Exploring The BUILDING BLOCKS of SCIENCE

Book 3

STUDENT TEXTBOOK

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Illustrations: Janet Moneymaker

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Chemistry

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Chapter 3 Un-mixing

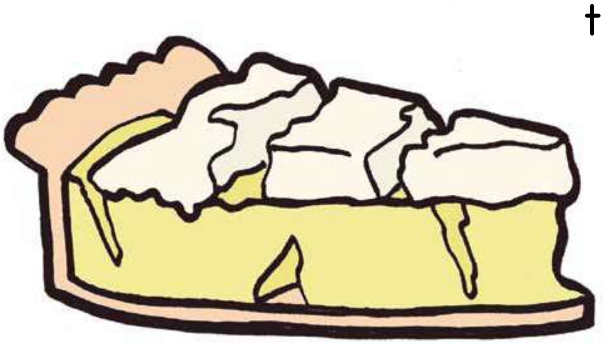
3.1 Un-mixing

In the last chapter we learned about mixtures, but how do we get things that are mixed to "un-mix?" Can we get the water and sand to "un-mix" from a mud pie? Can we get the eggs, sugar, water, and lemons to "un-mix" from a lemon pie?

Try to think of ways to "un-mix" a mud pie. What if you let the mud pie bake in the sun? What happens to the water? What happens to the sand?

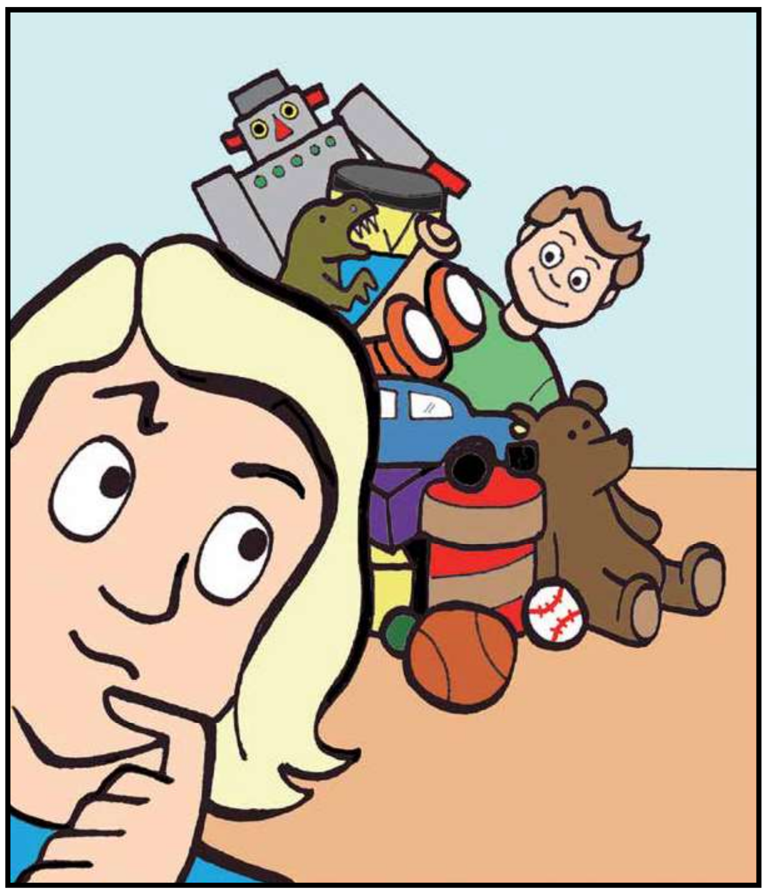
3.2 Evaporation

You may know that the water "disappears" from the mud pie and the sand stays behind. We say that the water has evaporated. Evaporation is one way to "un-mix," or separate, mixtures that have water in them.



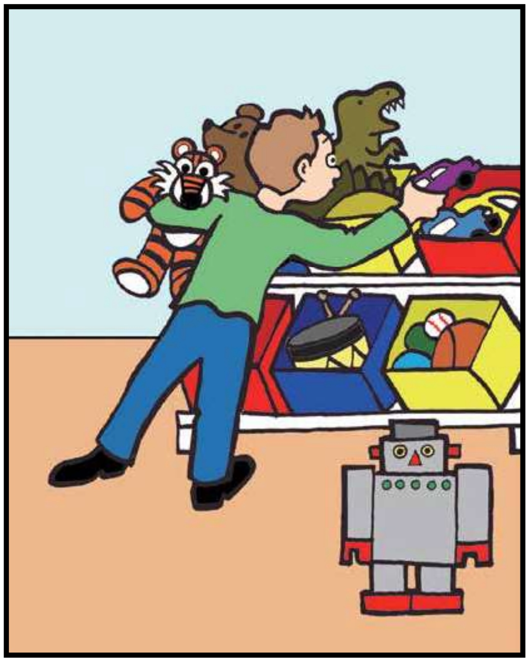
What happens if we leave the lemon pie to bake in the sun? Will the lemon pie "un-mix?" The water will evaporate, but what happens to the eggs, sugar, and lemons? They do not evaporate. In fact, they stay behind and we have a not-so-tasty lemon mess!

3.3 Sorting By Hand



Sometimes we can "un-mix" things, and sometimes we cannot. The mud pie can be "un-mixed," by the sun, but the lemon pie cannot.

Large things are usually easy to "un-mix." Even though when your mom tells you to clean your room, the large pile of toys may seem impossible to "un-mix"—with some work, it can be done.



All of the toys are easy to pick up because they are large. They can be picked up with your hands and put into separate bins or boxes.

3.4 Using Tools

What about a pile of sand? The sand cannot be easily picked up because each piece of sand is very small. It would take hours to pick up all of the sand by hand!

Fortunately a tool can be used. Can you think of a tool for picking up sand and "un-mixing" it from your carpet?

That's right—a vacuum cleaner! A vacuum cleaner can be used as a tool for "un-mixing."

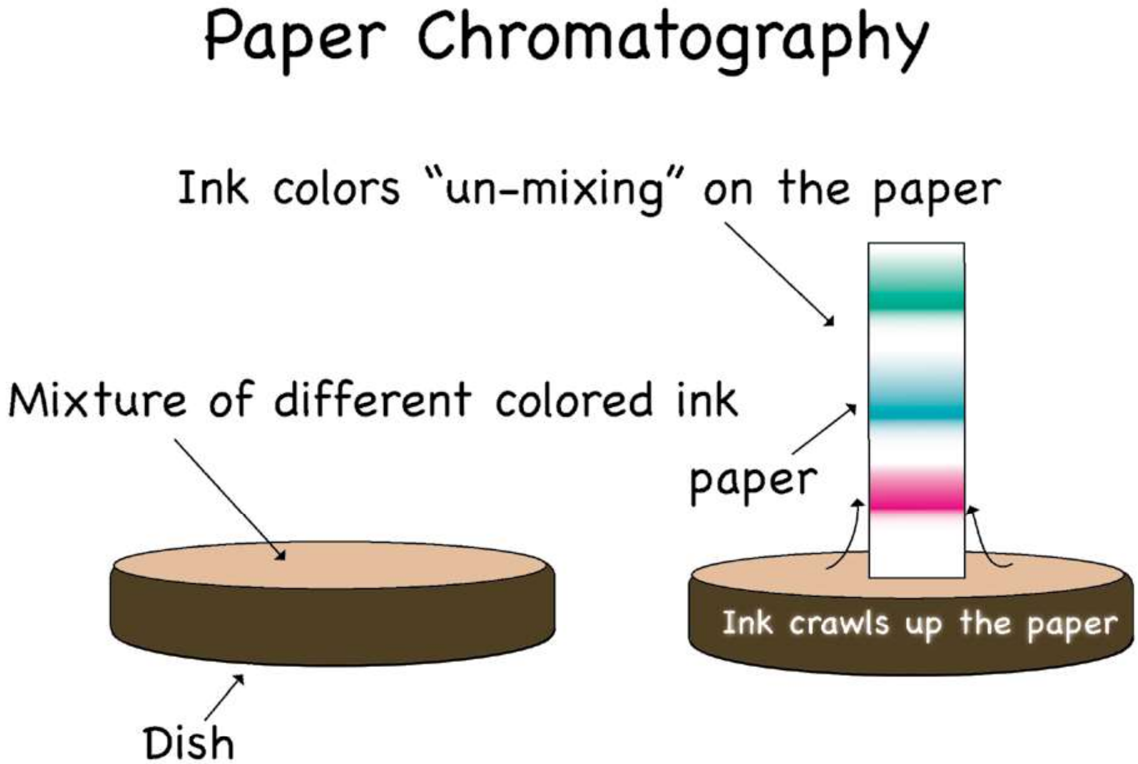
In fact, tools are used all the time to "un-mix" things that are hard to "un-mix" with your hands. For example, sieves or colanders are used to separate hot spaghetti or hot potatoes from boiling water.

3.5 Using "Tricks"

There are other tools and other ways to "un-mix" mixtures of small things. What about molecules that you can't even see? Are there ways to separate molecules?

There are! In fact, scientists use a trick called chromatography to separate molecules. Using chromatography, you can un-mix many different kinds of molecules.

