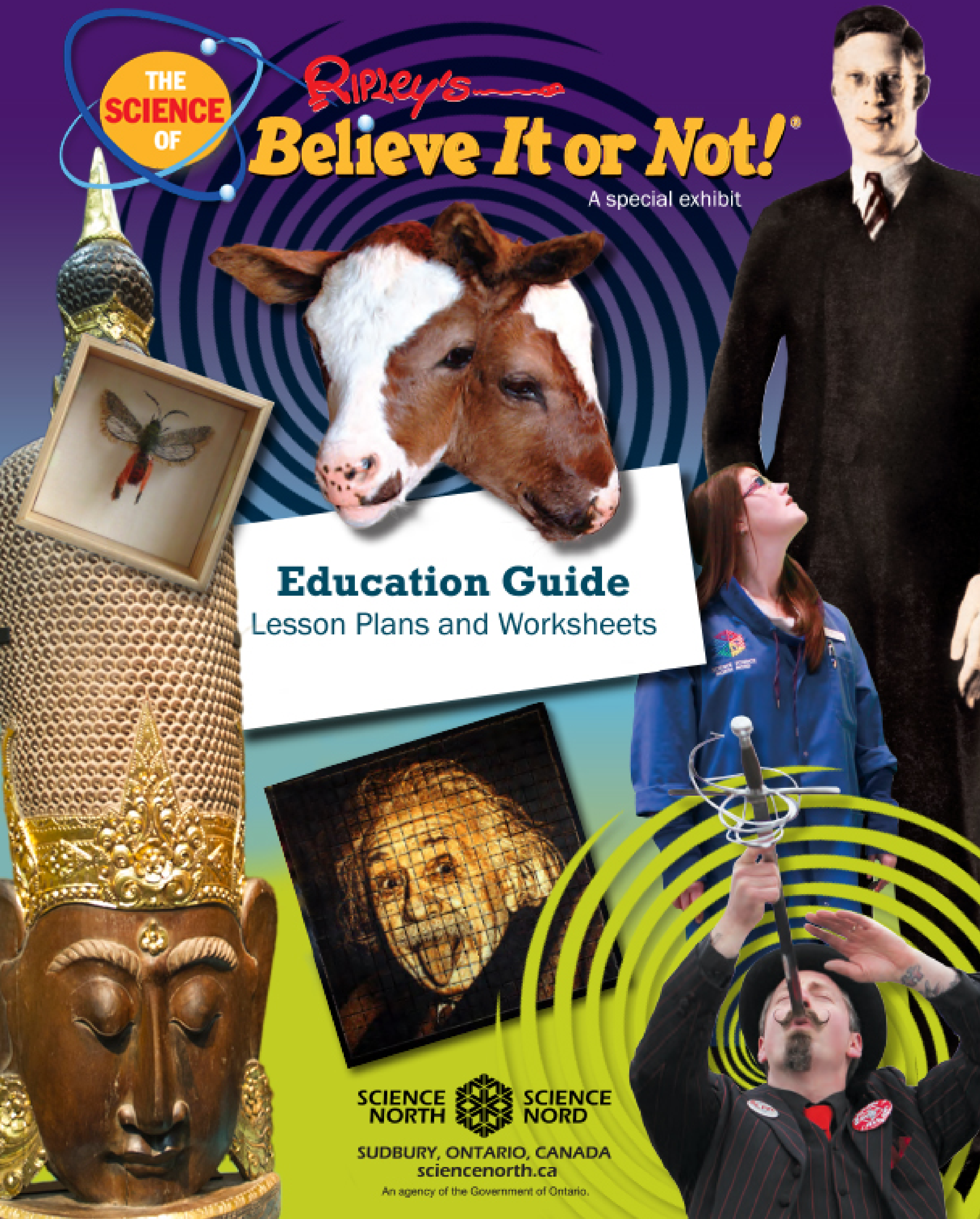

THE SCIENCE OF

Ripley's Believe It or Not!®

A special exhibit

Education Guide

Lesson Plans and Worksheets

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Featured at
TELUS World of Science - Edmonton

March 20 - September 7, 2020

The Science of Ripley's Believe It or Not!® is a production of Science North and Ripley Entertainment Inc.

Going to Great Lengths *Lesson Plans*

This activity is adapted from the California Academy of Sciences Snakes and Lizards Length and Movement lesson plan.

Activity Description

Students will investigate the wide range of lengths that snakes and lizards can reach. They will explore how the lengths of these modern-day animals relate to the longest snake that ever lived, *Titanoboa*.

Exhibit Description

This activity relates to the snake exhibits in Zone 2: *Extreme Biology*. Visitors will compare the size of snakes today and those of millions of years ago. They will learn how the warm climate in Colombia 60 million years ago allowed *Titanoboa* to grow much larger than today's snakes. Although *Titanoboa* was much larger, it shared many traits with modern snakes, such as behavior and anatomy.

Background Information

There are more than 8,000 different types of snakes and lizards in the world today and they vary greatly in size from unbelievably tiny to incredibly large. A number of factors can affect the size of these animals, including climate, available prey and available habitat.

Snakes and lizards are ectothermic (commonly called "cold blooded"), which means they cannot regulate their body temperature. Instead, their body temperature varies with the temperature of their surroundings. In a warmer climate, snakes and lizards can grow faster – and therefore larger – than their colder-climate counterparts.

The largest snake that ever lived, *Titanoboa*, was able to grow so large because the climate in Colombia 60 million years ago was so warm.

The body size of cold-blooded animals has been correlated with ambient environmental temperatures. Even though it may seem like a slight difference, *Titanoboa's* size has lead researchers to believe that Colombia's rainforests were about 5°F to 8°F (3°C to 4°C) warmer than modern tropical rainforests, which have temperatures of 79°F to 82°F (26-28°C).

In this activity, students will compare the lengths of modern-day snakes and lizards to the very large size of *Titanoboa*.

For an overview of *The Science of Ripley's Believe It or Not!*® exhibit and a description of the *Extreme Biology Zone*, please refer to *The Science of Ripley's Believe It or Not!*® Exhibit Booklet.

Materials

(per group of students)

Note: Please select either imperial or metric measurements. Due to conversion and rounding, the metric measurements actually add up to about 15.1 meters.

Lengths of yarn, string or twine 50 feet (15 m) long – one for each group of students and one extra for the class

Masking tape and colored markers, or colored tape

Images of 10 snakes and lizards (including *Titanoboa*) – see Appendix 1

Empty toilet paper tubes

Paper clips

Measuring tape

Procedure

Prior to the activity:

1 Print the animal images (page 26). There should be one copy of all 10 images for each group of students.

2 Measure and cut the lengths of twine or string. There should be one 50-foot (15 m) length for each group of students, and one additional 50-foot length for the class to share (to represent the length of *Titanoboa*).

3 Set aside the string representing the length of *Titanoboa*. On the remaining lengths of string, measure the distances below and mark each with a different colored piece of tape. If you do not have colored tape, simply use masking tape and markers to color each piece of tape a different color.

Mark the following measurements on a piece of string for each student group:

1 0.5 inches (1.5 cm): Dwarf gecko (*Jaragua sphaero*)

2 1 foot (30 cm): Mountain horned lizard

3 1.5 feet (45 cm): Panther chameleon

4 2 feet (55 cm): Common garter snake

5 2.5 feet (75 cm): Green basilisk

6 5 feet (1.5 m): Water monitor

7 8 feet (2.5 m): Eastern diamondback rattlesnake

8 10 feet (3 m): Komodo dragon

9 19.5 feet (6 m): Reticulated python

4 Once all the lengths are marked off with tape, carefully roll each string onto an empty toilet paper roll to keep it neat and untangled.

During the activity:

Note: It is recommended to do this activity outside or in a large space at least 50 feet (15 m) in length.

