

Outdoor SCIENCE LAB

BUGS & PLANTS & DIRT

GET OUT
& LEARN!

EXPERIMENTS BY
PAUL BECK

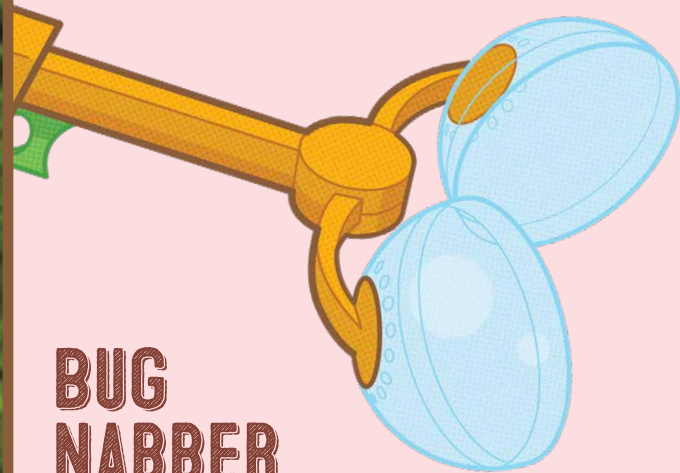


OUTDOOR SCIENCE

Hand wash your equipment in warm, soapy water before using it the first time. Wash and dry it between experiments as needed.

Your lab is the great outdoors! Investigate your yard, your neighborhood, the park, school grounds, or anywhere else you find interesting things to explore outside.

HERE'S WHAT'S INCLUDED:



BUG NABBER

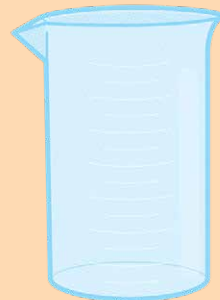
Catch insects to observe in the Nature Scope or take a look at them in the Bug Nabber itself! Pull the trigger to close the Nabber and nab your bug. Be careful not to pinch the animal between the edges.

NATURE SCOPE

Place the scope over your specimen and have a look through the magnifying lens. Slide the bottom in place to create an observation box for bugs. Open the bug door to let captured critters out when you're finished observing them.

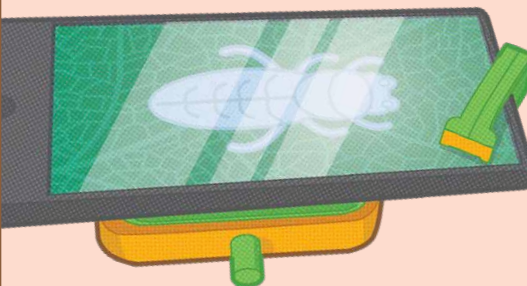
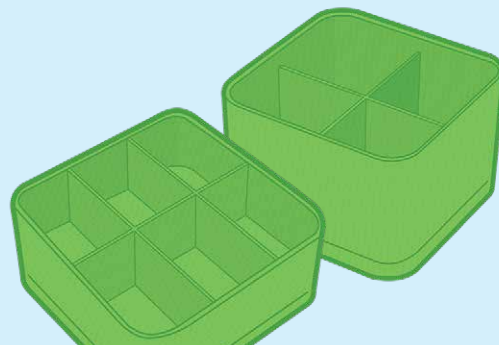


BEAKER



SAMPLE CONTAINERS

For collecting and sorting samples. Snap a container onto the bottom of the Nature Scope for a magnified view, or stack them both with the scope to create a handy carrying kit.



MACRO LENS CLIP

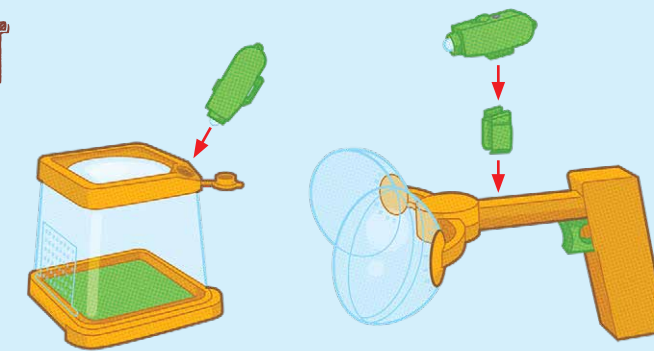
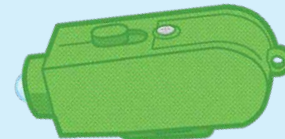
Turns your cell phone into a microscope! See page 4 for how to use your Macro Lens Clip.

ZOOM-AND-FOCUSING PLATFORM

Helps steady the phone for precise, extra-close viewing. Place the phone on the platform with the camera lens over your specimen. Turn the knobs to select the distance and focus.

ULTRAVIOLET (UV) LAMP

Use it by itself, insert it in the light port on the Nature Scope, or mount it on the Bug Nabber with the mounting clip.



CAUTION!

Don't point the UV lamp directly at your eyes or anyone else's.

TAKE-ALONG ID CHARTS

Identify bugs, plants, and rocks in the wild.

YOU'LL ALSO NEED:

Depending on the experiment, you'll also need some other supplies. You'll find them listed at the beginning of each activity. You might also want a notebook and pencil or pen to make notes and sketches of your discoveries and questions.

SAFETY FIRST!

There are a few things to keep in mind before you head out the door:

- Before starting an experiment or activity, read all the information and instructions, all the way through.
- Make sure you have all the tools and materials you need, and that you understand what you're going to be doing.
- Don't do anything that would hurt an animal. (Yes, insects, slugs, and roly-polies are animals!) Catch only insects and other invertebrates with your Bug Nabber and Nature Scope. Don't try to catch anything that's too big to fit. Release all animals after studying them, in the same place where you caught them.
- Don't do anything that could hurt you! Stay away from stinging and venomous insects, and leave spiders and centipedes alone. Watch out for plants that could sting you (like nettles), poke you (like blackberries or cactuses), or give you a rash (like poison ivy or poison oak).

READY TO GET STARTED?

Turn the page and head outside!

HOW TO USE THE MACRO LENS

The macro lens works great with a single lens phone camera, so you can try different phones—even older ones.

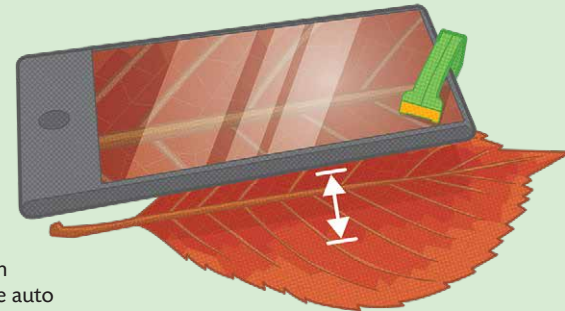
The same instructions work for phones and tablets.

- 1 If your phone has more than one lens, determine which is the primary lens. To do this, turn on the camera and hold your finger over each lens, one at a time. When your view is blocked, you have found your primary lens.

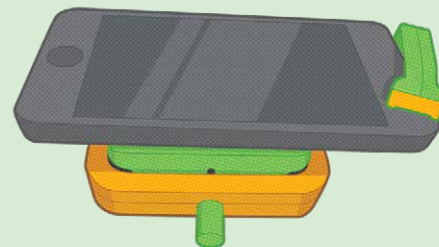


- 3 Using either the photo or video setting, start with the standard zoom and get the hang of focusing.