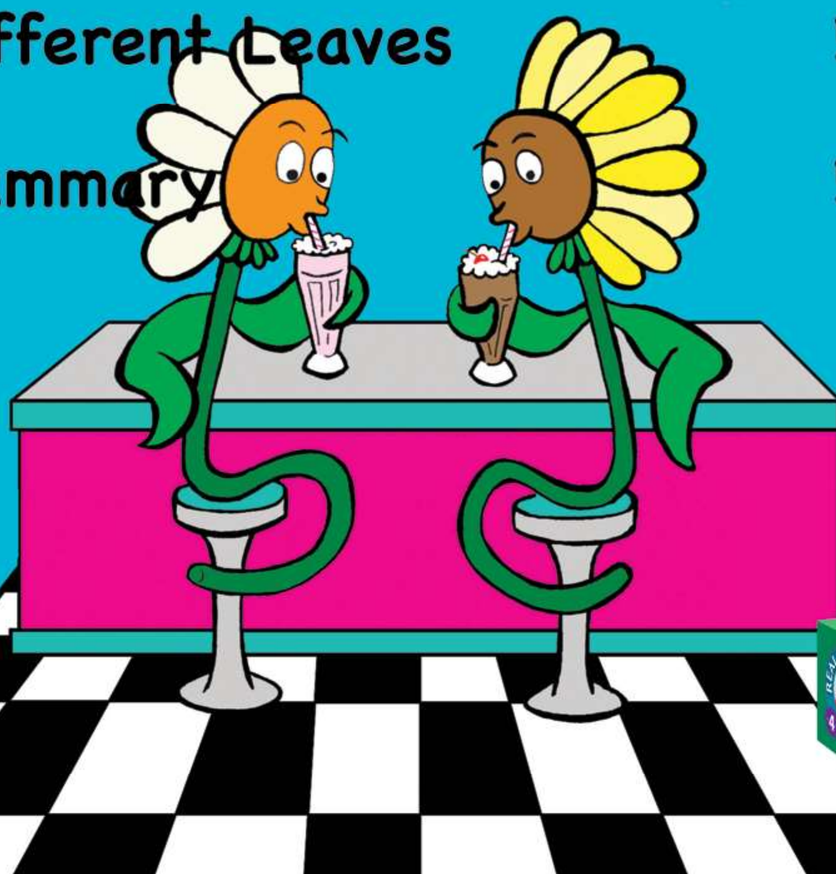
One type of chromatography is called paper chromatography. With paper chromatography, a piece of paper is used to separate small things like molecules. You can use paper chromatography to separate the small molecules that are in ink or dye, or even the molecules found in a colored flower!


Paper Chromatography
Ink colors "un-mixing" on the paper
Mixture of different colored ink
paper
Ink crawls up the paper
Dish

3.6 Summary

- The sand and water in a mud pie can be "un-mixed" by evaporating away the water.
- Some mixtures, such as lemon pies, cannot be easily "un-mixed."
- Mixtures of large things are easier to "un-mix" than mixtures of smaller things.
- Tools, like vacuum cleaners and sieves, can be used to "un-mix" some mixtures.
- A trick called chromatography can be used to separate molecules.

Chapter 7 Food for Plants



7.1 Introduction

How do plants eat? Do they eat spaghetti or french fries? Have you ever met a plant at the diner drinking a milk shake?

No, probably not. Plants can't eat spaghetti or french fries or drink milk shakes.

In fact, most plants have to make their own food. They make their food using sunlight.

7.2 Factories

Cells are like little cities. Just like cities have factories that make bread or cereal, cells also have places inside them that act like factories.

We call these little factories organelles. An organelle is like a little organ inside cells that does a special job.

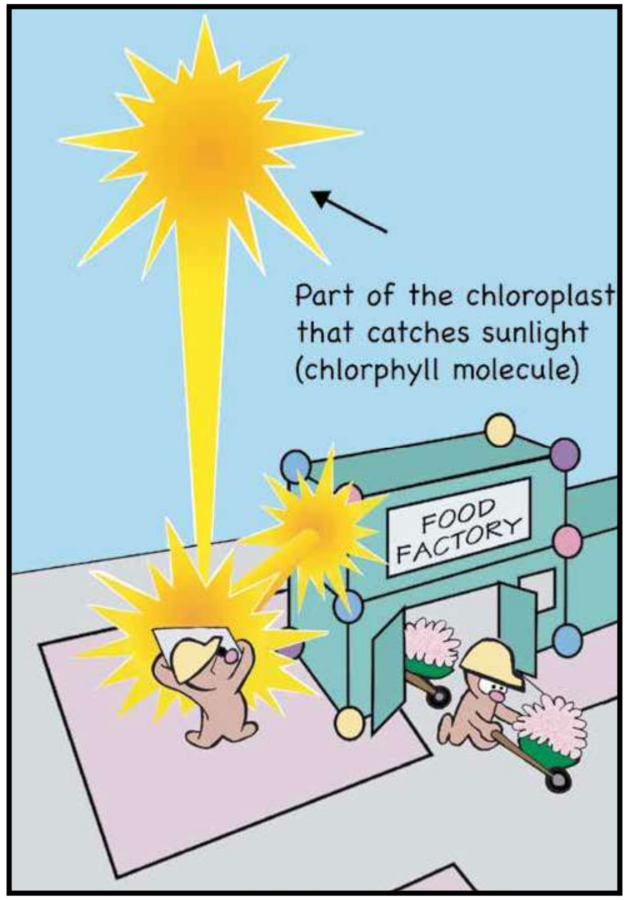
A food factory (called a chloroplast) is a kind of organelle.

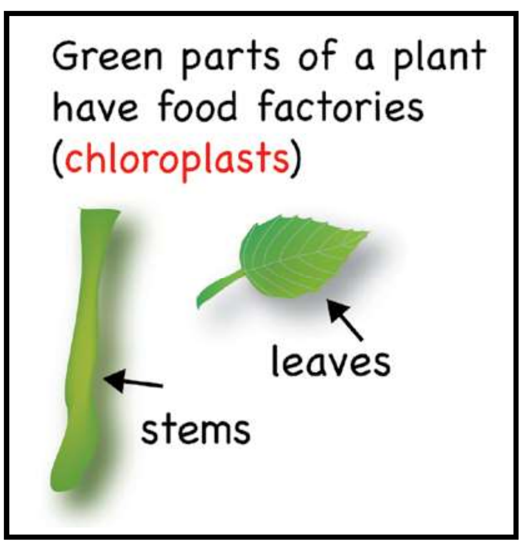
There are many different kinds of organelles inside cells. To make food, a plant cell has an organelle called a chloroplast.

7.3 How Plants Make Food

Plants use sunlight to make food. This process is called photosynthesis. Photo means "light" and synthesis means "to make." So photosynthesis means "to make with light."

Plants do this by catching the light from the Sun in a very special molecule inside their cells. This molecule is called chlorophyll. The job of the chlorophyll molecule is to catch sunlight and use it to make sugar!

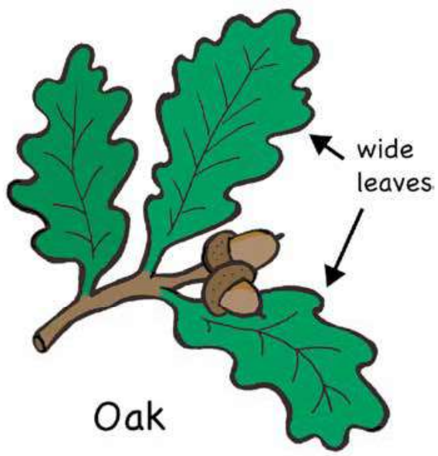




7.4 Food Factories

Food for a plant is made in all of the green parts of the plant. This is because the chloroplasts are found in all these green parts. Green plant leaves and green plant stems both have chloroplasts.

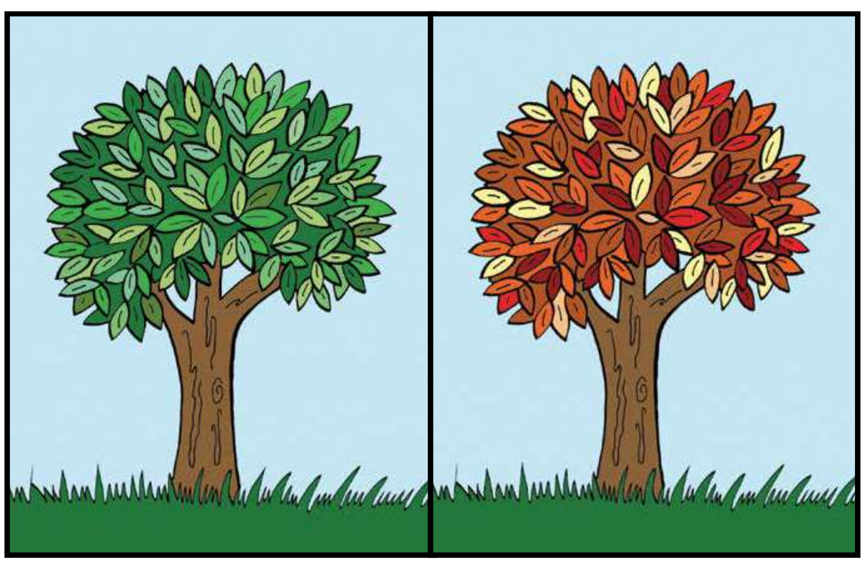
The green color in a chloroplast comes from the chlorophyll molecule. The chlorophyll molecule catches the sunlight and also makes the leaf or stem green.