1 Give each group a set of 10 animal images, 10 paper clips and a measuring tape.

2 Ask students to unroll their string down the length of the activity space.

3 Using their measuring tapes, ask students to measure out the length of one of the animals and determine which piece of colored tape on their string corresponds to that animal.
4 Have them attach the image of the animal to the appropriate piece of tape using a paper clip.
5 Repeat the activity for each of the nine modern species.
6 Once the students have identified all their reptiles, unroll the string that represents *Titanoboa.* Explain where and when *Titanoboa* lived, and why it could grow so long.

Conclusion:
You may wish to ask the students the following questions:

- What do you notice about the lengths of the snakes and lizards?
- What surprised you about this activity?

Try this!
Have the students lie down on the Titanoboa string, head to toe, to see how many students it takes to form the length of the giant snake.

Resources:

Titanoboa: Monster Snake (Smithsonian Institution Traveling Exhibition site):
http://www.sites.si.edu/titanoboa/
(Note: search the Internet using key words if this page has been moved)

Extensions/Adaptations:

Instead of putting the tape on the string for the students beforehand, aks the students to perform this step.

Ask students to complete a short research project on one of the snakes or lizards mentioned in this activity.

Younger students can create their own snakes out of play dough. Simply combine 3 cups (750 ml) flour, 1 cup (250 ml) salt, 1 cup (250 ml) water and 1 tbsp. (15 ml) vegetable oil in a large bowl and knead until smooth. The students may wish to choose a color for their snakes and use food coloring to tint the dough.

You may wish to discuss the fact that snakes have no legs and therefore use their muscles to move their bodies around.

CREATIVE CAMOUFLAGE *Lesson Plans*

Activity Description

In this activity, students will explore the function and importance of camouflage. They will also discover why animals may have trouble surviving in the wild if they are born with unusual coloration.

Exhibit Description

The activity relates to the exhibit about color mutations in *Zone 2: Extreme Biology*. Students learn the importance of color to an animal's ability to survive in its environment. They discover the science behind what makes an animal albino or melanistic and have the opportunity to view images and specimens of animals with various color conditions.

Background Information

Prey animals use camouflage to hide from predators and to avoid being eaten. In contrast, predators use camouflage to hide from their prey, enabling them to ambush their target prey.

In the winter, many animals turn white to blend in with snow. In the spring, their darker color returns, which helps them blend in with their forest habitat.

Two types of color mutations are albinism and melanism. *Albinism* is characterized by the complete or partial absence of pigment, or melanin, in the skin, hair and eyes. *Melanism* has the opposite effect of albinism. Melanistic animals have an unusually high level of melanin pigmentation. Compared to other animals in their population, melanistic animals generally appear darker in color than average.

Though both albinism and melanism are a result of genetic differences, melanistic animals are much more likely to survive in the wild than are albino animals, since albino animals generally stand out more in their environments and often have poorer eyesight.

For an overview of *The Science of Ripley's Believe It or Not!®* exhibit and a description of the *Extreme Biology Zone*, please refer to *The Science of Ripley's Believe It or Not!®* Exhibit Booklet.

Materials

Colored, patterned wrapping paper – 2 sheets per student

Printed animal templates (page 28) – print one per student

Markers/pencils

Scissors

Procedure

Introduce the activity by discussing camouflage with your students. You may wish to ask the following questions:

- Why might animals need to use camouflage?
- How might the change of seasons affect the camouflaging methods of animals?
- Do humans ever use camouflage?

Ask students to perform the following steps:

1. Cut out the printed animal template.
2. Place the template over one piece of wrapping paper and trace around the template.
3. Cut the traced animal shape out of the wrapping paper.
4. Place the wrapping-paper animal shape over top of the uncut sheet of wrapping paper, in approximately the same location as the shape was cut out of the first piece of paper.

Conclusion:
What happens to the wrapping-paper animal? Is it easy for student to see the animal when the patterns on the paper line up with one another?

What happens if students move or rotate the wrapping-paper animal? Does the shape of the animal become more visible?

Extensions/Adaptations

- Try this activity using newspaper instead of wrapping paper, to investigate how animals use patterns in their coloration to help camouflage themselves in their environments. To do this, give each student two pieces of newspaper – one to cut out their animal from their template, and one to place their cutout animal on to investigate camouflage. If possible, collect two issues of the same newspaper, and give each student two identical pages – one from each newspaper.

- Instead of using wrapping paper or newspaper, ask the students to trace their animal templates on plain paper and decorate them so that their animal is camouflaged for a certain habitat (either outdoors or in the classroom).

- You may wish to introduce the concept of camouflage to younger students with the following activity (adapted from Melissa Kaplan's Herp Care Collection):

    1 Give each group of students a box of colored toothpicks. Ask the students to sort the tooth picks by color and write down how many toothpicks there are of each color.
    2 Spread the toothpicks over a large area that is the same color as one of the toothpick colors (e.g., green grass, brown earth, or a blue blanket).
    3 Have the students pick up as many toothpicks as they can in 10 seconds.
    4 Ask the students to count the number of each color of toothpick they were able to pick up. Compare this number to the original number of toothpicks they counted at the beginning of the activity.
    5 Ask the students if a particular color was easier to find, or more difficult to find. Why?

- Your students may enjoy learning about camouflage artists such as those listed below, and looking at their amazing work on-line. You can search for information and images related to each on the Internet using the artist's name along with other keywords such as "camouflage artist":
    - Art Wolfe and his nature photography project, entitled "The Vanishing Act," which shows animals near perfectly camouflaged in their environments
    - "The Invisible Man," Liu Bolin, who has himself photographed after being painted into various backgrounds
    - Desiree Palmen, who designs a new camouflage suit for each camouflage photograph
    - Beverly Doolittle, who uses camouflage to hide elements in her paintings

My Genetic Traits *Lesson Plans*

Activity Description

In this activity, students will learn about the physical traits they possess and how their traits compare to those of their classmates.

Exhibit Description

This activity relates to *Zone 2: Extreme Biology*. In this zone, students will explore the fascinating science related to human biology. They will discover the conditions that cause unusual growth in people and have the opportunity to see how the world looks from the perspective of a very tall person.

Background Information

Your DNA (deoxyribonucleic acid) makes you unique, but it also connects you to the people in your family. Your DNA contains two copies of almost every gene – one copy comes from your mother and one copy from your father. The combination of genes you get from your parents determines what you will look like.

Many genes come in two versions – a dominant version and a recessive version. If you get a recessive copy of the gene from each of your parents, you will show the recessive trait. If you receive even one copy of the dominant version of the gene, you will show the dominant trait.

Students might assume that a more common trait is “dominant”, but this is not always the case. Some traits simply show up more frequently in the general population.

For an overview of *The Science of Ripley’s Believe It or Not!®* exhibit and a description of the *Extreme Biology Zone*, please refer to *The Science of Ripley’s Believe It or Not!®* Exhibit Booklet.

Materials

Copies of the "My Genetic Traits" worksheet (page 29) – one per student

Procedure

1 Introduce the concept of genetic traits to the students. Go over the "My Genetic Traits" work sheet and describe each of the traits.

2 Ask students to complete their own "My Genetic Traits" worksheet by going through each trait and checking the appropriate box as it applies to them.

Extensions/Adaptations

1 Math:
- Using the formula below, students can use the data they have gathered to calculate the frequency of each trait in the class:

(# of students with a particular trait ÷ # students in the class) x 100 = ____%

2 Bingo:
- Print and hand out a copy of the "Genetic Traits Bingo" sheet (page 30) to each student.
- Call out the squares on the sheet and have students color in that square if the trait applies to them.
- The first student to color in an entire line, or other pre-determined pattern, wins.

3 My Dominant and Recessive Traits:
- When they go home, ask students with dominant traits to see which parent(s) have that dominant trait (children must receive a dominant gene from at least one parent).
- When they go home, ask students with recessive traits to see if one or both parents have that dominant trait (parents with dominant trait must then be DR for that gene and have passed the recessive gene on to their child).
- For more information, search on the Internet for "Punnett squares".
- Notes for teachers:
  - o Be sensitive to the fact that some students may be adopted, have step-parents or other non-biological parents.
  - o If students report back that their parents have traits that suggest they may not be the child's biological parents, you can reply that some traits aren't highly visible, or that in some cases it can be hard to tell one trait from another. (This scenario is extremely unlikely and has not yet occurred at Science North.)