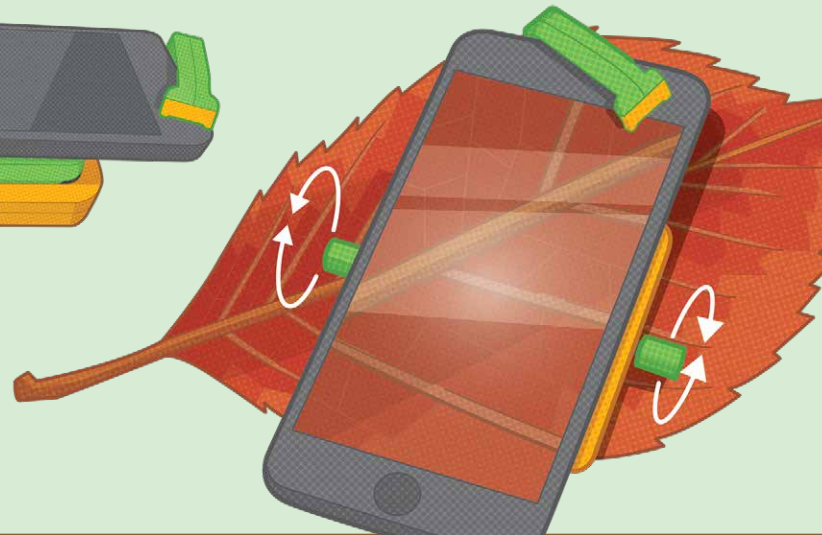
- Get close to your specimen. Move the phone slightly up and down over your specimen and let the phone auto focus. You will need to get pretty close—about half an inch.
- Once your specimen is in focus, zoom in on it! You may need to move your phone slightly to refocus.
- Take pictures or videos of what you find! Keep practicing and you will get better at using your macro lens.



- 4 To use the focusing base, place your phone on the base, as shown.



- 5 Turn the focus knobs to bring different levels of the specimen into focus!



- 2 Spread the clip apart and place the macro lens over the primary lens on your phone. You can turn the clip so that it rests against the phone and is out of your way.



UNDERNEATH IT ALL

It all starts with soil. Plants get their nutrients and minerals from it. Animals get their food from plants, and still other animals gobble up those plant-eating animals. Soil is where plants and fungi grow, and it's where many animals make their homes. In short, soil makes life on land possible.

DIRT DETECTIVE

GET THE DIRT ON SOIL!

TOOLS & SUPPLIES:

- Nature Scope
- Phone with macro lens clip and focusing platform
- Six-compartment collection container
- White paper
- Tape
- Marker
- Small digging and scooping tool—a spoon works well, but be sure to get permission to use it. (Don't use the fancy silverware!)
- Notebook and pencil

- 1 Use the tape and marker to label the compartments of the collection container 1–6.

- 2 Now go outside and dig up six small soil samples. Look for soils that are different from one another. Try different places: around trees, in places with and without plants, damp areas, dry areas, and so on.

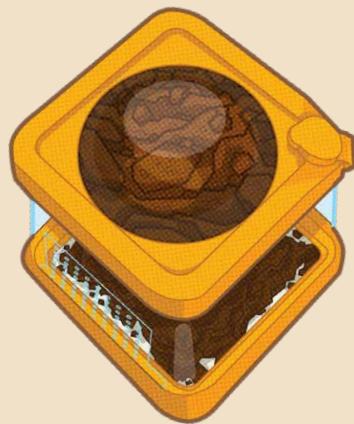
- 3 Put each sample in a different compartment of the collection container. Write down where each one came from. Note the place, the types of plants growing in the soil, and anything else you notice.

- 4 Take the samples to your work area to examine them. For each sample, make these observations and write down what you find:

NEXT UP...
Examine your soil samples!

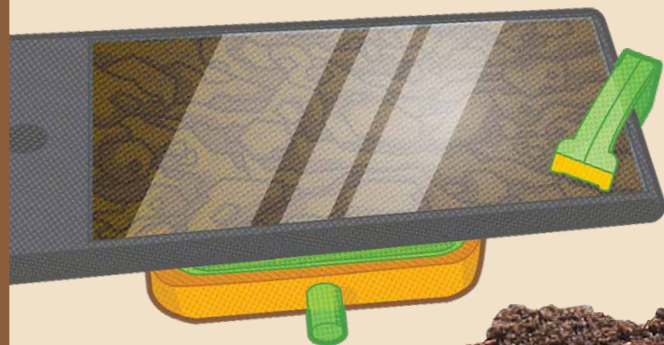


Spread the sample out on a piece of paper. Feel it with your fingers. Is it coarse? Fine? Damp? Dry? What color is it?



Use your Nature Scope to take a closer look. What soil components do you see? What are the particles like? Do you see plant parts? Are there insects, worms, or other animals?

For an even closer view, use your phone with the macro lens and focusing platform.



When you're finished, take the soil samples back outside. Be sure to clean your tools and work area.

LOAM ON THE RANGE

One way to talk about soil is by the size of the mineral particles in it. There are three main categories:

- **Sand:** big, coarse particles. Easily falls apart if you squeeze it.
- **Silt:** small, fine particles. If squeezed, holds its shape better than sandy soil.
- **Clay:** very small, fine particles. Sticks together well if you squeeze it.

MIXING IT UP

Soils with a mix of all three particle sizes is called loam. The amounts of sand, silt, and clay in the loam affect how much water and air the soil holds, how well it drains, and what kinds of plants grow best in it.

Compare the soil composition in your yard with the soil in your friend's yard (get permission before you dig!)

ACIDS, BASES, AND SOILS

A soil's pH affects how well different kinds of plants can grow.

You know what an acid is: it's something that tastes sour, like vinegar or lemon juice. A base is the opposite of an acid. The strength of acids and bases is measured with a number called pH. One of the big differences among soils in different areas is their pH.

MUD MILKSHAKE

STIR, SETTLE, SEPARATE!

TOOLS & SUPPLIES:

- Beaker
- pH test strips
- Water
- Small garden trowel, metal spoon, or other digging tool
- Stir stick
- Notebook and pencil for recording your results

pH TEST STRIPS

Your test strips change color depending on the pH of the liquid you dip them in, red for acid and blue- for base. The stronger the acid or base, the redder or bluer the color. Orange and green indicate weaker acids and bases.

- 1 Go outside and fill the beaker to the 60 mL mark with soil.
- 2 Add water to the 120 mL mark. Stir until the soil and water are completely mixed.
- 3 Let the beaker sit for about an hour to allow the soil and water mix to settle.
- 4 The soil components will settle into different layers:
- 5 Dip the end of a pH strip in the liquid for a count of 2 seconds. Is the soil acidic (pink)? Basic (blue or green)? Neutral (no change in the test strip)?
- 6 Dump the mixture outside, rinse out the beaker, and try a sample from a different area: near a tree or from a flowerbed or vegetable garden (get permission!). Are your results different?



DIFFERENT PLANTS, DIFFERENT SOIL NEEDS

Most plants grow best in soil that's slightly acidic or neutral.

THE SCOOP ON SOIL

It's not just a pile of dirt! Soil isn't simple. It's a mix of minerals, air, water, living things, and things that were once alive.

- **Organic Material:** The organic part of soil is the part made of once-living things such as decaying leaves and other plant material, along with the bacteria that break them down. This material is sometimes called humus (HYOO-muss). Not to be confused with hummus!
- **Minerals:** Minerals are the non-organic particles in the soil, including pebbles, sand grains, and silt and clay particles. (More about those later.)
- **Air:** Soil includes tiny air spaces between the particles.
- **Water:** Different soils hold different amounts of water. (More about that later, too.)
- **Living Organisms:** Finally, soil is home to living organisms. Not just plants, but also bacteria, fungi, worms, insects, and more.