7.5 Different Leaves

There are many different kinds of leaves on plants and trees. Some trees, like oak trees, have very wide leaves. This is so they can collect as much sunlight as possible.

Other trees, like a willow tree, have lots of narrow leaves. Having lots of leaves will also help a tree collect as much sunlight as possible.



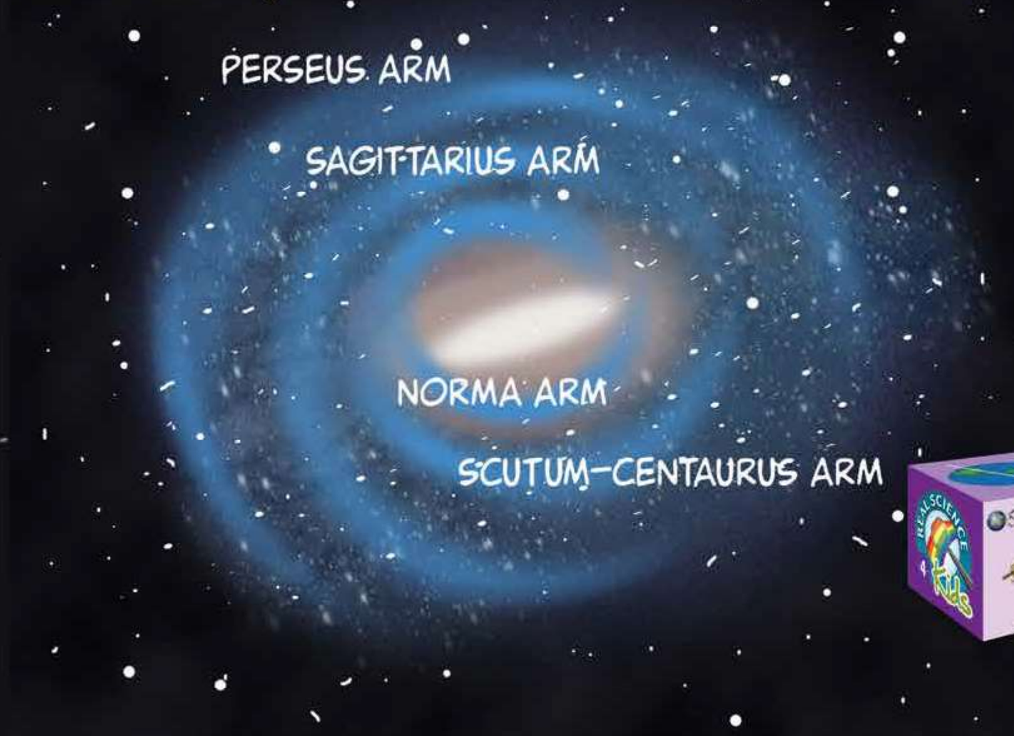
What happens to leaves when they change color? Why do leaves turn yellow in autumn and then fall off in winter? Leaves change color in autumn because in autumn the days are shorter.

It is a lot of work for a tree to use sunlight to make sugar to use for food. When there isn't enough sunlight to do this, the tree gets rid of its leaves. A tree knows when the days are getting shorter, and this causes the green chlorophyll molecules to go away, the tree to stop making food, and the leaves to first turn color and then fall off.

7.6 Summary

- Most plants make their own food by photosynthesis.
- Plants have tiny factories called chloroplasts inside their cells. Chloroplasts are used by plants for making food.
- The green parts of a plant, like leaves and stems, contain chloroplasts and make the food for the plant.
- Leaves change color in autumn when the tree doesn't get enough sunlight to make food.

Chapter 19 Our Galaxy
The Milky Way

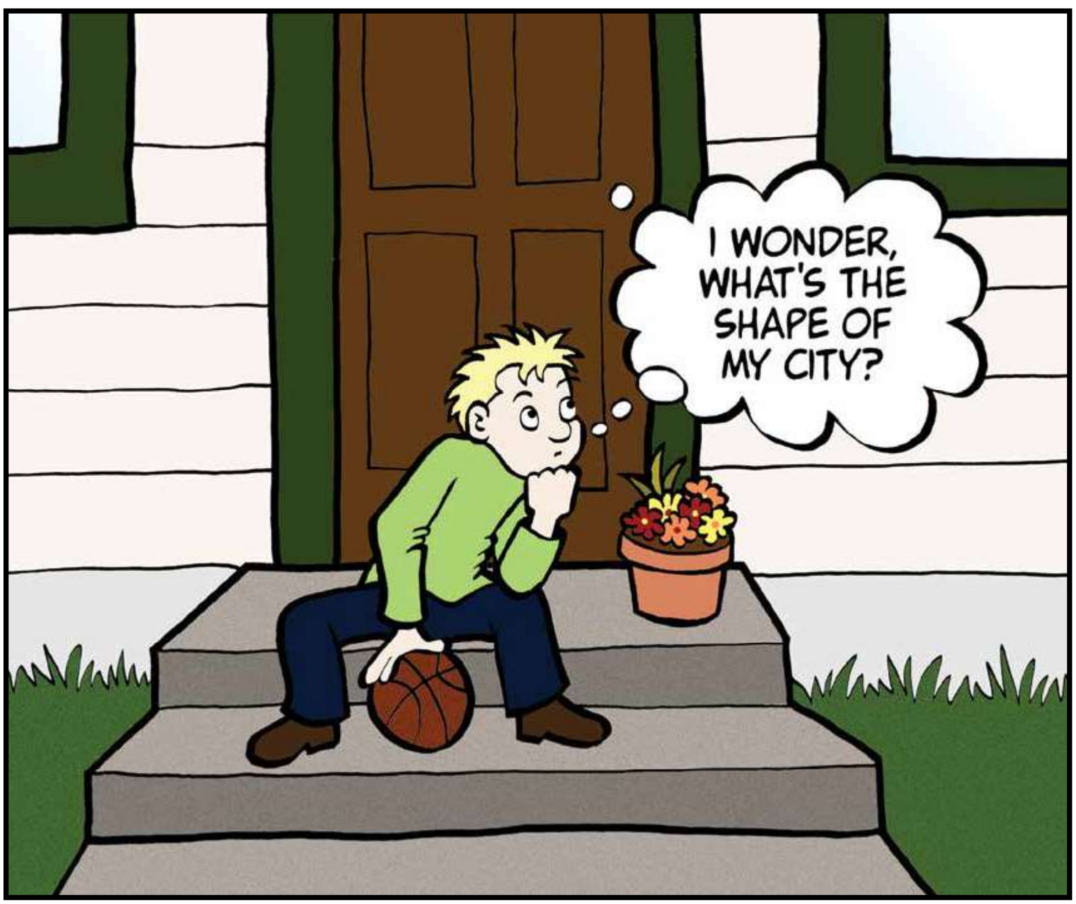


19.1 Introduction

In this chapter we will take a closer look at our galaxy, the Milky Way Galaxy. Scientists estimate that there are many billions of stars in the Milky Way Galaxy and that many of these stars may have planets orbiting them.

19.2 Our Galaxy

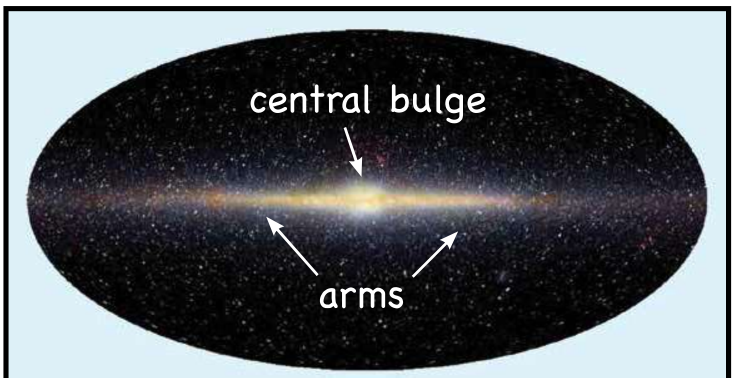
Think about the city you live in or one you have visited. Can you see the whole city from your house? Is it easy to tell the shape of your city from where you live?



No! Because you are one small person in a big city, you can't tell what your city looks like from your house. You would need to see your city from a different place, like an airplane or spaceship, to see what shape it has.

In the same way, it is difficult for astronomers to see the Milky Way Galaxy. No one has taken a picture of the Milky Way Galaxy because it is too big and we can't fly far enough away to see the whole galaxy. However, astronomers can guess what the Milky Way Galaxy looks like by observing other galaxies.