Resources

Online Mendelian Inheritance in Man® (OMIM®) -
http://www.ncbi.nlm.nih.gov/omim and http://omim.org/
Note: "OMIM is a comprehensive, authoritative, and timely compendium of human genes and genetic phenotypes. The full-text, referenced overviews in OMIM contain information on all known mendelian disorders and over 12,000 genes. OMIM focuses on the relationship between phenotype and genotype. It is updated daily, and the entries contain copious links to other genetics resources."

CREATING CRYSTALS *Lesson Plans*

Activity Description

In this activity, students grow their own crystals using a solution of sugar and water. They will observe crystal growth and learn how crystal structures are formed in the natural world.

Exhibit Description

This activity relates to the *Cave of Crystals* exhibit in *Zone 4: Weird World – Past and Present*. In this exhibit, students learn about Naica Mine in Chihuahua, Mexico, where a specific combination of conditions allowed gypsum crystals to grow to immense proportions within the mine's "Cave of Crystals." This cave contains the largest gypsum crystals ever found on Earth! Students will also discover why the cave's environment is inhospitable to humans.

Background Information

A *crystal* is a solid substance in which atoms, molecules or ions are arranged in an orderly repeating pattern extending in three spatial dimensions. The process of forming a crystalline structure from a fluid or from materials dissolved in a fluid is called *crystallization*. The crystal structure formed from a fluid depends on the chemistry of the fluid and the physical conditions in the surrounding area, such as temperature and air pressure. Snowflakes, diamonds and table salt are examples of crystals. *Crystallography* is the scientific study of crystals and crystal formation.

When you add sugar to water, the sugar crystals dissolve and the sugar molecules disassociate from one another, forming a solution. You can't dissolve an infinite amount of sugar into a fixed volume of water. When as much sugar has been dissolved into a solution as possible, the solution is saturated. The saturation point will vary depending on the temperature. The higher the temperature, the more sugar can be held in that solution.

For molecules to form a crystal, there must be too many of them for the solution to hold. The solution must therefore be *supersaturated*. A supersaturated solution is one where the solution can no longer hold all the dissolved sugar, and some sugar remains as a solid in the liquid.

In any solution, molecules bump into one another frequently. When molecules bump into each other, bonds may form between them that cause them to stick together. This happens more frequently in supersaturated solutions, because there is such a high concentration of molecules. The beginning of the crystallization process, when molecules first start to bond to one another, is called *nucleation*. Once several molecules are already stuck together, other molecules are attracted to join them. This slow process is how the crystal "grows."

For an overview of *The Science of Ripley's Believe It or Not!®* exhibit and a description of the *Weird World*, please refer to *The Science of Ripley's Believe It or Not!®* Exhibit Booklet.

Materials

(per group of students)

1 Jar or beaker in which to grow the crystals

Sugar

Pencil, glass rod, popsicle stick or butter knife (to tie suspended thread to)

Porous thread, such as yarn or cotton string (for K – Grade 4)

Glass container such as a beaker or jar for heating water (for Grades 5-8)

Petri dish or saucer (for Grades 5-8)

Very thin non-porous thread, such as nylon thread or fishing line (for Grades 5-8)

Procedure
K – Grade 4 Activities

Ask the students to perform the following steps:

1 Tie a piece of yarn or string to a pencil. The string should hang down approximately 3 to 4 inches (7 to 10 cm). This will be the base from which the crystals will grow.

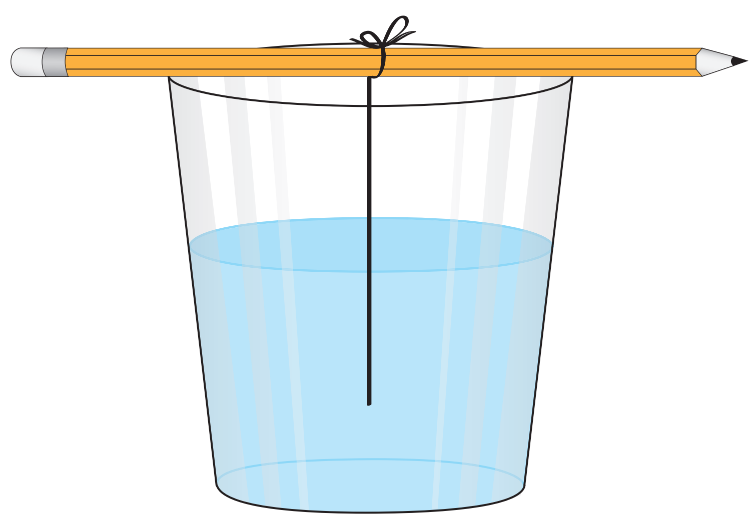
2 Select a glass container for the crystal to grow in.

Note: the teacher should perform steps 3 and 4 below:

3 Heat enough water to fill the container that the crystals will grow in.

4 Add sugar to the heated water. Add one teaspoon of sugar at a time, stirring after each addition. Continue adding sugar until it no longer dissolves and the water is super saturated with sugar.

5 Suspend the yarn or string in the sugar solution with the pencil lying across the top of the glass container.



6 Let the crystal grow in an undisturbed location. If necessary, cover the sugar solution with a coffee filter or paper towel to keep dust from contaminating the solution.

7 Check the growth of the crystals over time, and make note of your observations.

Grades 5 to 8 Activities

Ask the students to perform the following steps:

1 Select a glass container for your crystals to grow in.

The teacher may wish to complete steps 2 and 3 below:

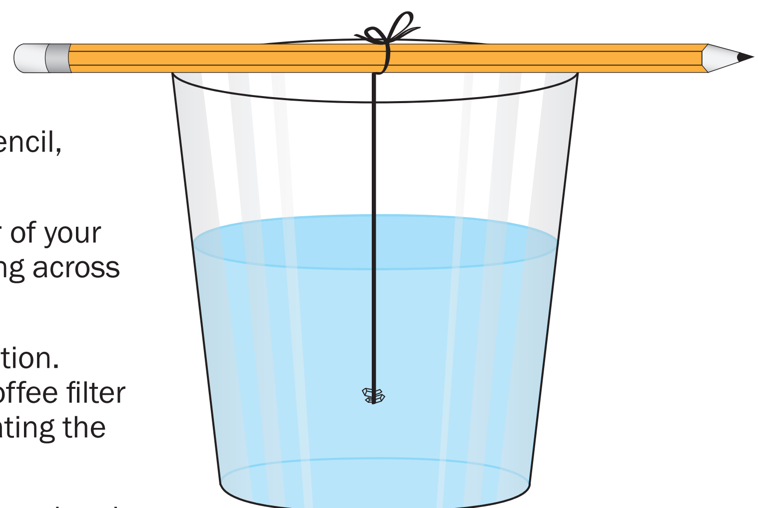
2 Heat enough water to fill the container that the crystal will grow in, plus an additional one half cup (125 ml) of water.

3 Add sugar to the heated water. Add one teaspoon of sugar at a time, stirring after each addition. Continue adding sugar until it no longer dissolves, and the water is supersaturated with sugar.

4 To prepare a seed crystal, pour some of the solution into a petri dish or saucer. Put the rest of your supersaturated solution aside for now.

5 Allow the heated solution to evaporate from the petri dish or saucer. Crystals will form as it evaporates. Choose the biggest crystal to use as the seed crystal.

6 Tie the seed crystal to one end of a piece of nylon thread or fishing line. The use of nylon thread is required due to its smoothness. Regular thread is porous and will encourage crystal growth away from the seed crystal.



7 Tie the other end of the nylon thread to a pencil, glass rod or butter knife.

8 Suspend your seed crystal in the remainder of your supersaturated solution with your pencil lying across the top of the glass container.