MAKE YOUR OWN SIGNATURE SOIL!

Now that you know what dirt is made of, make some super-healthy, plant-growing soil for your yard or garden!

COMPOST BOTTLE

NOTE: THIS IS A LOOOOONG EXPERIMENT!

TOOLS & SUPPLIES:

- Clear, clean 2-liter drink bottle with cap (Remove the label.)
- Scissors
- Tape
- Permanent marker
- Measuring cup
- Spray bottle for water (optional)
- 2 cups of fruit and vegetable scraps, cut up (No animal products!)
- 2 cups of leaves and/or grass clippings
- 2 cups of shredded paper (Newspaper works best.)
- 3 cups of soil

COMPOST NEEDS FOUR THINGS:



1

"Green" material (fruit and vegetable scraps, leaves, and grass clippings)



2

"Brown" material (dried leaves or shredded paper)



3

Water



4

Air

When you combine them, bacteria and fungi go to work breaking down, or decomposing, the compost.

REQUIRED!

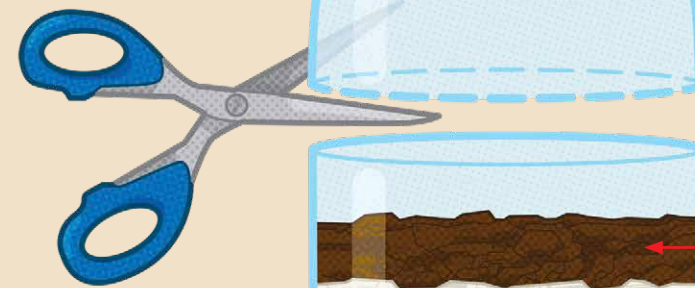
You'll need an adult assistant for the first step of this experiment.

1

Have your adult assistant cut the top off the 2-liter bottle. Set the top aside.

2

Layer the materials like this:



Repeat the layering with the rest of the food scraps, leaves, paper, and soil.

Water to the top layer of soil until it's damp.

3

Tape the top back on the bottle. With the marker, draw a line on the outside to mark the top of the compost pile.

4

Put your compost bottle in a sunny place for three weeks. Check weekly to see how the compost has changed. Things to look for:

- Has the level of the compost changed? Mark the new level on the outside of the bottle.
- Are the different layers breaking down differently?
- Do you notice any fungi (mold)?
- Feel the bottle. Is it warm? The bacteria and fungi release heat as they decompose the compost.

5

At the end of the third week, turn the bottle to mix all the layers together. Mark the level, then leave it for another week to see what happens.



1/2-inch Soil

1 cup Shredded paper. Spray the paper with water to dampen it.

1/2-inch Soil

1 cup leaves and grass clippings

1/2-inch Soil

1 cup food Scraps

1-inch Soil. Spray water on top to dampen it.

If the compost isn't decomposing well, unscrew the cap, add a little water, and close it up again.

WHEN YOU'RE FINISHED, YOU CAN USE YOUR COMPOST IN THE YARD OR GARDEN!

GEOLOGY ROCKS

Scientists who study rocks and minerals are called geologists. Check out the Rocks section of your ID chart to learn about different types of rocks.

ROCK ON!

START YOUR OWN ROCK COLLECTION!

TOOLS & SUPPLIES:

- A container to carry your rocks in, such as a bag or small backpack (you don't have to fill it!)
- Sample containers (for keeping and sorting small rocks)
- Nature Scope
- Phone with macro lens clip and focusing platform

- 1 Go outside and collect some rocks and pebbles. Try to collect different kinds. Look for interesting patterns, textures, shapes, and colors, but don't forget to include a few that are just plain old rocks.
- 2 When you feel like you have a nice-sized collection, bring it home and have a look. Sort your rocks and group similar ones together. How many different kinds did you find?
- 3 Use the Nature-Scope for a magnified view of each specimen. Look for interesting features such as textures, patterns, or small crystals.
- 4 Use the phone and macro lens to zoom in for close-up pictures.



MINERALS

Minerals are the building blocks of rocks. Quartz is a mineral. So is diamond. You may see small crystals of quartz in the rocks in your collection. You probably (okay, definitely) won't see diamond!

DOES IT GLOW?

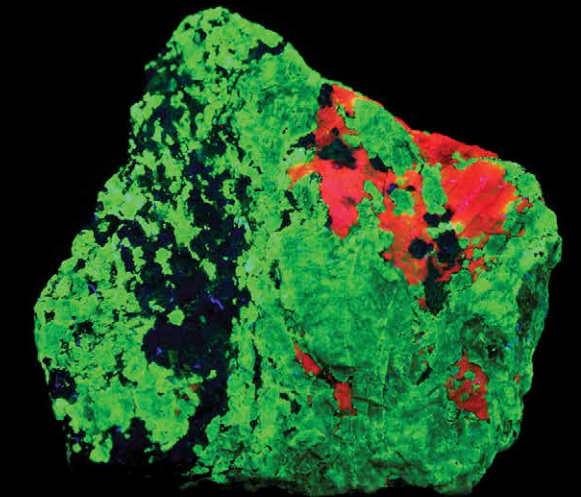
YOU'LL NEED TO WAIT UNTIL DARK FOR THIS EXPERIMENT.
TEST YOUR ROCK COLLECTION FOR FLUORESCENT MINERALS!

TOOLS & SUPPLIES:

- Your rock collection
- UV lamp
- Nature Scope
- Flashlight

- 1 Before you start, bring your rock collection, UV lamp, flashlight, and Nature Scope to your work area. Make sure to put everything where you can find it in the dark. When you're ready, grab the UV lamp and turn out the lights.
- 2 Now turn on the UV lamp and check out the rocks in your collection. Look for deep or glowing colors. You may see white, blue, green, orange, purple, pink, or other colors. If you like, you can fit the UV lamp into the Nature Scope to get a magnified view.
- 3 When you find a rock with an interesting color or glow, turn on the flashlight to see what it looks like in white light. The difference may surprise you!

If you don't find any color-changing rocks this time, don't worry. You can collect some more and try again. You might have good luck with rocks that have white or translucent areas.



The glow in the rocks comes from minerals that absorb energy from invisible ultraviolet (UV) light and release it again in the form of light you can see. That's called fluorescence (flor-ESS-sense). The color given off by the minerals under UV light can be surprisingly different from the color seen in the white light of the flashlight.

CREEPERS & CRAWLERS

The great outdoors is simply crawling with creatures. Check out the Creepies section of your ID chart to learn about different types of creepy-crawlies.