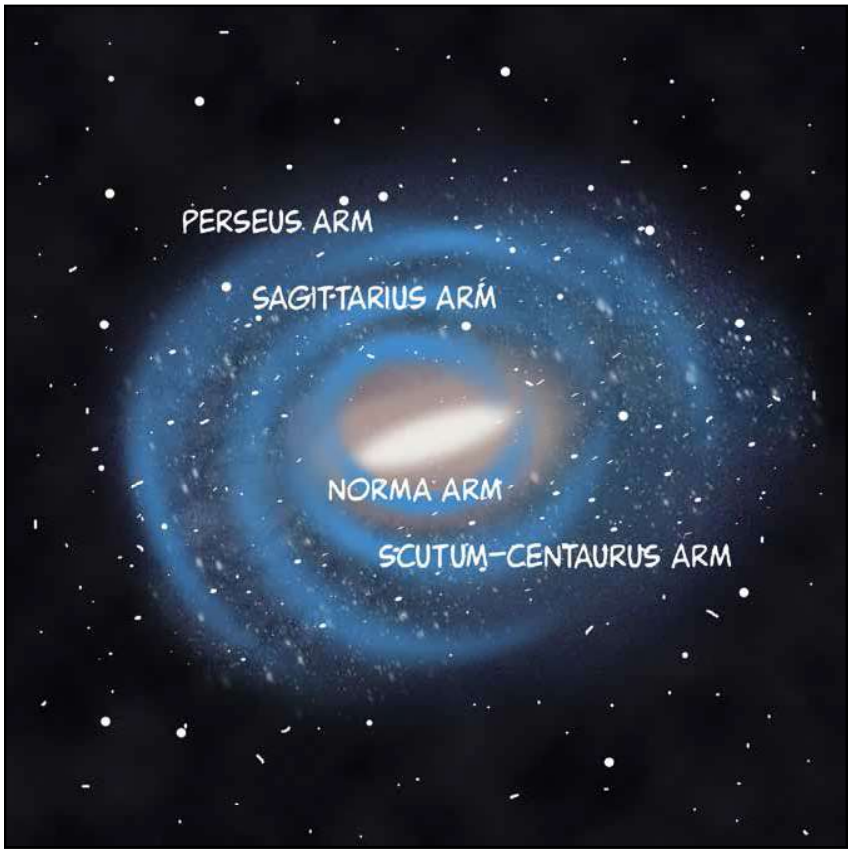
Is our galaxy round or flat? Is our galaxy large or small? Does our galaxy have a fixed center, like an orange, or does it move like Jell-O?



SIDE VIEW OF MILKY WAY GALAXY
(artist's illustration) Credit: NASA/UMass/Caltech

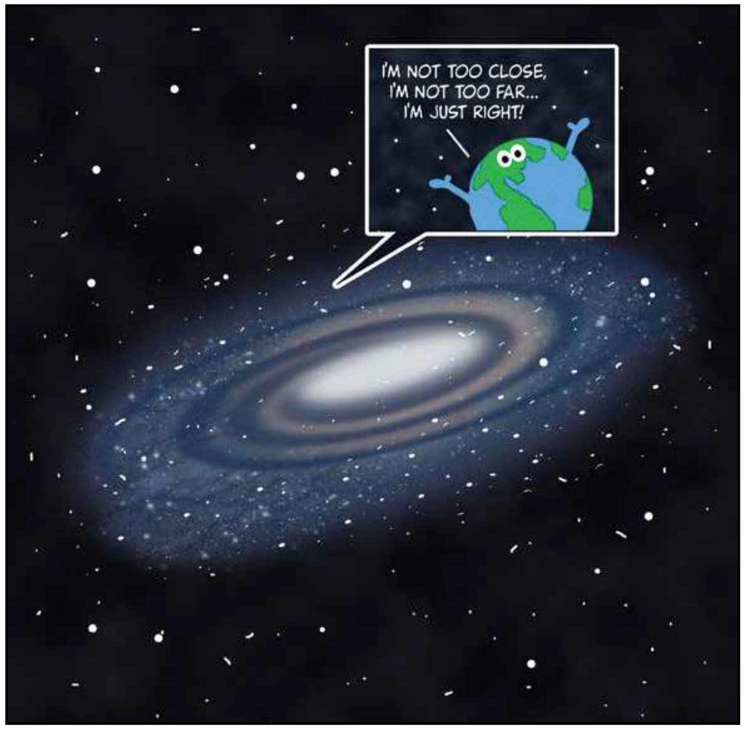
Even though we've never seen our galaxy from the outside, modern astronomers think that the Milky Way is shaped like a pinwheel. Just like a pinwheel, our galaxy has spiraling arms and a bulge in the center. This central bulge is a dense ball of stars. The arms of our galaxy are flatter at the edges than the center. Most of the stars in our galaxy are in the center, with fewer stars on the edges.

The Milky Way has two major arms, which are called the Scutum-Centaurus Arm and the Perseus Arm, and two minor arms, called the Norma Arm and the Sagittarius Arm. These arms spread out from the center, creating a spiral galaxy that looks like a pinwheel.



19.3 Where Are We?

Our Sun and solar system are located on a partial arm called the Orion Arm. The Orion Arm is between the Sagittarius and Perseus arms. Scientists think that our solar system may be about halfway between the center and the outer edge of the Milky Way Galaxy, but this is still uncertain.



We happen to live at just the right place in our galaxy. If our solar system were too far from the center of the galaxy, a planet like Earth might not be able to form. If our solar system were too close to the center, there might be too many stars creating too much radiation and gravity for life to form. As it turns out, we live in the right place in our galaxy for life to exist—not too close to the center and not too far away!

19.4 Earth Moves

The Milky Way Galaxy, like other galaxies, is in motion. It is thought that the objects in the Milky Way Galaxy revolve around a black hole at the center and that the entire Milky Way Galaxy moves through space. We can see that Earth, too, is constantly in motion. The Earth spins on its axis, revolves around the Sun, travels with our solar system around the center of the Milky Way Galaxy, and moves through space with the entire galaxy.

19.5 Summary

- Astronomers think the Milky Way Galaxy is shaped like a pinwheel.
- The shape of the Milky Way Galaxy is called a spiral galaxy.
- Our Earth is in the right spot in our galaxy for life to exist.
- Earth moves through space in several ways—spinning on its axis, revolving around the Sun, traveling with our solar system around the center of the Milky Way Galaxy, and moving through space with the entire Milky Way Galaxy.

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Book 3

LABORATORY NOTEBOOK

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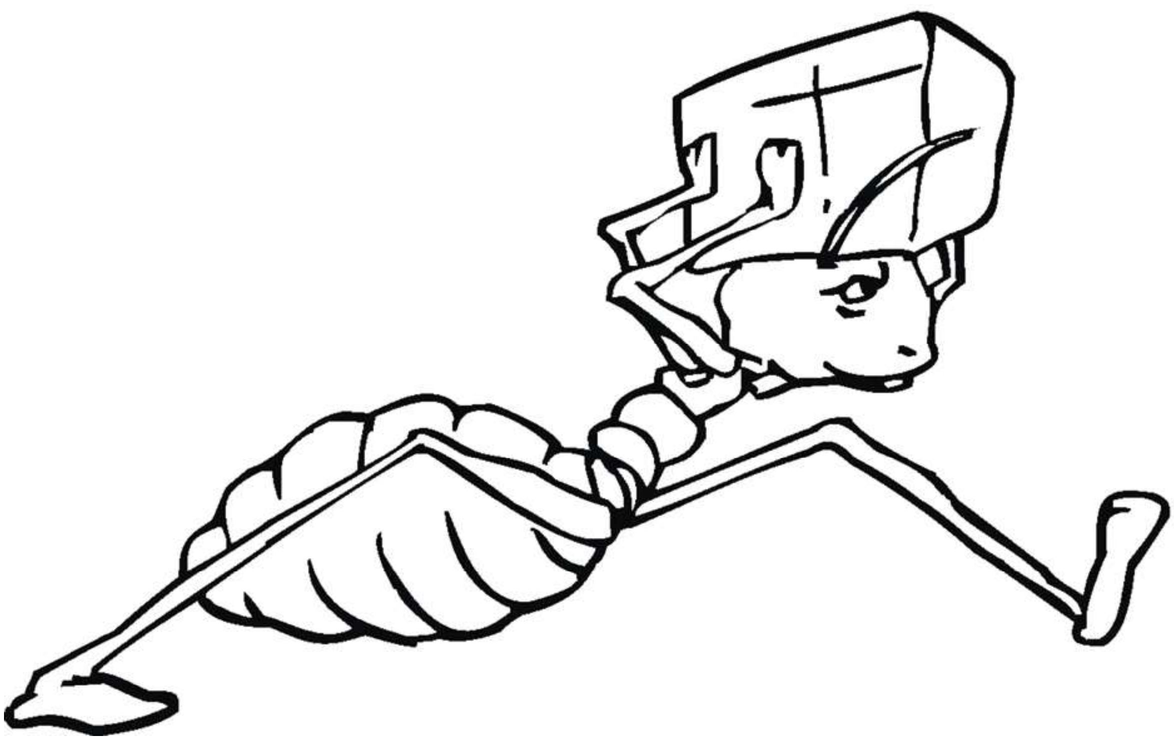
Contents

Experiment 3

Make It Un-mix!



Introduction

Do this experiment to discover some ways to separate different kinds of mixtures.

I. Think About It

❶ If you had rocks and Legos mixed together, how would you un-mix them?

____

____

❷ If you had rocks and sand in a bag, how would you un-mix them?

____

____

❸ If you had sand and salt in a bag, how would you un-mix them?

____

____

❹ If you had salt and sugar in a bag, how would you un-mix them?

____

____

❺ If you had salt and sugar in water, how would you un-mix them?

____

____

CHEMISTRY

II. Observe It

❶ Take a handful of rocks and a handful of Legos and mix them together on the table. Now try to un-mix them. Draw or describe what you did.

❷ Take a handful of rocks and mix them with sand in a bag. Now un-mix the rocks and sand. Draw or describe what you did.