9 Let your crystal grow in an undisturbed location. You may wish to cover the solution with a coffee filter or paper towel to keep dust from contaminating the solution.

10 Check the growth of your crystals over time, and make note of your observations.

Extensions/Adaptations

1 Try this experiment with different types of sugar (e.g., brown sugar, confectioner's sugar) or salt to see if or how the types of crystals produced are different.

2 Try adding food coloring to the solution to create colored crystals.

3 Provide students with a magnifying glass and different types of salt crystals to look at and compare (e.g., table salt, sea salt, kosher salt, and coarse road salt, if available). Observe that the different types of salt all display the same type of cubic crystal structure. However, just as with other minerals in nature, the crystal structure cannot always be seen clearly.

Crashing Craters *Lesson Plans*

This activity is adapted from Dark Skies, Bright Kids – *University of Virginia*

Activity Description

In this activity, students learn how impact craters are formed and how the size, shape and weight of the impactor can affect the final crater. Students explore various impactors and examine the different ejecta patterns they generate.

Exhibit Description

This activity relates to the meteorite exhibits in *Zone 4: Weird World – Past and Present*. In these exhibits, students check out real specimens of meteorites and learn the impact they can have on Earth. They also experience the rare and very special opportunity to see a real piece of Mars! They discover why Martian meteorites are such important rocks to science, and how scientists determined that they originated from Mars.

Background Information

Impact craters are formed when celestial objects, such as asteroids, meteoroids or comets, collide with the surface of a planet or a moon at high speeds. The object that does the colliding is called the *impactor.* If a piece of the celestial object remains, it is referred to as a *meteorite*. The debris that is thrown out of the crater upon impact is called *ejecta*. Many factors influence the size, depth and ejecta pattern of an impact crater: the velocity, composition and hardness of the impactor, as well as the composition of the target rock, the angle of impact, and the gravity of the target planet or moon.

Every solid surface in the solar system has been impacted. The resulting craters can be seen on many celestial objects, including our Moon. In contrast, objects without many visible craters are those with surfaces that are continually being altered by processes such as erosion, volcanoes and tectonic activity. These surfaces are known as *active surfaces.* Earth is an example of a planet with an active surface that is constantly changing due to geological processes.

For an overview of *The Science of Ripley's Believe It or Not!*® exhibit and a description of the *Weird World*, please refer to *The Science of Ripley's Believe It or Not!*® Exhibit Booklet.

Materials

15 inch (40 cm) aluminum roasting pan

5 pound (2.27 kg) bag of flour

18 oz (500 g) cocoa powder

Various impactors such as marbles, pebbles, rocks, crumpled aluminum foil, erasers

Resources

Use keywords to search for these online sources for information about meteorites:

- The Universe Today
- Astronomy Cast

Procedure

1 Place a layer of flour in the roasting pan. You may wish to smooth out the top of the flour to make an even surface.
2 Sprinkle a thick layer of cocoa powder over the entire surface of the flour. (This will allow students to see the pattern of the crater's ejecta more clearly.)
3 Ask students to drop different impactors onto the surface and to observe what happens upon impact.
4 Examine the resulting craters and ejecta patterns and draw conclusions as to how the composition, angle of impact and speed of the impactor affect crater formation.
5 Once the surface of your flour becomes too mottled with cocoa powder, mix the cocoa powder into the flour until it is evenly dispersed and the mixture becomes light brown. To continue observing impacts, add a fresh layer of cocoa power to the surface.

Conclusion:

Guide the students through a discussion to determine which properties of the impactors had the greatest effect on the craters produced. Generally, speed and impactor size produce the most noticeable differences in crater size. The angle of impact also causes a difference in ejecta patterns. The density of the impactor affects the size of the crater. In general, impactor shape is irrelevant and pebbles of various shapes will all produce round craters.

Craters made by impacts of celestial bodies are almost always round. This is because celestial bodies impact with such velocity that they are usually vaporized upon impact (as in the case of a bomb exploding). The shape and direction of the impactor is insignificant compared to the tremendous energy it carries due to the speed it is travelling at the time of the impact. Rarely, an elongated crater results if the celestial body impacts at no more than a few degrees from horizontal.

Extensions/Adaptations

1. Ask students to make predictions about what will happen prior to dropping their chosen impactor.
2. The following are some variables that students may choose to manipulate: height from which the impactor is dropped, angle of impact, size of impactor, density of impactor (e.g., crumpled aluminum foil versus a pebble of the same size).
3. Try different combinations of materials in the roasting pan such as flour, cornstarch, cornmeal or oatmeal.

Fantastic Fossils *Lesson Plans*

This activity is adapted from the Carlsbad Caverns Geology Curriculum.

Activity Description

In this activity, students learn about some of the various ways in which fossils form, and investigate two different types of fossils: cast fossils and mold fossils.

Exhibit Description

This activity relates to fossil exhibits in *Zone 4: Weird World – Past and Present.* In this zone, students learn how fossils provide glimpses into the world of the past. They discover ancient life through examination of real specimens. They can even have their photo taken inside the jaw of the largest shark species that ever lived!

Background Information

Fossils occur in many forms: petrified remains, molds and casts, original remains, and trace fossils. *Petrified* remains are remains that were literally “turned to stone”. This happens as groundwater soaks into and through a buried organism. The minerals dissolved in the groundwater gradually replace the original tissues.

Molds and casts are formed when a fossil decays, erodes, or dissolves away. The void left behind is called a *mold*. This void can then be filled in with sediments washed in through cracks or by minerals that precipitate out of groundwater. This new “replacement” fossil is called a cast.

Occasionally, *original remains* of ancient organisms are found. A relatively common example of this is insect remains trapped in amber (tree resin that has hardened). Within the amber, the insects’ bodies are protected from decay or petrification. Another example of original remains is mammoth remains that have been found frozen in ice.

Trace fossils are evidence that an organism was there without any remains present. Examples of trace fossils are tracks, drag marks, wormholes and burrows. From these fossils, it is possible to determine such things as an organism’s size, lifestyle, hunting behavior and diet.

For an overview of *The Science of Ripley’s Believe It or Not!®* exhibit and a description of the *Weird World*, please refer to *The Science of Ripley’s Believe It or Not!®* Exhibit Booklet.

Materials

Small aluminum pie plates
(butter tart size)
(one per student)

Plaster of Paris

Water

Petroleum jelly

Shells, bones, leaves, small plastic animals (or any other object that can be used to create a fossil)
(one per student)

Procedure

1. Prepare the plaster of Paris according to the package instructions. A smooth and thick consistency is desired.
2. Fill pie plates with plaster to a depth of about one inch (2.5 cm).

Ask students to perform the following steps:

3. Coat the object to be fossilized (e.g., shell or bone) with a thin layer of petroleum jelly.
4. Press the coated object into the plaster, but do not allow the plaster to flow over the top of the object.
5. Allow the plaster to dry at least 24 hours, and then remove the object.
6. Coat the entire surface of the plaster (including the mold left by the embedded object) with a thin layer of petroleum jelly.
7. Pour more plaster of Paris on top to a depth of about one inch (2.5 cm) and allow to dry for at least 24 hours.
8. Separate the two halves. The original half represents a mold fossil and the second plaster poured represents a cast fossil.

Conclusion:

After the students have created their fossils, you can conclude the activity by reviewing the necessary steps for fossilization.

For fossilization to occur, the animal or plant must be buried fairly quickly to prevent decomposition. A quick burial also protects the animal or plant from the elements and scavengers. Volcanic eruption, mudslides, desert sandstorms, water and ice are different ways in which the potential fossil can be buried. Once buried, the transformation from animal or plant to a fossil can take thousands of years or more.

Extensions/Adaptations

1 If flat objects (such as leaves) were used to create the mold and cast fossils, students can make rubbings of their fossils.