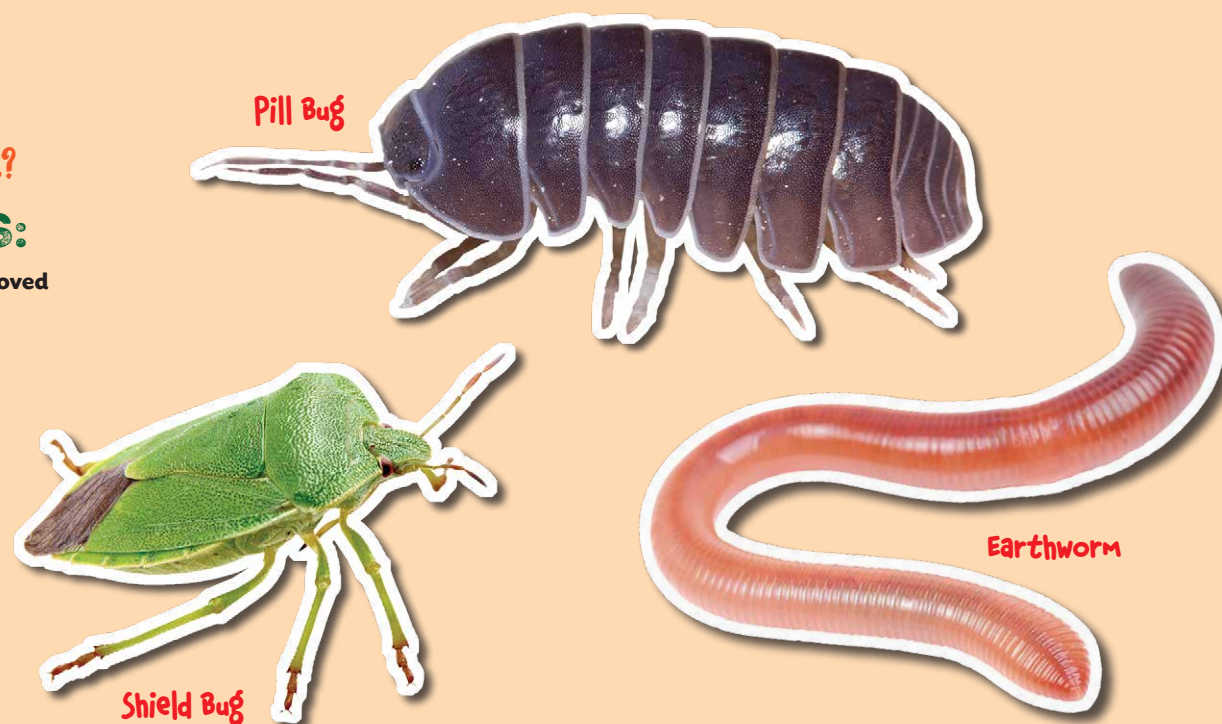
CREEPIES

WHAT'S CRAWLING IN THE SOIL?

TOOLS & SUPPLIES:

- **Nature Scope with bottom panel removed**
- **Phone with macro lens clip**
- **Notebook and pencil**

Go outside and get close to the ground. Search among the grass and plants. Turn over rocks—are animals like slugs, pill bugs, or worms creeping or crawling underneath? When you find an animal, trap it temporarily under the Nature Scope to get a magnified look. Take some close-up pictures with the phone and macro lens. Keep a list in your notebook of the animals you see. Make sketches of what you find.



BUG HUNT

GO ON AN INSECT SAFARI!

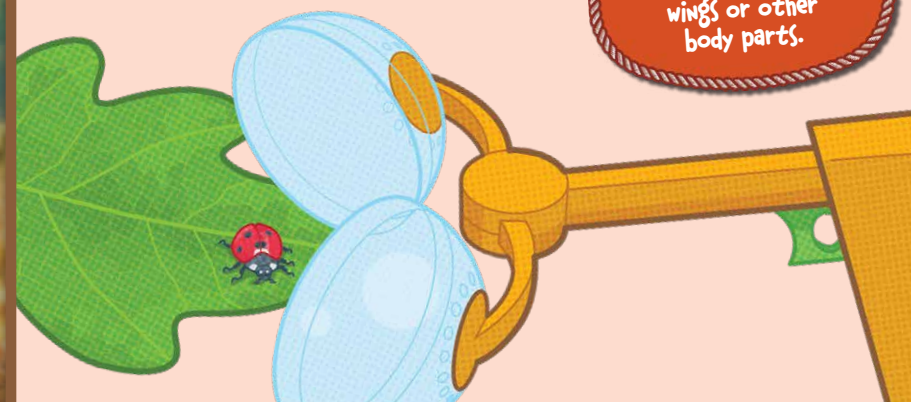
TOOLS & SUPPLIES:

- Bug Nabber
- Nature Scope with slide-in bottom panel
- Phone with macro lens clip
- Notebook and pencil for sketching

There are *millions* of insect species, tens of thousands in the United States alone. That's more than any other kind of animal. For that reason it's really hard to tell the exact identity of insects you catch on your bug hunt.

This one's simple: go outside and look for insects! You'll find them just about everywhere—on the ground, in the grass, on plant stems and leaves, walls, trees, and flying through the air. If you can, catch them (one at a time!) with your Bug Nabber, then transfer them to the Nature Scope for a close-up look. Try to identify all the body parts. Look for similarities and differences between different insects, big and small. Sketch what you see.

Be Sure not to hurt the insects when you catch them in the Bug Nabber. Don't try to catch anything that's too big to fit, and make sure you don't snap it closed on fragile wings or other body parts.



Another insect-viewing method is to slide the bottom out of your Nature Scope and just place it over an insect on the ground. And if you find an insect that will stand still long enough, you can also take some super close-up pictures with your phone and macro lens.

when you're finished studying each insect, let it go again in the same place where you caught it.

DOES THE WORD “BUG” BUG YOU?

Most people who aren't entomologists (EN-tuh-MALL-uh-jists, the scientists who study insects) use the word "bug" to mean any insect. Or sometimes even things that aren't insects all, like spiders or germs! But entomologists will tell you that only one kind of insect is a true bug: members of the order called Hemiptera (huh-MIP-tuh-ruh). Cicadas, aphids, and leafhoppers belong to this group.

DON'T TOUCH!

Don't try to catch bees, wasps, hornets, or any other insect you know can hurt you! But you already knew that, right?



CRITTERS

In addition to invertebrate animals like bugs, snails, and worms, the outdoors is home to countless vertebrates—animals with backbones and skeletons. You can't (and shouldn't, even if you could!) catch them, but you can keep an eye out for their tracks, droppings, or even the animals themselves. Many of these animals are nocturnal (awake at night). Look for their footprints or other evidence early in the morning.

HERE ARE A FEW OF THE VERTEBRATES THAT MAY VISIT YOUR YARD, PARK, OR OTHER OUTDOOR AREAS.

OPOSSUM

Opossums are the only marsupials in the United States. Females have a pouch where their tiny young, called joeys, grow after birth. Opossums aren't harmful to humans. In fact, they eat pests like ticks, cockroaches, and slugs.



RACCOON

Raccoons' mask-like markings make them look like the bandits that they are. These mammals will eat just about anything they can get their dexterous paws on. They're famous for nighttime raids on poorly-closed garbage cans and chicken coops.



SQUIRREL

Squirrels are great at living around humans. They're also great at snatching food from people's bird feeders. In the fall squirrels bury nuts to dig up and eat during the winter.



COYOTE

Coyotes have made their way into every state but Hawaii. These wild relatives of dogs don't mind living near people, even in big cities. They can be a problem, eating garbage and even people's pets. If you see one, stay away.



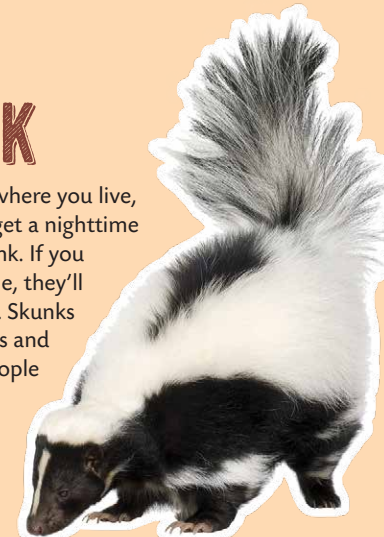
CAT

Don't forget these common nighttime visitors!



SKUNK

Depending on where you live, your yard may get a nighttime visit from a skunk. If you leave them alone, they'll leave you alone. Skunks eat many insects and rodents that people consider to be pests.



REPTILES & AMPHIBIANS

Depending on where you live, your yard may get visits from snakes, lizards, toads, or frogs.

