew Lanham
Milkweed • 978-1-57131-350-8 • PB • 2017 • 240 pages



Wild Buildings and Bridges: Architecture Inspired by Nature
Etta Kaner • Illustrated by Carl Wiens
KidsCan Press • 978-1-77138-781-1 • HC • 2018 • 40 pages



Beyond the Solar System: Exploring Galaxies, Black Holes, Alien Planets & More
Mary Kay Carson
Chicago Review Press • 978-1-61374-544-1 • PB • 2013 • 144 pages

Society for the Study of Evolution
Resources for Teachers and Students
https://www.evolutionsociety.org/content/education/resources-for-teachers-and-students.html

PBS
Online Lessons for Students: Learning Evolution
https://www.pbs.org/wgbh/evolution/educators/lessons/index.html

Ask Nature
It is time to quiet our cleverness, to observe and listen deeply, and reconnect to nature's wisdom by asking, "How does nature solve this?"
https://asknature.org/

National Science Foundation Kids' Science Challenge
Providing resources for future scientists from elementary through college
http://www.kidsciencechallenge.com/

Society for Science & the Public Science News for Students
Dedicated to providing age-appropriate, topical science news to learners, parents, and educators.
https://www.sciencenewsforstudents.org/

NASA's Imagine the Universe!
Intended for students age 14 and up, and for anyone interested in learning about our universe.
https://imagine.gsfc.nasa.gov/

Event Horizon Telescope
An international collaboration capturing images of black holes using a virtual Earth-sized telescope.
https://eventhorizontelescope.org/

Iowa State University BugGuide
Identification, images, and information for insects, spiders, and their kin for the United States and Canada.
https://bugguide.net

iNaturalist
A joint initiative of the California Academy of Sciences and the National Geographic Society.
https://www.inaturalist.org/

Arbor Day Foundation: What Tree Is That?
Tree identification field guide.
https://www.arborday.org/trees/whattree/