2 Use a larger tub (or multiple tubs) of plaster to create a paleontology dig for several students, or a whole class of students. After Step 4, instead of creating cast fossils, cover the entire surface of the hardened plaster with a material that the students can dig through (e.g., sand, cornmeal, flour or wood shavings). Provide the students with tools appropriate for digging in the chosen material, such as brushes or small shovels. The original "fossils" can be either left embedded or removed.

3 Create individual paleontology digs for each student:

Materials for individual paleontology digs:

Plaster of Paris
Spray bottle filled with water
Small disposable cups (preferably plastic)
"Fossil" objects (suggestion: shark teeth can be purchased from suppliers on the Internet such as "Steve's Fossil Shark Teeth")
Large mixing bowl
Fossil removal ("digging") tools, such as toothpicks and plastic knives

Procedure:

1 Measure approximately 2 cups (500 ml) of plaster of Paris into the large mixing bowl.
2 Spray the plaster of Paris until it is moist but not wet (it should stick together nicely).
3 Fill each cup with the damp plaster of Paris to a depth of approximately one inch (2 to 3 cm).
4 Place a "fossil" in each cup and add approximately 1.5 to 2 inches (4 to 5 cm) more plaster of Paris.
5 Press the mixture together, making sure that you are pushing out most of the air bubbles.
6 Let the filled cups sit for about five minutes, then gently remove the contents of the cups by tipping the cups upside down and gently tapping on the bottoms.
7 Allow the plaster to air dry for a minimum of 24 hours before use.
8 Once the plaster is dry, provide tools for the students to remove the plaster-encased "fossils".

The Magnificent Möbius Strip *Lesson Plans*

Activity Description

In this activity, students will not believe their eyes when a paper loop does not behave the way they expect it to. This is a wonderful introduction to the topic of illusions.

Exhibit Description

This activity links to *Zone 7: Perceptions and Illusions*. In this zone, students explore how illusions exploit the way our brains process sensory information to turn it into an image or sound that we can comprehend. Students will learn how they perceive the world around them. The amazing illusions will keep them fooled even after they find out how they work!

Background Information

A Möbius strip is a mathematical phenomenon and a great example of an object that does not behave as one would expect – in fact, it is downright unbelievable!

A Möbius strip (also called a Möbius loop or band) is a loop that contains a twist and has several curious properties. Here's a common example to help explain the complex math behind a Möbius strip: if an ant were to walk along the edge of the strip, it would travel twice as far as the length of the loop before it got back to its starting point. A line drawn starting from the seam down the middle will meet back at the seam but at the "other side." If continued, the line will meet the starting point and will be double the length of the original strip.

Möbius strips were historically used for factory conveyor belts because they allowed the surface of the belt to last twice as long.

For an overview of *The Science of Ripley's Believe It or Not!*® exhibit and a description of the *Perceptions and Illusions Zone*, please refer to *The Science of Ripley's Believe It or Not!*® Exhibit Booklet.

Materials

Paper (one piece of 8.5 x 11 inch paper per student)

Scissors

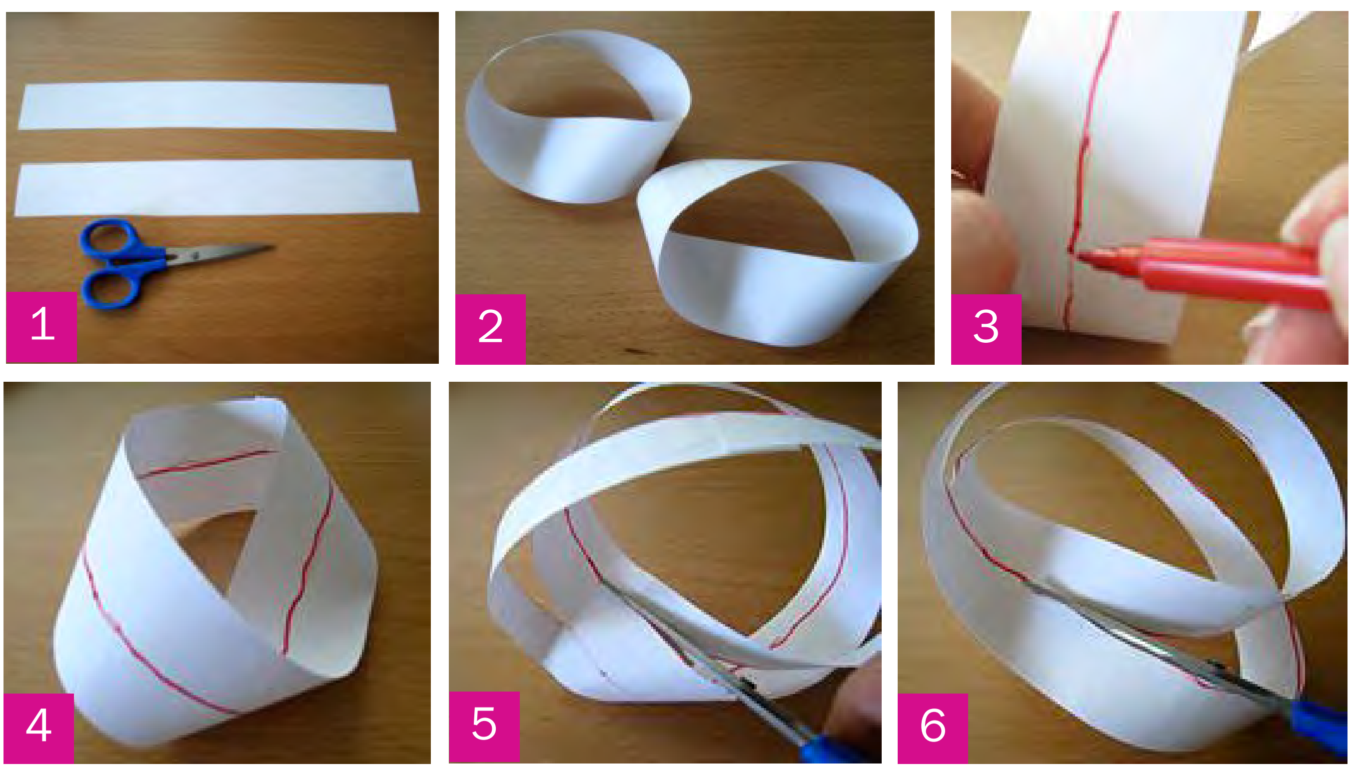
Tape or glue sticks

Markers

Procedure

Ask students to perform the following steps:

1. Cut out four strips of approximately 1.5 by 11 inches (4 by 28 cm).
2. Tape two of the strips together to form one long strip. Repeat with the other two strips, so that each student has two long strips.
3. Bring the two ends of one strip together to form a loop. Make a half-turn with one end and attach the two ends together. You should have a loop with a twist in it. Repeat this with the other strip of paper.
4. Draw a line down the middle of the first looped strip. Take note of what happens. You should see ink on both sides of the strip, though you did not lift your marker!
5. Cut along the line that you have just drawn. What happened?
6. On the second Möbius loop, draw a line one third of the way across the strip. This line will eventually connect with itself.
7. Cut along this new line. What happens?



Conclusion:

The result of cutting a Möbius strip in half is described in this limerick:

A mathematician confided
That a Möbius band is one-sided,
And you'll get quite a laugh,
If you cut one in half,
For it stays in one piece when divided.
(courtesy of Scientific Explorations with Paul Doherty)

The main property to remember about a Möbius loop is that unlike an ordinary loop, which has two sides and two edges, the Möbius loop has only one side and one edge.

Extensions/Adaptations

Try these:

- Make a few thicker Möbius strips and experiment with cutting them in fourths, fifths and sixths. Keep a record of what happens.
- Make a long strip of paper as in Steps 1 to 3, but then twist it twice before attaching the two ends. Cut this loop in half. What happens?

References

Image credit to Northwestern University's Center for Talent Development (http://ctdblog.northwestern.edu/2012/03/06/rainy-day-activity-make-a-mobius-strip)

Activity Description

In these two activities, students will create their own optical illusions and explore how their interpretations can greatly affect the way they perceive the world around them.