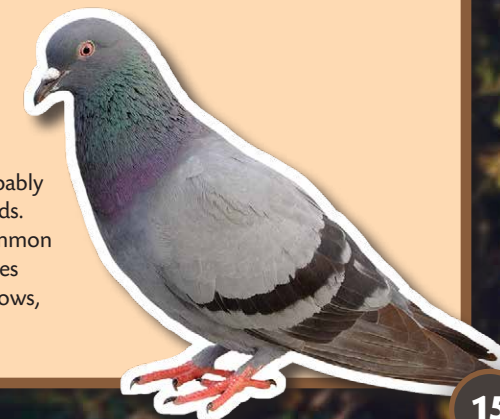
RAT

Rats have probably been living around humans for as long as there have been humans. These resourceful rodents can be troublesome pests, finding their way into people's garbage, gardens, and buildings.



BIRDS

During the day, the vertebrates you'll probably see most often are birds. Some of the most common birds in towns and cities include pigeons, sparrows, starlings, and robins.



PLANTS & THE PLANET

Plants produce the air we breathe and the food we eat. If it weren't for plants, none of us would be here. Period.

PLANT QUEST

TAKE A TRIP AROUND YOUR NEIGHBORHOOD ON THE HUNT FOR PLANTS!

TOOLS & SUPPLIES:

- Notebook and pencil
- Plant ID chart from your kit

1 For this activity, just head outside with your notebook and start investigating. Look for a variety of plants: trees, bushes, ground plants, grasses, flowers, and more.

2 For each plant you observe, make a page in your notebook with these headings, then write down what you observe. When you get back home, you'll have a whole catalog of leaves.

- Plant location
- Plant type or name, if you know it
- Leaf type
- Shape
- Draw a picture of the leaf.
- Leaf arrangement
- Notes: Is there anything special or unusual about the leaf or plant?

You'll find some plant ID information on the chart that came with your kit, but there are so many different kinds that it's impossible to list them all.

Scientists who study plants are called botanists.

If you're careful and courteous, you can collect samples of the leaves. After making your observations, pick a leaf from the plant and place it between the pages of your notebook at the place where you have written the information. Don't take leaves from people's yards or gardens (unless you have permission), and don't take them from delicate plants or ones that have only a few leaves.



WHAT LEAVES DO

A leaf's job is to make food for the plant. The leaf takes in light from the sun, carbon dioxide (CO₂) from the air, and water from the ground (through the roots). Inside the leaf's cells, the chemical reactions of photosynthesis (FOE-toe-SINTH-uh-sis) use energy from the sunlight to turn the CO₂ and water into sugar and oxygen. The sugar becomes the food that the plant uses for energy to grow and stay alive. The oxygen passes back out through the leaves into the air.

LEAVES UP CLOSE

GET A DETAILED LOOK!

TOOLS & SUPPLIES:

- Container or bag for collecting leaves
- Nature Scope
- Phone with macro lens clip and focusing platform
- Notebook and pencil for writing down notes, results, and sketches

- 1** Collect a variety of leaves and bring your collection back to your workspace.
- 2** For each leaf, try to identify the parts.
- 3** Then look for the pattern of the veins. Different leaves have different patterns. Put the leaf under the Nature Scope for a magnified view. Don't forget to turn the leaf over to look at the underside.
- 4** For an extra-close closeup of the leaf structure, take some pictures with the phone and macro lens.

A PLANT'S VEINS HAVE THREE MAIN JOBS. THEY CARRY WATER AND MINERALS FROM THE ROOTS AND THROUGH THE STEM TO THE LEAVES. THEY CARRY CARBOHYDRATES (THE PLANT'S FOOD, MADE BY THE LEAVES) FROM THE LEAVES TO THE REST OF THE PLANT. AND THEY ADD SUPPORT TO THE STRUCTURE OF THE PLANT.

SHOOTING GALLERY

When you're looking at leaves (especially the undersides of leaves) under the macro lens, you might find tiny bugs that aren't visible to you without the lens. Zoom in on these critters and take a photo with the phone's camera! You'll be amazed at what you can find!



LEAVE IT TO LEAVES

Leaves perform a plant's most important function—photosynthesis.

WHAT'S BEHIND THE GREEN?

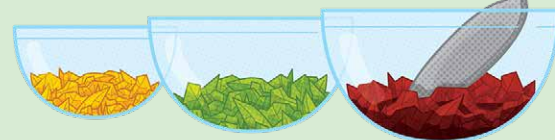
YOU'LL HAVE TO WAIT TILL FALL FOR THIS COLORFUL EXPERIMENT!

TOOLS & SUPPLIES:

- Coffee filter or thick paper towel
- Rubbing alcohol (ask permission)
- Scissors
- Bowls
- Small drinking glasses
- Pencils (sticks or chopsticks also work)
- Measuring spoon
- Wooden cooking spoon
- Four-compartment collection container
- UV lamp

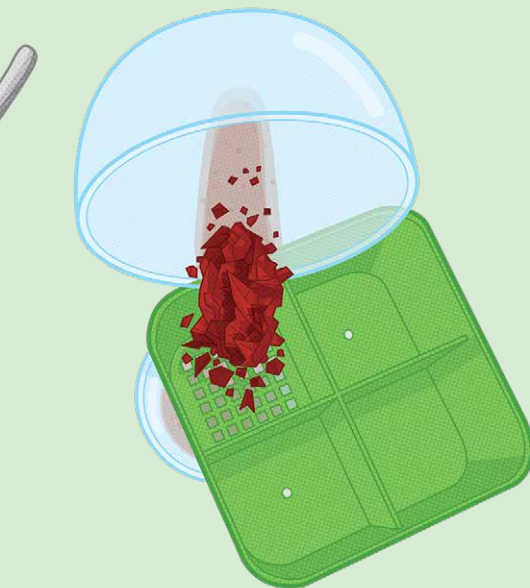
1 Go outside and gather some green, red, and yellow or orange leaves. Divide the leaves into piles by color.

2 For each color, tear the leaves into small pieces and put them in a bowl.



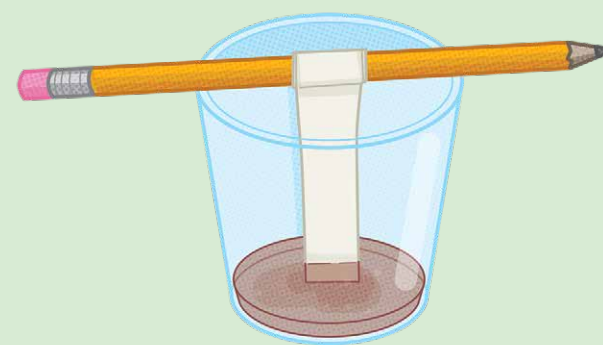
3 Add 2 tablespoons (30 mL) rubbing alcohol, then mash up the leaf pieces with the liquid using the spoon. You want the alcohol to absorb color from the leaves. The longer you mash, the better the results! Be sure to rinse off the spoon between colors.

4 Set the bowls aside for 15 minutes. While you're waiting, cut the coffee filter or thick paper towel into 1-inch-wide strips, one strip for each leaf color.



5 Carefully pour the liquid from each bowl into a separate glass. You can use the screen-like section of the collection container as a strainer. Be sure to empty and rinse it between colors. It's okay if there are a few tiny leaf pieces in the liquid.

6 For each glass, roll the end of a filter strip around the middle of a pencil, then put the pencil across the top of the glass so the strip hangs down inside with the very end in the liquid.



7 Leave the experiment alone for at least an hour (the longer, the better!). When it's time, take the filter strips out and have a look. You'll see bands of color! They come from the leaf pigments (colored substances) dissolved in the alcohol. You may see bands with different colors on a single strip. That's because the molecules of different pigments are different sizes. Larger molecules don't travel as far up the filter as smaller ones, so the colors end up in different places on the strip.