CHEMISTRY

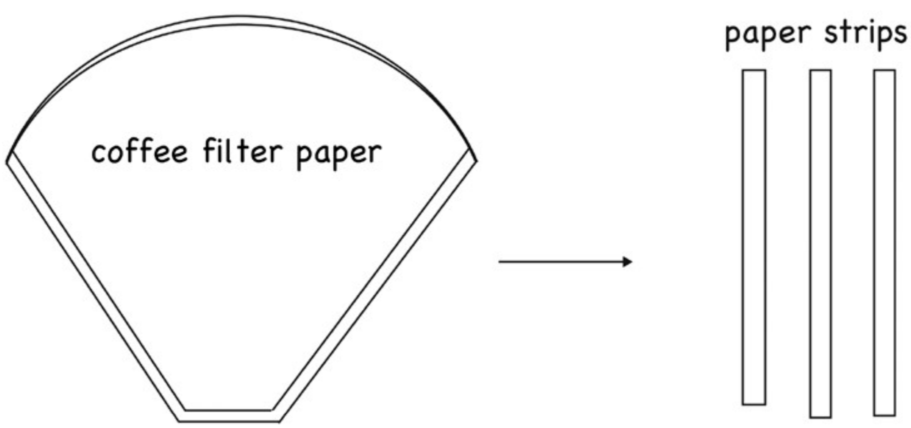
❸ Take a handful of sand and a handful of salt and mix them in a bag. Now un-mix them. Draw or describe what you did.

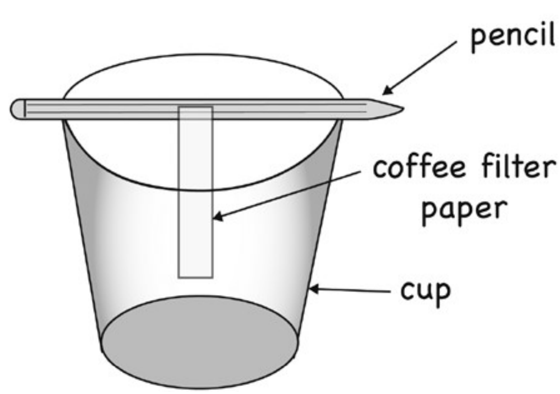
❹ Place a few drops of several different colors of food coloring into a glass or paper cup that contains 120 ml (1/2 cup) of water. Think about ways you might un-mix the colors.

❺ Now try a method called *chromatography* which uses paper to un-mix the colors.

Take a piece of coffee filter paper and cut it into long strips. Place a pencil over the top of the glass or paper cup that contains the colored water mixture and tape one end of a paper strip to the middle of the pencil. The other end of the filter paper will be in the colored water.

It should look like this:





CHEMISTRY

❻ Carefully observe what happens, and record your observations.

Let the filter paper dry and tape it in the box.

❼ Repeat the experiment with an "unknown." Have someone mix two colors together in water. See if you can tell, using chromatography, which colors are in the water.

❽ Make an unknown for your teacher. Mix two colors together without telling your teacher what they are. Have your teacher use chromatography to find out which colors you put in the glass.

❾ Record all of your results below.

Your Unknown

Teacher's Unknown

CHEMISTRY

III. What Did You Discover?

❶ How many different ways did you discover to un-mix things that were mixed? List them.

❷ Can you use your fingers to un-mix the rocks and Legos? Can you use water? Can you use paper? Why or why not?

❸ Can you use your fingers to un-mix the sand and the rocks? Can you use water? Can you use paper? Why or why not?

❹ Can you use your fingers to un-mix the sand and the salt? Can you use water? Can you use paper? Why or why not?

____

❺ Can you use your fingers to un-mix the colors in the water? Can you use water? Can you use paper? Why or why not?

IV. Why?

You found out in the last experiment that some items mix and some do not. In this experiment you discovered that sometimes you can un-mix items and sometimes you cannot. You also discovered that large objects, like rocks and Legos, are easier to un-mix than small items, like salt and sand. You discovered that items that look similar, like salt and sugar, are difficult to un-mix.

Why are some mixtures hard to separate and some easy? Larger objects, like rocks and Legos, are easier to un-mix than smaller items like sand and salt. Items that have very different properties, like sand and sugar, are easier to separate than items that are very similar, like salt and sugar. Also, very small objects that are hard to see are very difficult to separate. For example, molecules are very difficult to separate from other molecules.

You found out that when items are difficult to un-mix you can use a few "tricks," one of which is *chromatography.*

V. Just For Fun

Take a handful of salt and a handful of sugar and mix them in a bag. Now un-mix them. Draw or describe what you did.

CHEMISTRY

Experiment 7

Who Needs Light?

Introduction

What happens to plants when they don't get sunlight? Do this experiment to find out.

I. Think About It

❶ List three things a plant needs to have in order to live.

___

___

___

❷ What do you think would happen to a plant if it did not get light from the Sun?

___

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BIOLOGY

II. Observe It

1. Take two small plants that are the same kind and about the same size.

2. Carefully observe each plant. Note any unique features they have.

3. Make a list of words that describe the plants and their features.

❹ Label one plant **A** and the other **B**. Draw each plant.

A **B**

❺ Take the plant labeled **A** and put it in a sunny place.

❻ Take the plant labeled **B** and put it in a dark place.

❼ Describe what you think will happen to each plant.

Plant A

Plant B

❽ Make a schedule for watering your plants on a regular basis. Be sure to water both plants with the same amount of water.

Draw each plant after week 1.

A

B

Draw each plant after week ________

A

B

Draw each plant after week ________

A

B

Draw each plant after week ________

A

B

III. What Did You Discover?

❶ How did the plants look on the first day?

Plant A ____

____

Plant B ____

____

❷ How did the plants look after the first week?

Plant A ____

____

Plant B ____

____

❸ How did the plants look after the last week?

Plant A ____

____

Plant B ____

____

❹ Describe any differences you observed between the two plants.

Plant A ____

____

Plant B ____

____

IV. Why?

A regular houseplant needs sunlight to make food. If a houseplant is not able to get sunlight, it cannot make the food it needs to stay healthy. Eventually, a houseplant will die if it does not get enough sunlight.

When you put one plant in the dark and keep one plant in the sunlight, you are testing what happens to a plant that does not get sunlight. Why do you think you needed two plants—one in the sunlight and one in the dark?

You used two plants because, as a scientist, you want to make careful observations when you change something. When you use two plants (one in the sunlight and one in the dark), you can easily compare any changes in each of the plants. You want to know what happens to a plant that is in the dark compared to a similar plant that stays in the sunlight.

This is called using a *control*. The control shows you what will happen if nothing is changed. In this way, scientists can be sure that they will be able to observe what happens when something is changed. In this experiment, you observed what happened when sunlight was taken away from a plant. Your control plant (plant **A**) showed you what the plant looked like when it had sunlight. The plant you took away from the sunlight (plant **B**) showed you what happened to the plant when it could not use the Sun's energy to make food. Using a control helped you determine what happens when a plant does not get sunlight.

V. Just For Fun

Do another experiment using two more plants that are both the same kind and about the same size. This time water one plant and don't water the other one. Based on the last experiment, think of the steps you will need to take to preform this experiment. Record your results at the beginning and the end of the experiment.

Plant A — Beginning

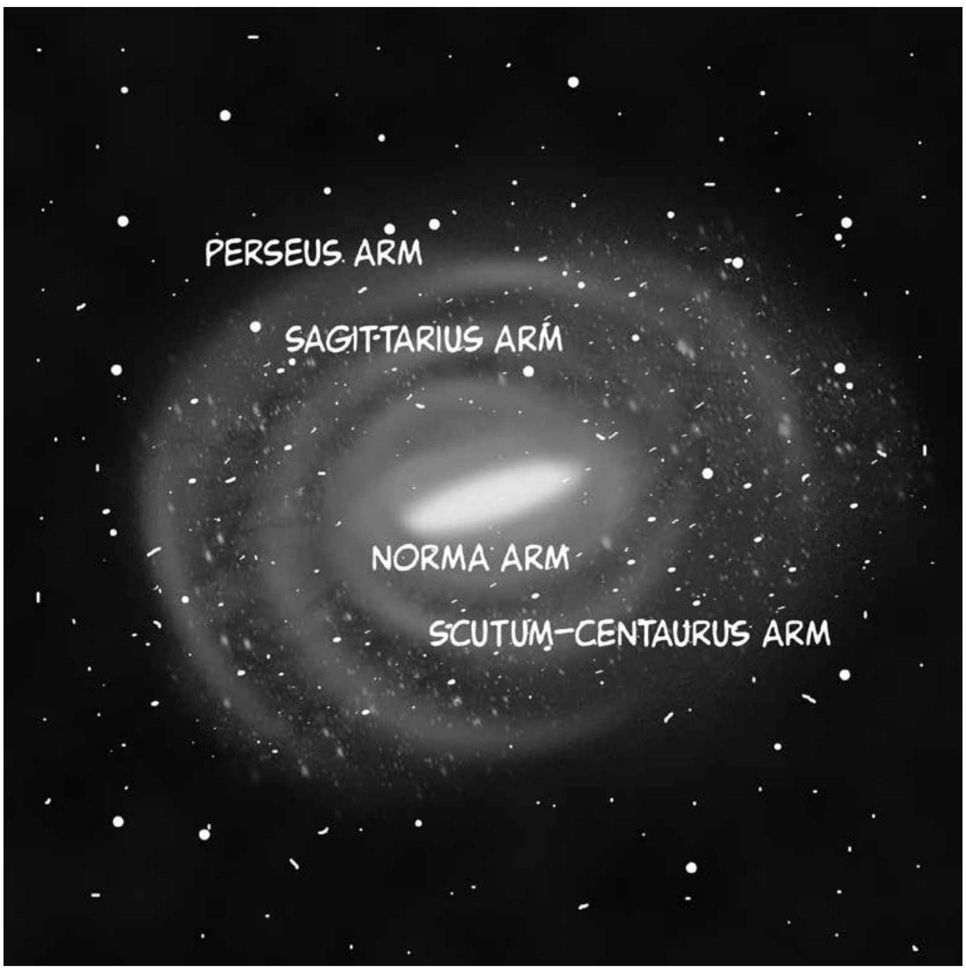
Plant B — Beginning

Plant A — Ending

Plant B — Ending

Experiment 19

See the Milky Way



Introduction

In this experiment you will look at the Milky Way.