Exhibit Description

These activities relate to *Zone 7: Perceptions and Illusions*. In this zone, students explore how illusions exploit the way our brains process sensory information to turn it into an image or sound that we can understand. They will trick their sight and hearing while learning how we perceive the world around us. The amazing illusions will keep them fooled even after they learn how they work!

Background Information

Our brains are constantly trying to interpret what we see through our eyes and make sense of the world around us. Optical illusions trick our brains into perceiving something differently than it is in reality, so that what we perceive does not necessarily correspond to physical reality. Illusions can make use of color, light and patterns to generate images that mislead or deceive our brains.

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Materials

per student

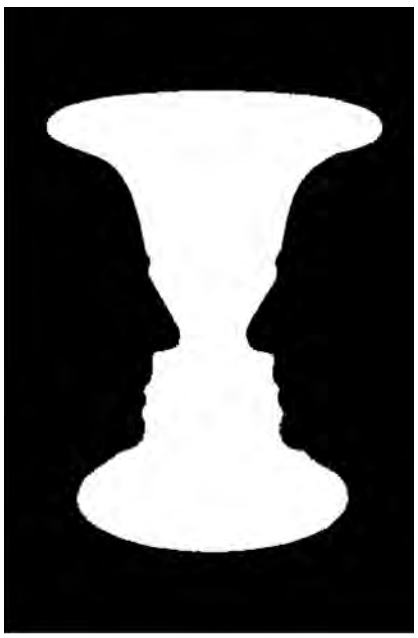
1 sheet of black construction paper

Scissors

1 large sheet of white paper

White coloring pencil

Glue



Activities

Make a Rubin Vase

The Rubin vase is a simple illusion devised by Danish psychologist Edgar Rubin, which can be perceived as either a vase or as the profiles of two human faces gazing at one another. This is called an ambiguous figure-ground perception illusion. The "figure" is the image that you see, and the "ground" is the background. Most people can see both interpretations – but not at the same time! Your brain actually alternates between perceiving the vase and perceiving the pair of faces, because it can only identify the image as one or the other at a time.

The Rubin vase illusion works because of the striking color contrast between the vase and faces, as well as the lack of detail in both images. These two factors cause your eyes to have difficulty determining which part of the image is the background and which is the figure.

Procedure

Ask students to perform the following steps:

1. Fold the black construction paper in half.
2. Use a white pencil to trace the contour of your face on the black construction paper. You may need a friend to help you trace the contour of your face.
3. Cut out the contour of your face, so that you have two copies.
4. Glue the two black copies "face to face" on white paper to create the image of a white "vase" shape in between.
5. Place the completed Rubin vases at the front of the class and have the students discuss what they see in the images. Do they see two faces looking at one other, a vase, or both?

Materials

(per student or per group)

Ponzo background
(page 32)

(page 33)

Make a Ponzo Illusion

Named for an Italian psychologist, the Ponzo illusion uses your brain's tendency to judge an object's size according to cues perceived from the background. You interpret the background using linear perspective, so your brain interprets the illusion's converging lines to be parallel lines that are getting further away from you. When two objects that are actually the same size are placed on this background, you perceive the objects as larger or smaller depending on how close or far they appear to be.

Procedure

1 Provide students with a copy of the Ponzo background and two copies of the provided image of Robert Wadlow, the world's tallest man ever known, standing with a person about 5 feet 4 inches (163 cm) tall.
2 Ask students to cut out the images and place them at different positions on the background.
3 Discuss whether the images seem to change size depending on where they are placed on the background.

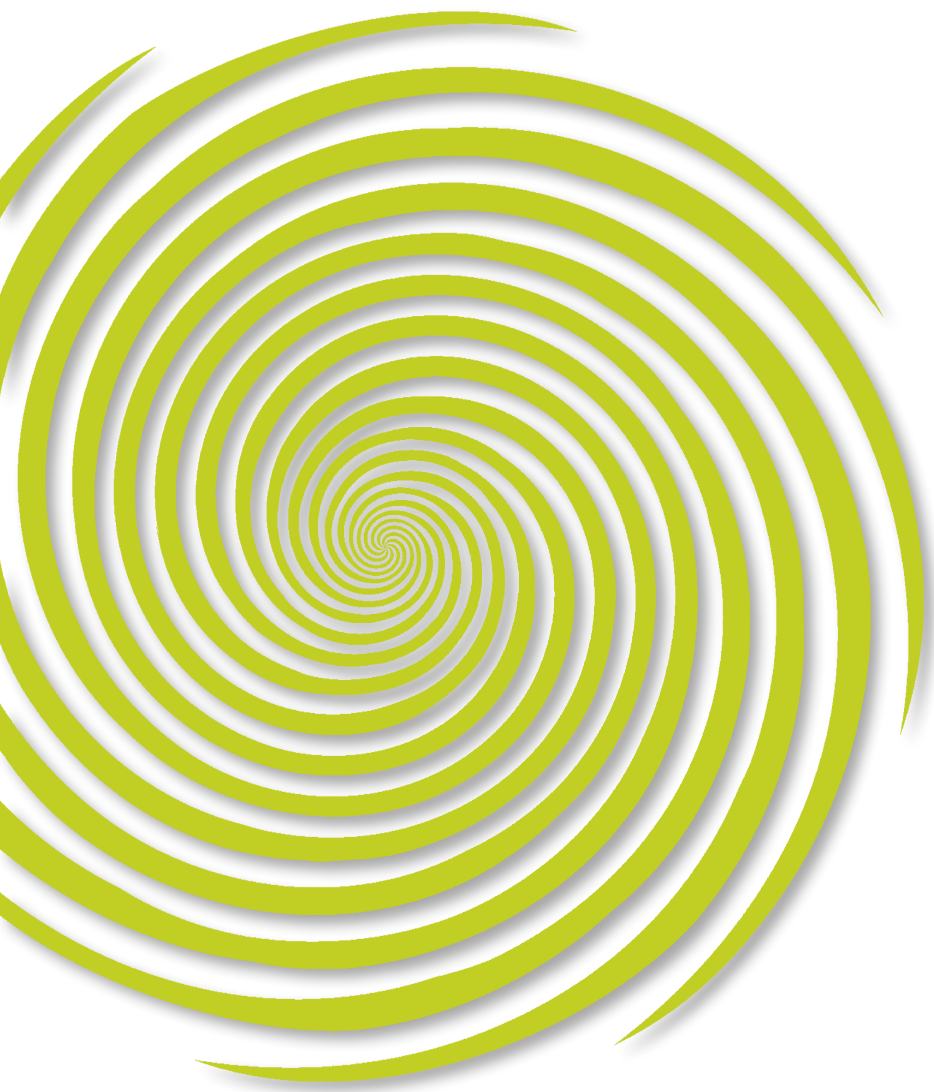
Extensions/Adaptations

1 To extend the Ponzo illusion activity, students can try substituting the supplied image with other drawings or objects, such as two crayons. Students can also experiment with creating their own backgrounds for the illusion.

2 You may wish to try the following additional activities with your students:
- Try drawing "impossible objects". (Search on the Internet using keywords such as "impossible objects illusions" and "Michael Bach, impossible objects".)
- Practice taking "forced-perspective photographs" or film a short video using the principles of forced perspective. (For examples, search on the Internet using keywords.)
- Explore the work of modern optical illusion designers, such as Akiyoshi Kitaoka.
- Try recreating some of the following simple optical illusions:
    - o geometrical-optical illusions, such as the Poggendorff, Zöllner, and Müller-Lyer illusions;
    - o the Kanizsa triangle subjective contour illusion;
    - o the Ebbinghaus illusion (Titchener circles) of relative size perception.
      (For information about these illusions, search on the Internet using keywords above for each type of illusion.)