BONUS EXPERIMENT

Before cleaning up, take the glasses into a dark room and look at the liquids with your UV lamp. You'll see at least one surprise color change!

NOT JUST GREEN

Leaves have lots of different pigments. In the spring and summer, the main one is the green pigment called chlorophyll (KLOOR-uh-fill). It's an important part of photosynthesis. There's so much chlorophyll that you can't see the other colors.

In the fall, the leaves of many trees and other plants stop making food, so they don't need chlorophyll. The green pigment goes away, leaving the yellow and orange colors that were there all along. Some plants also make new, red pigments in the fall.

Separating pigments by the size of their molecules is called chromatography (CROW-muh-TOG-ruh-fee). The method you used in this experiment is called paper chromatography. (Can you guess why?)

SUN WORSHIPERS

Plants need light in order to grow, and they will bend toward light to get the most of it!

LIGHT MAZE

WATCH PLANTS FIND THEIR WAY THROUGH A MAZE!

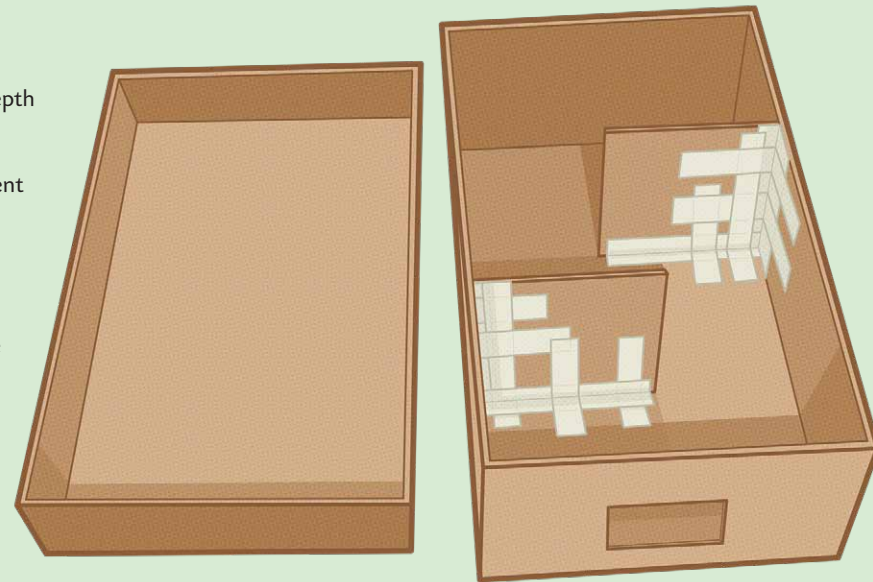
TOOLS & SUPPLIES:

- Bean seedlings in a small pot
- Cardboard
- Masking tape or other opaque (not clear) tape
- Scissors
- Ruler
- Shoebox with lid (or other rectangular box with a lid on the long side)

1 Cut a 2-inch hole in one end of the box.

2 Measure the inside depth of the box. Cut two squares of cardboard using that measurement for the sides.

3 Tape the cardboard squares inside the box to form a simple maze like this. Make sure to tape up the cracks completely where the square meets the box. The squares will work as baffles to keep the light from reaching your seedlings.



- 4 Stand the box maze on a windowsill or other place with lots of light. The hole should be on the top.
- 5 Set the seedlings in the bottom of the maze, underneath the lower cardboard square.
- 6 Put the lid on the box. Make sure there are no cracks where light can get in.
- 7 Now wait for your plants to find their way through the maze. Open the box daily to check their growth. Notice the direction the plants are growing. Does it change? Water the plants when needed. Make sure to close the box again so that light only gets in through the hole in the top.



Be patient—the plants won't solve the maze overnight!

PHOTOTROPISM

The light-following ability of plants is called **phototropism** (FOE-toe-TROPE-ism). It means "light turning," in other words turning toward the light.



FOLLOWING THE LIGHT

If the light comes from just one direction, the stem of a growing plant will curve toward it. As your plants grow, they curve toward the light coming from the openings in each part of the maze, first one direction, then the other, eventually reaching the hole in the top.

FLORAL ARRANGEMENTS

Flowers produce pollen, fruits, and the seeds that grow into new plants. Some flowers have scents and bright colors to attract the insects that carry pollen from one flower to another. Others release their pollen into the air, to be carried from flower to flower by the wind.

FLOWER QUEST

IT'S TIME TO HEAD OUTDOORS AGAIN, THIS TIME TO FIND FLOWERS!

TOOLS & SUPPLIES:

- Notebook and pencil
- Nature Scope
- Phone with macro lens clip

Take a trip around your neighborhood to see how many different flowers you can find. Sketch or describe them in your notebook. Be sure to describe the types of plants they're growing on. Try to locate all the flower parts. Use your nature scope and macro lens for a close-up view and pictures.

The quest is for looking only. Don't pick the flowers! Leave them for others to enjoy. (You can pick flowers from your own yard or garden IF you have permission.)

FLOWER FIREWORKS

ART AND SCIENCE AT THE SAME TIME!

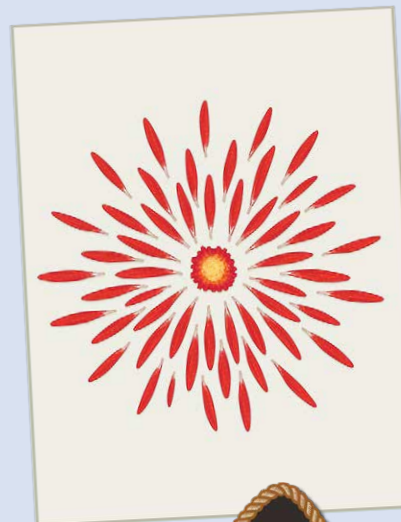
TOOLS & SUPPLIES:

- White paper (one large piece for each flower)
- Optional: phone or camera to take pictures of your fireworks

- 1 Go outside and pick some flowers. Make sure you have permission to pick them! Bigger ones work best for this project, but you can use flowers of any size. (For flowers with really tiny petals or other parts, you may need tweezers!)

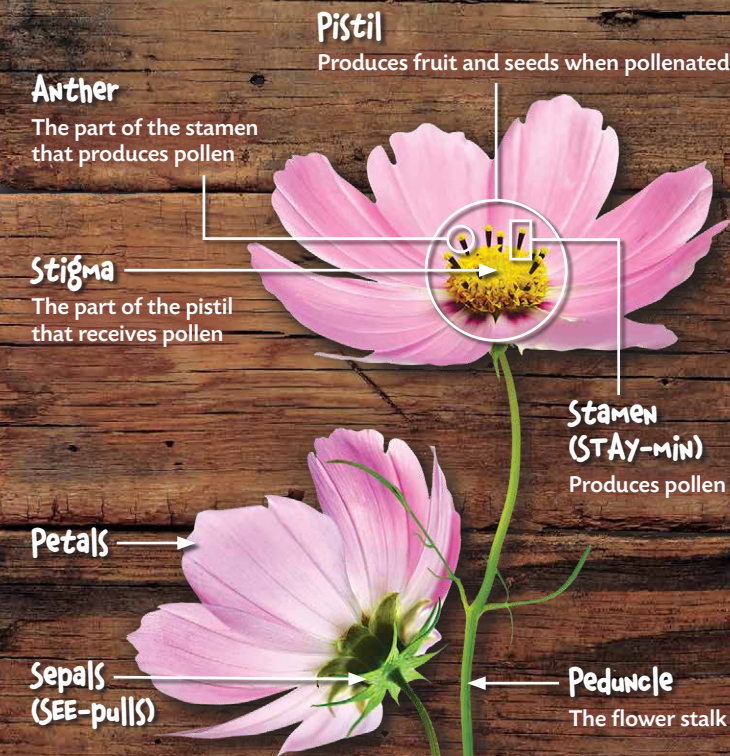
TO MAKE EACH FLOWER FIREWORK:

- 2 Carefully pinch off the parts of the flower and arrange them in a pattern on your paper. Start from the outside and work your way in.
- 3 The leaves, if any, go at the outer edge of the pattern.
- 4 Next come the sepals, leaf-like parts at the bottom of the flower.
- 5 Then the outer petals, then the inner petals, and finally the stamens and pistil at the center.
- 6 When you're finished, you'll have an "exploded" starburst showing the whole flower.