I. Think About It

❶ Looking at the Milky Way is like looking at your city. If you are near the edge of your city and you can see tall buildings from where you are, look for the area that has the most tall buildings. This will probably be the center of your city.

If you can see the center of your city, draw it below. If you can't actually see the center, draw what you think it might look like. If you don't live in a city, think about one you have visited or seen in movies or pictures and draw what you think a city center looks like.

❷ When you look away from the center of the city you will probably see fewer buildings. If you can look away from the center of your city, draw what you see below. If you can't actually see away from the center or if you don't live in a city, draw what you think the part of the city that is farther away from the center might look like.

❸ Let the buildings in the center of your city represent stars in our galaxy. In the space below, draw what the stars in the center of our galaxy might look like.

❹ Letting the buildings that are farther away from the city center represent stars, draw what you think the stars that are farther away from the center of our galaxy might look like.

II. Observe It

1. Find an area that is free of city lights on a clear night when there is no moon.
2. Look into the night sky without a telescope or binoculars. Use only your eyes.
3. Study the sky and observe areas where there are lots of stars. Compare this to areas with fewer stars.
4. See if you can find a band of light and stars stretching across the night sky.
5. In the space below, draw what you observe.

III. What Did You Discover?

❶ How many stars did you see?

❷ Were there areas with lots of stars and other areas with fewer stars? How would you describe the areas of the sky?

❸ Were you able to see a band of stars stretching across the night sky? If so, how would you describe it?

❹ If you could see this band of stars, do you think you were seeing the center of the Milky Way Galaxy, the edge of the Milky Way Galaxy, or something else? Why?

IV. Why?

Earth has an atmosphere that allows us to look through the air to see the stars, Moon, planets, and other objects in our Milky Way Galaxy. Most of the stars and other objects we see in the night sky are part of our galaxy. Earth is located at a perfect spot within the Milky Way Galaxy to observe what surrounds us.

When you see a narrow band of light and stars stretching across the night sky, this band is referred to as the Milky Way. To see this, you are actually looking through the spiral arms of the Milky Way Galaxy toward the center of the galaxy. Because the Milky Way Galaxy is a flat, disk-shaped spiral and we are looking at it edge-on, the stars you observe as you look through the spiral arms appear as a band of light across the sky. If we lived closer to the center of the galaxy, we would see so many stars all around us that it would be difficult to know which way to look to see toward the center.

V. Just For Fun

If you have a computer and would like to see the Milky Way Galaxy, download Google Earth from the internet. Follow the setup instructions. Click on the planet symbol at the top, choose "Sky" from the drop down menu, and type "Milky Way" in the search box.

What did you discover? On the next page write or draw what you found out.

Milky Way Discoveries

Exploring The BUILDING BLOCKS of Science

Book 3

TEACHER'S MANUAL

REBECCA W. KELLER, PhD

Exploring the Building Blocks of Science Book 3 Teacher's Manual
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A Note From the Author

This curriculum is designed for elementary level students and provides an introduction to the scientific disciplines of chemistry, biology, physics, geology, and astronomy. *Exploring the Building Blocks of Science Book 3 Laboratory Notebook* accompanies the *Building Blocks of Science Book 3 Student Textbook*. Together, both provide students with basic science concepts needed for developing a solid framework for real science investigation. The *Laboratory Notebook* contains 44 experiments—two experiments for each chapter of the Student Textbook. These experiments allow students to further explore concepts presented in the *Student Textbook*. This teacher's manual will help you guide students through laboratory experiments designed to help students develop the skills needed for the first step in the scientific method — making good observations.

There are several sections in each chapter of the *Laboratory Notebook*. The section called *Think About It* provides questions to help students develop critical thinking skills and spark their imagination. The *Observe It* section helps students explore how to make good observations. In every chapter there is a *What Did You Discover?* section that gives the students an opportunity to summarize the observations they have made. A section called *Why?* provides a short explanation of what students may or may not have observed. And finally, in each chapter an additional experiment is presented in *Just For Fun*.

The experiments take up to 1 hour. The materials needed for each experiment are listed on the following pages and also at the beginning of each experiment.

Enjoy!

Rebecca W. Keller, PhD

Materials at a Glance

Experiment 1	Experiment 3	Experiment 4	Experiment 5	Experiment 6
pencil or pen **Optional** colored pencils **Experiment 2** clear plastic cups, 15 or more measuring cup measuring spoons spoon for mixing liquid soap marking pen food items (approx. 60 ml (¼ c.) each: water milk juice vegetable oil melted butter	glasses or plastic cups, several measuring cup 3 bags, small paper or plastic several small rocks (5-10) Legos (handful) sand (2 handfuls) sugar (handful) salt (2 handfuls) water food coloring, several colors 1-2 white coffee filters white paper, several sheets scissors several pencils tape	Elmer's white glue, approx. 30-60 ml (⅛-¼ cup) liquid laundry starch, approx. 30-60 ml (⅛-¼ cup)* 2 plastic cups measuring cup 30 metal paper clips *Just For Fun*: non-toxic glue such as blue glue, clear glue, wood glue, glitter glue, or paste glue; approx. 30-60 ml (⅛-¼ cup) *If you are unable to find liquid laundry starch, you can use a mixture of equal parts cornstarch and borax mixed with enough water to dissolve them. Make about 30-60 ml (⅛-¼ cup) for this experiment. **Optional** food coloring	flour, 2 liters (8 cups) 1 package active dry yeast, 7 grams (¼ oz.) lukewarm water, 240 ml (1 cup) cold water, 240 ml (1 c.) sugar, 30 ml (2 Tbsp.) vegetable oil, approx. 60 ml (4 Tbsp.) salt, 5 ml (1 tsp.) butter, 120 ml (½ cup) softened double-acting baking powder, 15 ml (1 Tbsp.) milk, 360 ml (1½ cups) measuring cups measuring spoons marking pen 4 mixing bowls mixing spoon floured bread board 2 bread pans or cookie sheets refrigerator oven timer **Optional** rolling pin biscuit cutter	notebook or drawing pad with blank pages (not ruled) to make a nature journal pencil colored pencils **Optional** camera and printer tape

Experiment 7	Experiment 8	Experiment 9	Experiment 10	Experiment 11
2 small houseplants of the same kind and size 2 more small houseplants of the same kind and size water measuring cup closet or cardboard box colored pencils	2-4 white carnations 1 or more other white flowers (rose, lily, etc.) 2-3 small jars food coloring water tape knife colored pencils	1-2 small clear glass jars 2 or more dried beans (white, pinto, soldier, etc.) 2 or more additional dried beans (different kind) or other seeds absorbent white paper scissors knife plastic wrap clear tape rubber band water **Optional** magnifying glass	3-5 large lemons knife 3-5 copper pennies older than 1982 3-5 galvanized (zinc coated) nails LED (Radio Shack #276-30700 [as of this writing]) 4-6 pairs alligator clips* plastic coated copper wire, .6-1.2 m (2-4 feet) wire clippers small Phillips screwdriver *duct tape can be substituted for alligator clips]	2-3 rubber balloons string or thread, at least 2 meters (6 feet) cut in half scissors different materials to rub the balloon on, such as: cotton clothing silk clothing wool clothing wooden surface plaster wall metal surface leather surface

Experiment 12	Experiment 13	Experiment 14	Experiment 15	Experiment 16
lemon battery supplies (see Experiment 10) suggested test materials: Styrofoam plastic block cotton ball nickel coin metal paper clip plastic paper clip glass of water table salt, 15 ml (1 Tbsp)	two bar magnets with the poles labeled "N" and "S"	3 Styrofoam cups: 355 ml (12 oz.) size about 240 ml (1 cup) each:* sand pebbles small rocks * student-collected or purchased from a place that sells aquarium supplies 3 containers for collecting sand, pebbles, and small rocks garden trowel or small shovel pencil 1-2 measuring cups water enough dirt, pebbles, rocks, water, etc. to make a mud city **Optional** stopwatch or clock with second hand	pencil colored pencils	2 bar magnets (narrow magnets work best) small, flat-bottomed, clear plastic box (big enough for 2 magnets to fit underneath with some space around them) corn syrup iron filings, about 5 ml (1 teaspoon) (see Experiment section for how students can collect iron filings — or iron filings may be purchased: www.hometrainingtools.com) **Optional** tape 2 plastic bags for collecting iron filings