Worksheets

The Science of Ripley's Believe It or Not!® - Education Guide



Going to Great Lengths *Worksheet - p 1 of 2*

Reticulated python

Eastern diamondback rattlesnake

Common garter snake

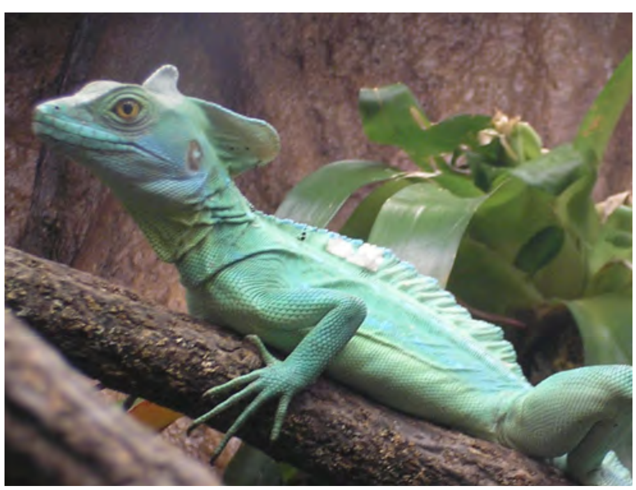
Mountain horned lizard

Komodo dragon

Dwarf gecko

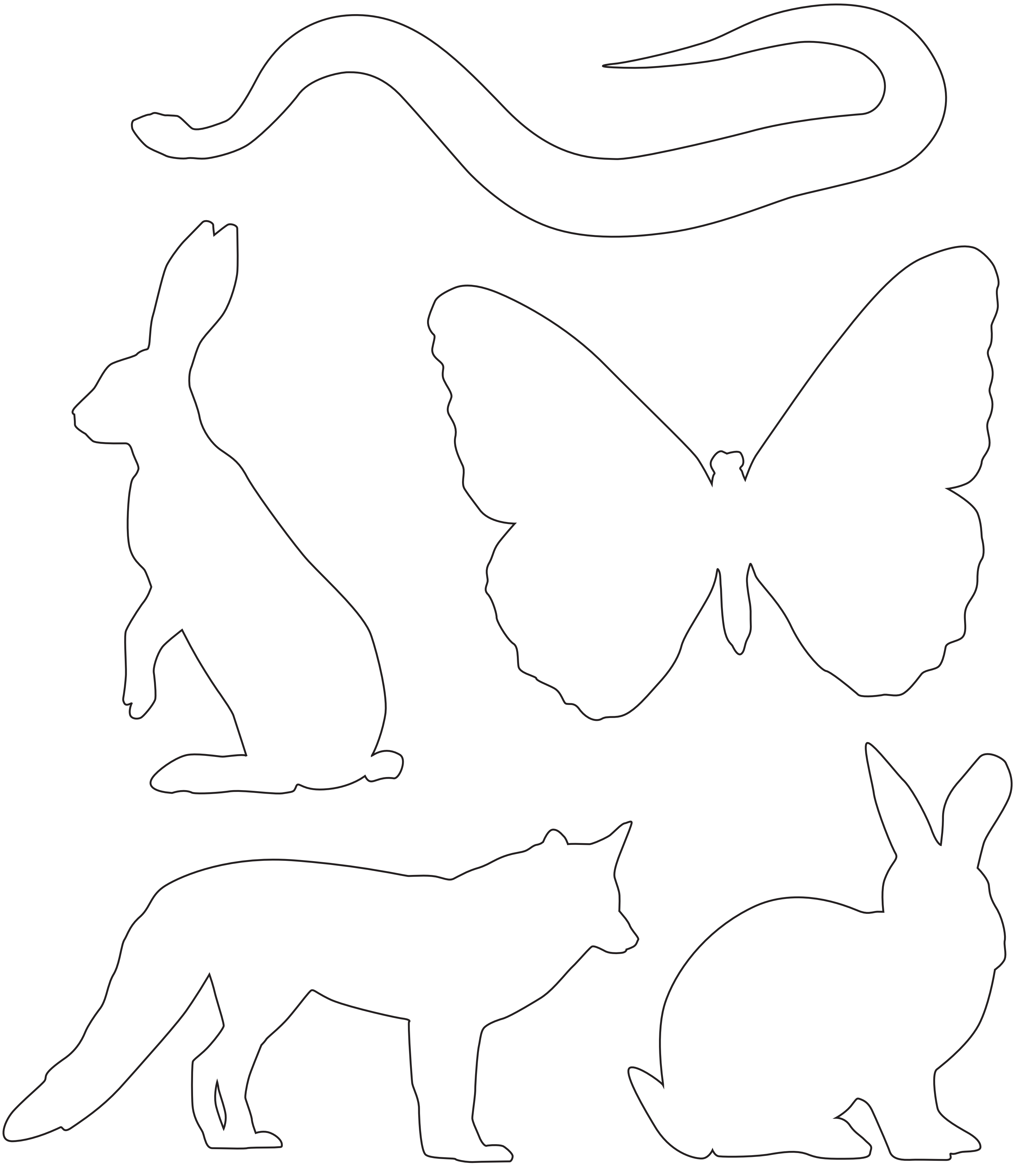
Water monitor

Panther chameleon



Green basilisk

CREATIVE CAMOUFLAGE *Worksheet*

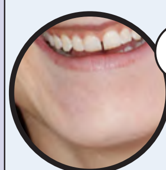
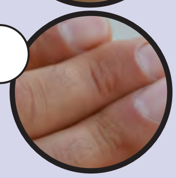
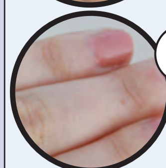
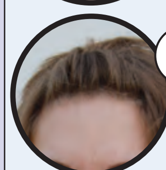
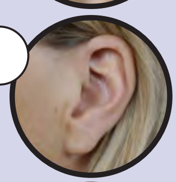
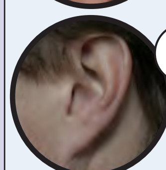
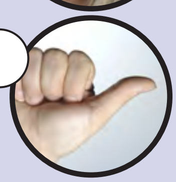
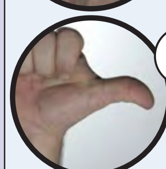
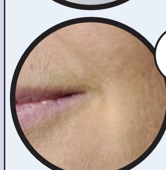
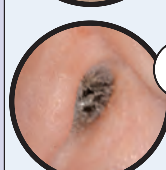


The Science of Ripley's Believe It or Not!®

MY GENETIC TRAITS

Which of the two physical traits do you show?

Your Name

DD or DR	RR
If you have a cleft chin, then your genes are: DD or DR 	 If you have a smooth chin, then your genes are RR
If the middle segment of your fingers have even one hair (called mid-digit hair), then your genes are: DD or DR 	 If the middle segments of your fingers have no hair, then your genes are RR
If you have a pointed hairline, then your genes are: DD or DR 	 If you have a straight hairline, then your genes are RR
If your earlobes dangle (called detached earlobes), then your genes are: DD or DR 	 If you have attached earlobes, then your genes are RR
If you have a thumb that stays straight, then your genes are: DD or DR 	 If you have a thumb that bends backward, then your genes are RR
If you have dimples, then your genes are: DD or DR 	 If you have no dimples, then your genes are RR
If you have orange, sticky earwax, then your genes aree: DD or DR 	 If you have grey, crumbly earwax, then your genes are RR

B	I	N	G	O
Free	Straight hairline	Thumb bends backward	Grey, crumbly earwax	I have a different trait than the person sitting behind me
Dimples	Attached earlobes	Thumb stays straight	I have a shared trait with the person sitting to my left	Detached earlobes
Orange, sticky earwax	Mid-digit hair	Cleft chin	Smooth chin	No Dimples
I have a shared trait with the person sitting to my right	I have a different trait than the person sitting in front of me	No mid-digit hair	Pointed hairline	Free

Genetic Traits BINGO

Instructions for the Teacher

This BINGO game should be played only after the students have completed the “My Genetic Traits” worksheet, so they will be able to recognize the various traits.

Distribute copies of the BINGO card to each student.

Read the list of traits below in order or at random, or have students draw numbers.