Don't forget to take pictures of your fireworks if you want to save your art.

FLOWER PARTS



Not all flowers have all of these parts. And on some flowers, the parts look different.

MUSHROOMS & OTHER FUN GUYS

They're not plants, they're fungi! Fungi break down organic matter in the soil and they release important chemicals into the atmosphere.

HOW DO YOU SAY...?

There are lots of different ways to pronounce "fungi." You can say FUN-guy, FUNJ-aye, FUN-gee (with a hard G), or FUN-jee. According to the dictionary they're all correct. It's easier if you're talking about just one: that's a fungus.

FUNGUS HUNT

Go exploring outside for mushrooms and other fungi. Take along the magnifying top part of your Nature Scope to get an up-close look.

See how many different fungi you can find. Write down your observations or draw them if you like. Refer to the ID chart for different types.

LOOK, BUT DON'T TOUCH!

Some mushrooms are poisonous. You already know not to eat or touch ANY mushroom you find outside. Be sure to wash your hands thoroughly when you get back from your fungus hunt.



THE TIP OF THE ICEBERG, ER, MUSHROOM

The mushroom you see is just the visible part of a much bigger fungus. The main part is a network of underground fibers called mycelium (my-SEE-lee-um). In fact, the biggest living thing on Earth is an underground mycelium network in an Oregon forest. It's nicknamed the Humungous Fungus, and it spreads out over almost four square miles!

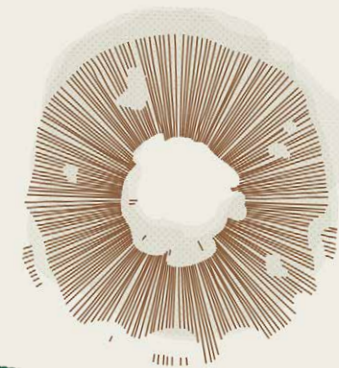
SPORE PRINT

ART AND SCIENCE AT THE SAME TIME!

TOOLS & SUPPLIES:

- 1 fresh portobello mushroom, available in the produce section of the grocery store (You can eat it at the end of the experiment!)
- 1 sheet of thick, white paper such as art paper or construction paper (If you don't have any, you can use a stack of two or three sheets of regular paper.)
- 1 bowl, big enough to fit over the mushroom when turned upside down
- Phone with and macro lens
- Optional: adult assistant with kitchen knife

Your spore print is easy to smear, so be careful!



RECIPE:

PORTOBELLO MUSHROOM SAUTE

- Have an adult slice the portobello mushroom into thin strips.
- Saute it lightly in a little olive oil with garlic, salt, and pepper.

SPORES GROW MORE MUSHROOMS

Spores are a mushroom's way of reproducing. Each microscopic spore has the potential to grow into a new mushroom.

- 1 Have your adult assistant cut the stem off the mushroom. Save the stem for cooking and eating.
- 2 Place the paper on a surface where no one will disturb or move it.
- 3 Place the mushroom cap in the middle of the paper, gill side down. Put a drop or two of water on the top.
- 4 Carefully place the bowl upside-down over the mushroom. Let everything sit overnight.
- 5 The next day, carefully remove the bowl and pick up the mushroom to reveal your spore print.
- 6 Without disturbing the paper, examine the spores through the macro lens attached to your phone.

LIKE A FINGERPRINT

A mushroom's spore print is a little (just a little!) like a fingerprint. Many mushrooms look alike. The color and pattern of their spore prints can help tell them apart.



TREES

Trees are amazing. They gobble up carbon dioxide and breathe out oxygen, filter the water we drink, keep the Earth cool, anchor soil to the ground, and provide habitat for millions of animal species. They also make great places for treehouses.

TREE WALK

HOW MANY DIFFERENT TYPES OF TREES CAN YOU FIND?

TOOLS & SUPPLIES:

- Notebook and pencil
- Tree ID chart from your kit

Grab your notebook, pencil, and tree ID, and head outside! Take a stroll around your neighborhood and see how many different types of trees you can find. Try to identify each type and keep a list in your notebook.

If you have an adult assistant who knows the trees that grow in your area, by all means take them with you!

Your tree ID chart will help you identify some general categories of trees, but the specific kinds you'll find depend on where you live. There are far too many possibilities to fit on one card. In fact, there are enough to fill a thick book.

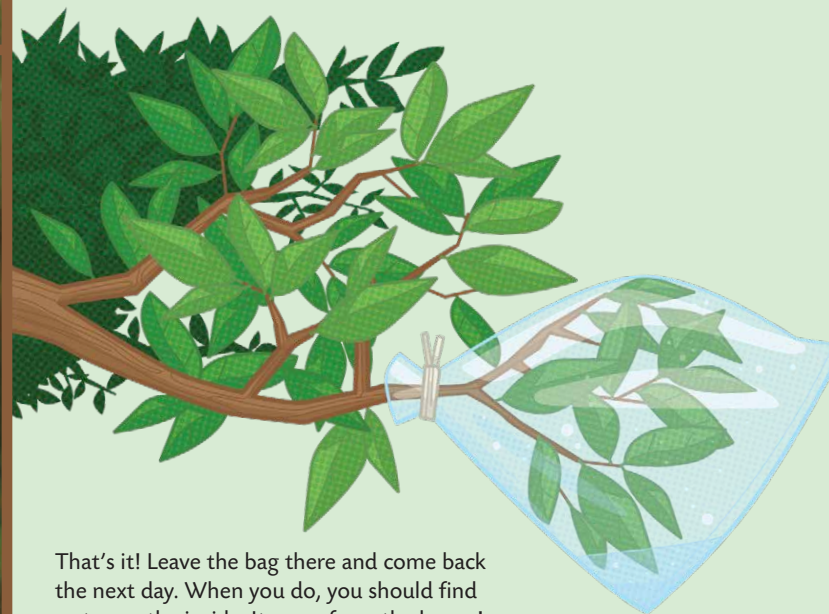
PLANT BREATH

SEE WHAT TRANSPIRES!

TOOLS & SUPPLIES:

- Clear, dry plastic bag
- Twist tie

For this simple experiment, go outside and tie the plastic bag over the end of a leafy branch on a bush or tree. (Make sure there are leaves inside the bag!)



That's it! Leave the bag there and come back the next day. When you do, you should find water on the inside. It came from the leaves!

WATER FROM LEAVES

Water vapor coming out of the leaves condenses inside the plastic bag. This is called *transpiration*.



In land-based plants, most of the stomata are on the underside of the leaves. In plants that live in the water, they're on the top.

STOMATA

A plant "breathes" through microscopic holes in the leaves called stomata (singular: stoma). Carbon dioxide (CO₂) for photosynthesis passes into the leaf through these openings. Oxygen and water vapor pass back out. Cells around the openings control whether the stomata are open or closed.