Experiment 17	Experiment 18	Experiment 19	Experiment 20	Experiment 21
seeds (student selected) a garden bed or containers and potting soil tools for tending plants herb seeds or small herb plants (student selected) This experiment is done over the course of several weeks.	student-selected materials to make a model of a galaxy, such as colored modeling clay, Styrofoam balls, tennis balls, marbles, sand, candies, etc. cardboard or poster board, .3-1 meter (1'-3') on each side **Optional** colored pencils or markers camera and printer	colored pencils a dark, moonless night sky far away from city lights **Optional** computer with internet access pictures of cities	2 bar magnets iron filings, purchased* or student collected (see Chapter 16) shallow, flat-bottomed plastic container (or a plastic box top or large plastic jar lid) corn syrup plastic wrap Jell-O or other gelatin and items to make it assorted fruit cut in pieces and/or berries **Optional** cardboard box *As of this writing, available from Home Science Tools: http://www.hometrainingtools.com Item #CH-IRON	small plastic pail that will fit in freezer water dirt small stones dry ice (available at most grocery stores) heavy gloves or oven mitts freezer **If dry ice is in a block:** safety goggles mallet or hammer grocery bag (cloth or paper) **Experiment 22** library or internet access **Optional** old toys to take apart for computer chips (1 or more)

Materials

Quantities Needed for All Experiments

Equipment	Foods	Foods (continued)
alligator clips, 4-6 pairs (duct tape can be substituted for alligator clips) bowls, mixing, 4 bread board bread pans or cookie sheets, 2 freezer jars, 2-3 small clear knife LED (Radio Shack #276-30700 [as of this writing]) magnets, 2 bar with the poles labeled "N" and "S" magnets, bar, 2 narrow measuring cup, 1-2 measuring spoons oven pail, small plastic that will fit in freezer refrigerator scissors screwdriver, small Phillips spoon, mixing timer tools for tending plants trowel, garden, or small shovel wire clippers **Optional** biscuit cutter camera computer with internet access computer printer magnifying glass rolling pin stopwatch or clock with second hand	baking powder, double-acting ,15 ml (1 Tbsp.) beans, dried, 2 or more (white, pinto, soldier, etc.) beans, dried, 2 or more additional different or other seeds butter, 120 ml (½ cup) corn syrup flour, 2 liters (8 cups) food coloring, several colors food items (approx. 60 ml (¼ c.) each: water milk juice vegetable oil melted butter fruit, assorted, cut in pieces and/or berries Jell-O or other gelatin lemons, 6-10 large milk, 360 ml (1½ cups) salt, 25 ml (5 tsp.) + 2 handfuls sugar, 30 ml (2 Tbsp.) or more vegetable oil, approx. 60 ml (4 Tbsp.) water yeast, active dry, 1 package, 7 grams (¼ oz)	

Materials

Quantities Needed for All Experiments

Materials	Materials (continued)	Other
bags, 3 small paper or plastic bags, 2 plastic, for collecting iron filings balloons, 2-3 rubber box, small, flat-bottomed, clear plastic (big enough for 2 magnets to fit underneath with some space around them) cardboard or poster board, .3-1 meter (1'-3') on each side coffee filters, 1-2 white container, shallow, flat-bottomed plastic (or a plastic box top or large plastic jar lid) containers (3) for collecting sand, pebbles, and small rocks cotton ball cups, plastic, clear, 17 or more cups, plastic or glasses, several cups, Styrofoam (3) 355 ml (12 oz.) size dirt dry ice (available at most grocery stores) [If dry ice is in a block: safety goggles mallet or hammer grocery bag (cloth or paper] flowers, carnations, 2-4 white flowers, white, 1 or more that are not carnations (rose, lily, etc.) gloves (heavy) or oven mitts glue, Elmer's white, approx. 30-60 ml (⅛-¼ cup) glue, non-toxic, such as blue glue, clear glue, wood glue, glitter glue, or paste glue; approx. 30-60 ml (⅛-¼ cup) herb seeds or small herb plants (student selected) houseplants, small, 4 (2 each of the same kind and size) iron filings, about 10 ml (2 teaspoons) (student-collected or purchased: www.hometrainingtools.com, Item #CH-IRON as of this writing)	laundry starch, liquid. approx. 30-60 ml (⅛-¼ cup), or a mixture of equal parts cornstarch and borax mixed with enough water to dissolve them Legos (handful) nails, 3-5 galvanized (zinc coated) nickel (coin) notebook or drawing pad with blank pages (not ruled) to make a nature journal paper, absorbent, white paper, white, several sheets paper clips, 30 (metal) paper clip, plastic pebbles, about 240 ml (1 cup) or more* pen pen, marking pencils (several) pencils, colored pennies, 3-5 copper, older than 1982 plastic wrap rocks, small* rubber band sand, more than 1 cup* seeds (student selected) soap, liquid stones, small string or thread, at least 2 meters (6 feet) cut in half Styrofoam, small piece tape tape, clear water wire, plastic coated copper, .6-1.2 m (2-4 feet) **Optional** markers, colored pictures of cities box, cardboard old toys to disassemble to look for computer chips (1 or more) * student-collected or purchased from a place that sells aquarium supplies	closet or cardboard box dirt, pebbles, rocks, water, etc. (enough to make a mud city) garden bed or containers and potting soil library or internet access materials (student-selected) to make a model of a galaxy, such as colored modeling clay, Styrofoam balls, tennis balls, marbles, sand, candies, etc. materials to rub a balloon on, such as: cotton clothing silk clothing wool clothing wooden surface plaster wall metal surface leather surface night sky, dark moonless, far away from city lights

Contents

CHEMISTRY
BIOLOGY
PHYSICS
GEOLOGY
ASTRONOMY

Experiment 3

Make It Un-mix

Materials Needed

- several glasses or plastic cups
- measuring cup
- 3 bags (small paper or plastic)
- several small rocks (5-10)
- Legos (handful)
- sand (2 handfuls)
- sugar (handful)
- salt (2 handfuls)
- water
- food coloring, several colors
- 1-2 white coffee filters
- white paper, several sheets
- scissors
- several pencils
- tape

CHEMISTRY

Objectives

In this experiment students will explore techniques used for separating various mixtures.

The objectives of this lesson are to have students:

- Gain a basic understanding of mixtures and the separation of mixtures.
- Explore different ways of separating mixtures of large, dissimilar items.
- Find ways to separate mixtures that have small, similar components.
- Experiment with a technique called chromatography that can be used to separate molecules from mixtures.

Experiment

I. Think About It

Read this section of the *Laboratory Notebook* with your students and discuss the questions with them. Help them think of things they might do to separate several different kinds of mixtures. Their answers may vary. Encourage them to think of different "tools," such as a sieve or flour sifter for separating mixtures. Also guide them to think of using water to dissolve part of a mixture, such as salt in the salt/sand mixture. There are no right answers to these questions.

II. Observe It

Read this section of the *Laboratory Notebook* with your students.

Have the students test one or more of their own ideas for separating each mixture. Even if you know their idea won't work, let them test it. Answers will vary—possible answers follow.

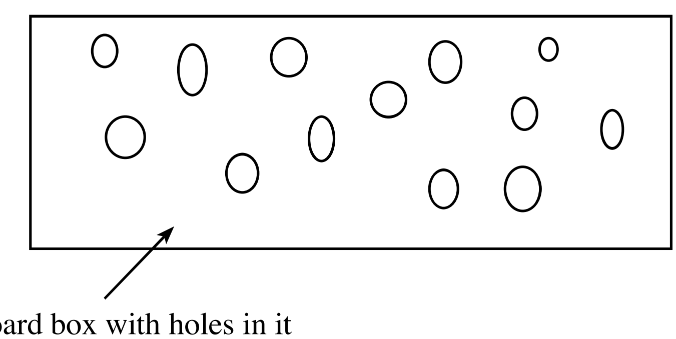
❶ Take a handful of rocks and a handful of Legos and mix them together on the table. Now try to un-mix them. Draw or describe what you did.

used hands and fingers to un-mix the rocks from the Legos

used a cardboard box with holes in it to un-mix the rocks from the Legos

(Answers may vary.)

Rocks and Legos



CHEMISTRY

❷ Take a handful of rocks and mix them with sand in a bag. Now un-mix the rocks and sand. Draw or describe what you did.

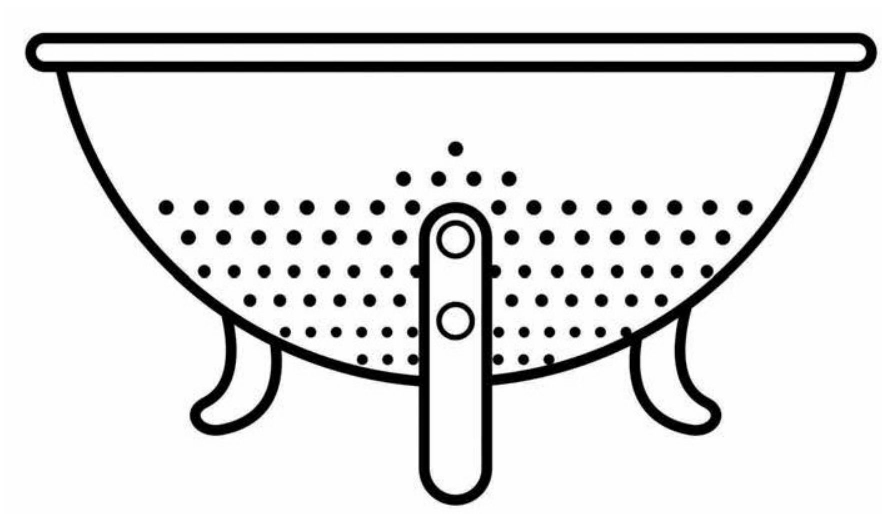
used a sieve to separate rocks and sand

used a hair dryer to blow away all of the sand

used cheesecloth to separate rocks and sand

(Answers may vary.)