The students color in the appropriate squares as they relate to their traits. When a student colors in an entire row or column (or other pre-determined pattern), they can call out “Bingo” to be declared the winner.

1 Color the square marked *I have a shared trait with the person sitting to my left* if this describes you.

2 Color the square marked *I have a shared trait with the person sitting to my right* if this describes you.

3 Color the square marked *Smooth chin* if you have this trait.

4 Color the square marked *Straight hairline* if you have this trait.

5 Color the square marked *No mid-digit hair* if you have this trait.

6 Color the square marked *Attached earlobes* if you have this trait.

7 Color the square marked *I have a different trait than the person sitting in front of me* if this describes you.

8 Color the square marked *Dimples* if you have this trait.

9 Color the square marked *Thumb bends backward* if you have this trait.

10 Color the square marked *Cleft chin* if you have this trait.

11 Color the square marked *No dimples* if you have this trait.

12 Color the square marked *Grey, crumbly earwax* if you have this trait.

13 Color the square marked *Mid-digit hair* if you have this trait.

14 Color the square marked *Thumb stays straight* if you have this trait.

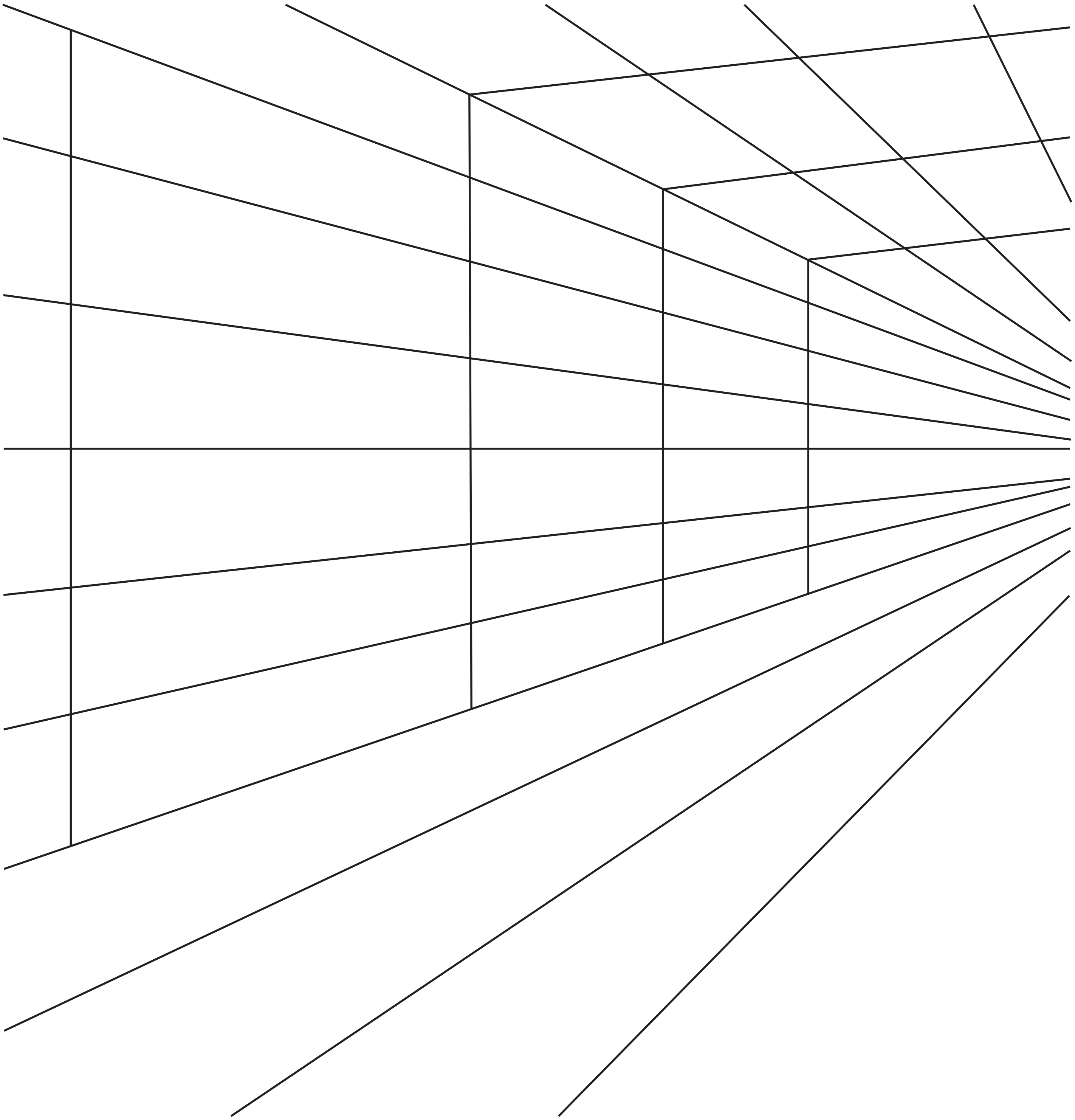
15 Color the square marked *Detached earlobes* if you have this trait.

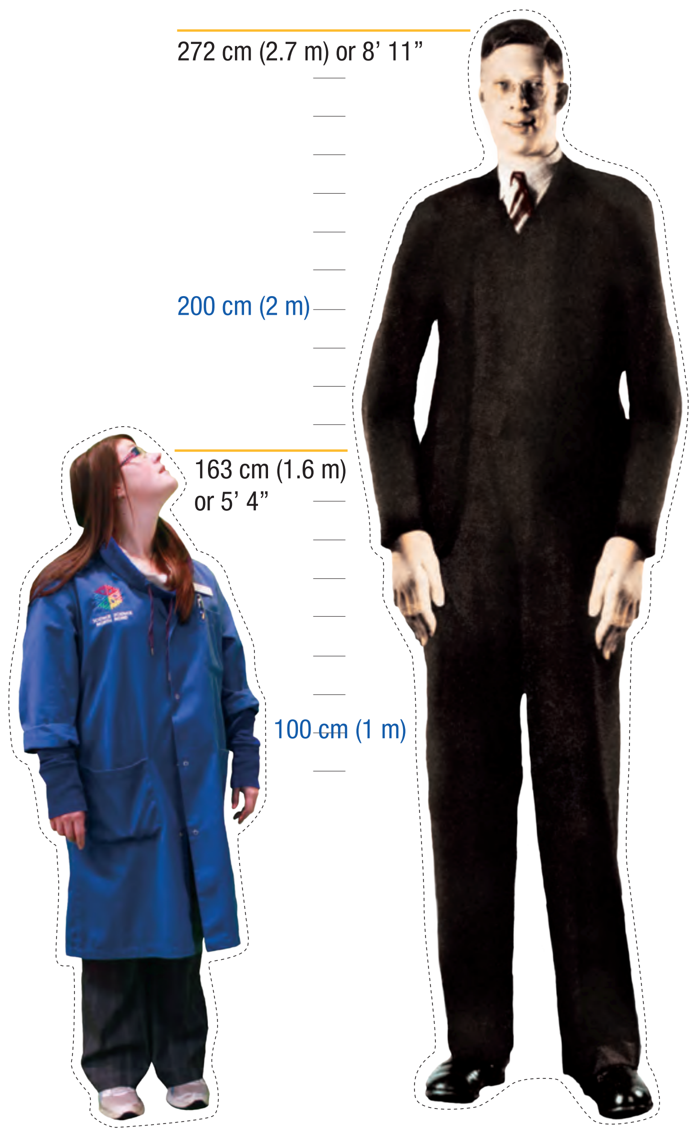
16 Color the square marked *I have a different trait than the person sitting behind me* if this describes you.

17 Color the square marked *Pointed hairline* if you and your neighbor to the right share a common trait.

18 Color the square marked *Orange, sticky earwax* if you have this trait.

PERSPECTIVES AND ILLUSIONS *Worksheets*





272 cm (2.7 m) or 8' 11"
200 cm (2 m)
163 cm (1.6 m)
or 5' 4"
100 cm (1 m)