AFTER DARK

Experiments to try at night!

MOTH MADNESS

Most people know that moths are attracted to lights at night, but not even scientists are sure exactly why. Whatever the reason, this behavior gives you a good way to catch some with your Bug Nabber.

YOU'LL BE USING ULTRAVIOLET (UV) LIGHT TO ATTRACT THE INSECTS. IT'S INVISIBLE TO HUMANS, BUT MANY INSECTS CAN SEE IT.

TOOLS & SUPPLIES:

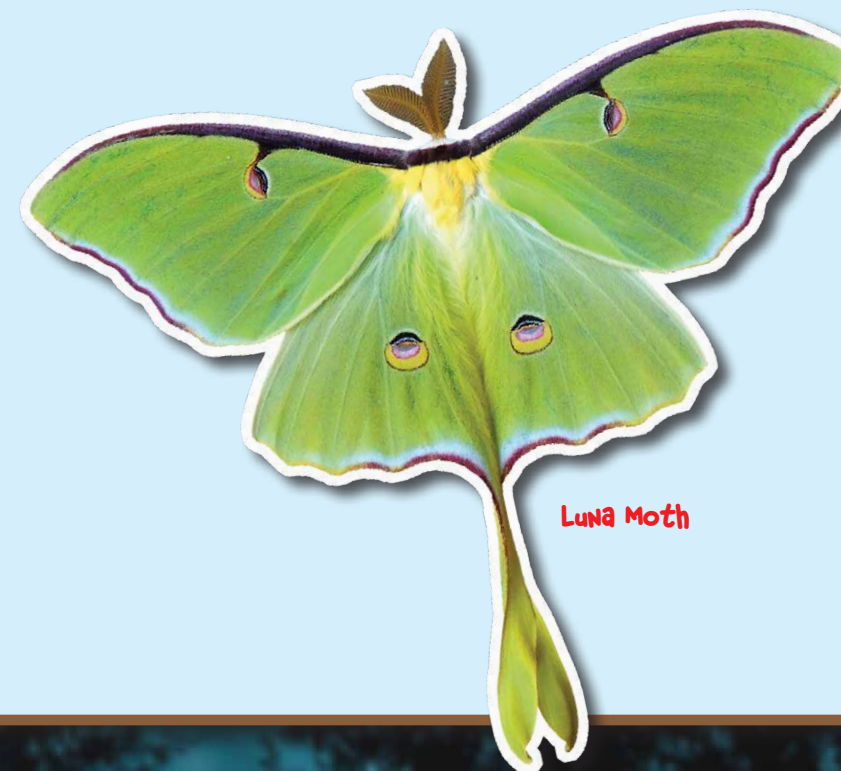
- Bug Nabber
- UV lamp and mounting clip
- Flashlight
- Nature Scope with bottom in place (optional)

- 1 Mount the UV lamp on your Bug Nabber, then grab your gear and head outside. You'll want to find a dark area, away from porch lights, streetlights, and other bright lights that might attract the insects away from your own, fainter light.
- 2 Switch on the UV lamp and wait for the bugs to come to you. It will probably take some patience. When a moth or other insect flies up to the light, nab it with the Bug Nabber. Be careful not to pinch its wings or body between the edges.
- 3 Now a look at the moth in the light of the UV lamp. You may see its eyes or other parts of its body glow with pale light. This effect only happens with some species, so don't be too disappointed if you don't get results. You'll get other chances to see the same effect later on.
- 4 Finally, switch on the flashlight to examine your catch. You can observe the moth in the Bug Nabber itself, or you can transfer it to the Nature Scope for a magnified look.

MOTH OR BUTTERFLY?

How can you tell a moth from a butterfly? One easy answer: if you see it at night, it's probably a moth.

There are couple of other ways, but they're not foolproof: Most moths have feather-like or tapering antennae, while most butterflies' antennae have rounded, club-like ends. Most moths rest with their wings held flat, while most butterflies rest with them held together over their backs.



BLACKLIGHT EXPLORER

A "blacklight" is another name for a UV lamp. You can use the one from your kit to explore your yard at night. Look for things that glow or change color. You'll have to be in a dark area and get up close to the things you're looking at. You can also attach the lamp to the light port on your Nature Scope for a magnified view.

NEVER SHINE THE UV LAMP DIRECTLY INTO YOUR OWN EYES OR ANYONE ELSE'S.

Here are some of the glowing things you may discover:

- Flowers
- Leaves
- Moss
- Lichen
- Rocks and pebbles
- Human-made objects like your clothes, paper, labels, stickers, and other things with bright colors

For a weird surprise, shine the blacklight on your own fingernails!



SEEING *THE* INVISIBLE

You can't see UV light, but you can see its effects. Some things, including some insects and other arthropods, glow in UV light. The material of their shells or other body parts absorbs the UV light waves, then releases the absorbed energy again in the form of visible light. That's called fluorescence (flor-ESS-ence). The color of the glow is often very different from the color under visible light.

COLOR-CHANGING CHLOROPHYLL

Transform green to red with ultraviolet light! You'll have to wait until dark for the observation part of this experiment.

TOOLS & SUPPLIES:

- UV lamp
- Two bowls: one small, one medium-sized or larger
- Measuring spoons
- Large mixing spoon
- Coffee filter or paper towel
- Rubber band or tape
- Rubbing alcohol

1 Go outside and gather a handful of soft green leaves or grass.

2 Tear the leaves into small pieces and put them in the medium-sized bowl. Add 1 tablespoon (15 mL) of rubbing alcohol.

3 Mash up the leaf pieces in the alcohol with the spoon. Keep mashing until the liquid turns green. The greener, the better.

4 Put the coffee filter or paper towel over the top of the small bowl and hold it in place with the rubber band or tape. If you have a coffee cone or funnel, you can use that instead.

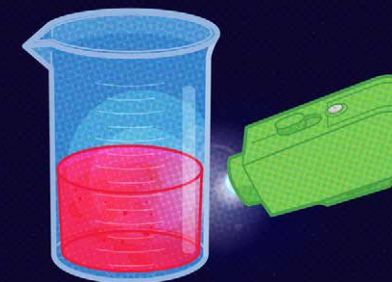
5 Pour the leaf-and-alcohol mash through the paper (slowly!) to filter the liquid into the bowl. Squeeze the filter at the end to get out as much liquid as possible.



6 Pour the green liquid from the bowl into the beaker.

7 Wait until dark.

8 Take your UV lamp and the beaker into a dark room. The room should be as dark as possible, with lights off, the door closed, and the shades or curtains closed. Turn on the UV lamp and observe the liquid in the beaker. What do you see?



PUTTING THE GREEN IN GREEN PLANTS

Chlorophyll (KLOR-uh-fill) is a pigment, or molecule with a particular color. It's what makes plants green. It's also the molecule that absorbs light energy for photosynthesis (FO-toe-SINTH-uh-sis), the process in plants that turns water and carbon dioxide into food. When you mashed up the leaves, you extracted chlorophyll from the leaves' cells into the alcohol.

RELEASING THE RED

Under visible light, chlorophyll is green. That's because it reflects green light waves and absorbs other colors. But ultraviolet (UV) light affects it differently. The chlorophyll molecules absorb energy from the invisible UV light, then release some of that energy in the form of red light.

KEEP EXPLORING!

The activities in this book are just the beginning. Go beyond bugs, dirt, and plants to collect and study other natural objects. Use your Nature Scope and Macro Lens to examine shells, seeds, twigs, grains of sand, and more! Use the ID Charts to check off the rocks, trees, and bugs you find on your nature explorations. Best yet, come up with your own experiments and share them with your friends and family!



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