Rocks and Sand



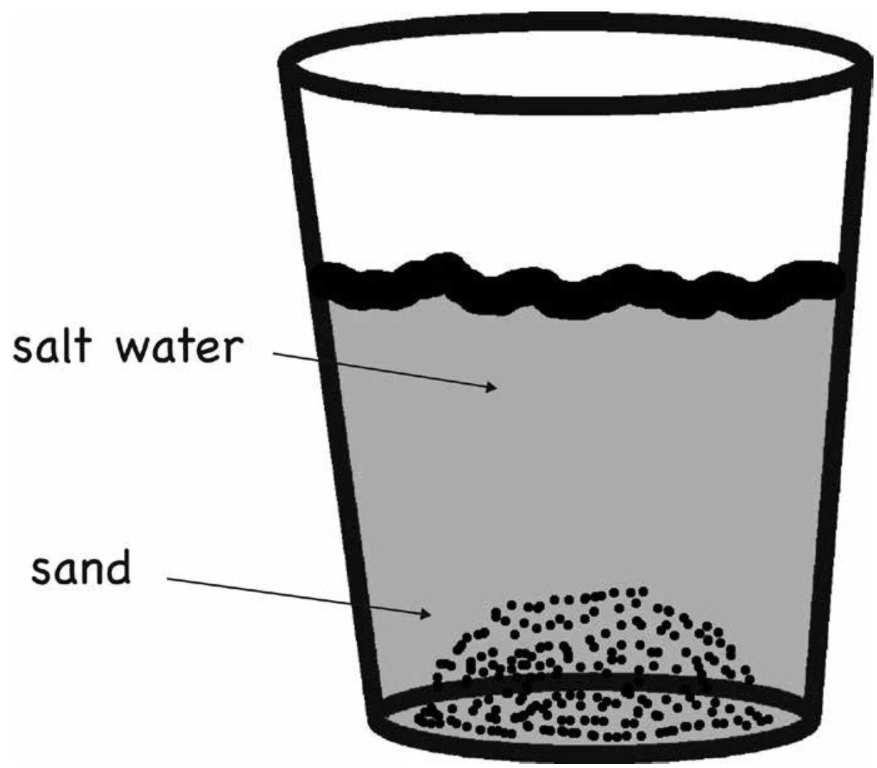
CHEMISTRY

❸ Take a handful of sand and a handful of salt and mix them in a bag. Now un-mix them. Draw or describe what you did.

used water to dissolve the salt

(Answers may vary.)

Sand and Salt



Paper Chromatography

The next steps in the experiment involve mixing different colors of food coloring and then separating the colors.

❹ Have the students place several drops of different colors of food coloring into 120 ml (1/2 cup) of water. The resulting color should be black or deep brown. Discuss possible ways to separate the colors.

❺ Next, discuss a method called *chromatography* that can be used to separate the colors from the water and from each other. Explain to the students that they can separate the colors by using a piece of coffee filter paper.

Help the students set up the chromatography sample. Have them cut the filter paper into long strips, tape one end of one strip to a pencil, and place the pencil across the glass containing the colored water, letting the paper strip dip into the water.

❻ They should observe the water immediately begin to migrate up the paper strip. They should detect the green food coloring migrating first, followed by the blue, then yellow, and finally red.

When they take the paper strip out of the water, have them lay it down on a piece of white paper. They should easily see the different colors. Have them record their results. When the paper strip is dry, it can be taped in the box in the *Laboratory Notebook*.

❼ Have them repeat the experiment with an "unknown." Without the students observing, add several drops of two or three colors into 120 ml (1/2 cup) of water in a glass. Give the glass to the students, and let them perform paper chromatography to determine which colors are in the water.

❽ Have the students prepare an "unknown" for the teacher, and let the teacher separate the colors. This is a lot of fun and can be repeated as many times as you wish.

❾ Have them record the results for Steps ❼ and ❽.

III. What Did You Discover?

Read this section of the *Laboratory Notebook* with your students.

Have the students answer the questions in this section of the *Laboratory Workbook*. Their answers will vary.

IV. Why?

Read this section of the *Laboratory Notebook* with your students.

Lead a discussion of the concepts covered in this section. Explain that there are many different ways to separate mixtures. Review the different ways the students discovered to separate the mixtures in their experiment.

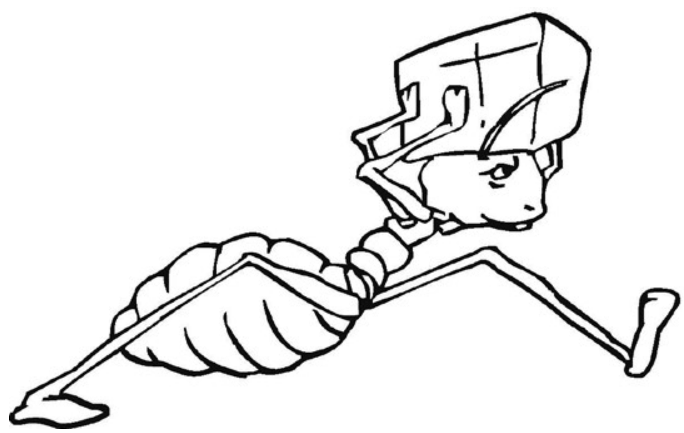
Also discuss why some mixtures are easier to separate than others. Mixtures that have small components and mixtures that are made of similar items are harder to separate than mixtures with larger components and dissimilar items. Explain that scientists use a variety of tools and techniques to separate mixtures. The "trick" called chromatography is a technique frequently used by scientists to separate a variety of molecules. Explain that chromatography can be used to separate different kinds of molecules, such as proteins or DNA, and not just molecules that make color.

V. Just For Fun

Take a handful of salt and a handful of sugar and mix them in a bag. Now un-mix them. Draw or describe what you did.

(Answers may vary.)

Salt and Sugar



[This one is just for fun. Encourage the students to use their imagination.]

Used ants at a picnic

Since ants like sugar better than salt, the ants will carry off the sugar and leave the salt.

Experiment 7

Who Needs Light?

Materials Needed

- 2 small houseplants of the same kind and size
- 2 more small houseplants of the same kind and size
- water
- measuring cup
- closet or cardboard box
- colored pencils

Objectives

In this unit students will observe what happens to a plant if it does not get sunlight.

The objectives of this lesson are:

- For students to make careful observations and to compare a plant grown with sunlight to one grown without sunlight.
- To introduce the concept of using a *control*.

A *control* is a tool scientists use to compare the specific effect that making a change has on an experiment. By comparing the plant that stays in the sunlight (the control) to a plant that does not get sunlight (the unknown), students can better observe the effect that the absence of sunlight will have on the plant. Without a control, it can be hard to know for certain what caused the observed changes.

Experiment

I. Think About It

Read this section of the *Laboratory Notebook* with your students.

❶ Have the students think about what things plants need to have in order to live. Some of the basic things plants need are sunlight, air, water, minerals, etc.

❷ Have the students answer the question that asks what they think will happen if a plant does not get any sunlight. This may seem obvious to the students, but help them think about the details. Use questions such as:

- *What do you think will happen to the leaves if there is no sunlight?*
- *What color do you think the leaves will turn?*
- *What do you think the leaves will feel like after a few days without sunlight? Firm or soft?*
- *How many days do you think it will take for the plant that is without sunlight to show some problems?*
- *What do you think will happen first?*
- *What do you think will happen last?*

II. Observe It

Read this section of the *Laboratory Notebook* with your students.

❶-❷ Have the students look carefully at the two plants.

❸ Help them find words to describe their plants in detail.

Have them notice anything different between the plants.

❹ Have them label one plant "**A**" and the other plant "**B**."

Have the students draw their plants. Drawing helps students make more detailed observations.

This step sets up the first part of the experiment. It is important for students to record, in as much detail as possible, the substances and conditions present when an experiment begins. This way, the changes that occur during the experiment can be more easily tracked.

❺-❻ Have the students place the plant labeled **A** in a sunny place and the plant labeled **B** in a dark place. A dark closet would work well, but a cardboard box could also be used as long as it does not let in any light.

❼ Have the students think about what they might observe and then record their ideas.

❽ Guide the students in coming up with a schedule for watering the plants on a regular basis and help them decide how much water to use each time. Have them measure the water each time they water the plants.

Have the students draw what has happened to the plants after one week. Help them observe any differences.

Depending on the type of plant you have selected, it may be several weeks before a significant difference is observed. Have the students observe the plants weekly and record any changes they observe.

III. What Did You Discover?

Read this section of the *Laboratory Notebook* with your students.

Based on their actual observations, have the students answer the questions about what happened to the two plants. Have them write about any significant differences they observed.

IV. Why?

Read this section of the *Laboratory Notebook* with your students.

Discuss what happens when a plant does not get enough sunlight to be able to make its own food. Also discuss how using a control helped in comparing normal plant growth in sunlight to abnormal plant growth with no sunlight. Help the students understand that by using a control, they can make direct comparisons between plants that are subject to two different conditions—sunlight or no sunlight. Explain to them that a control helped them to determine specifically what effect sunlight, or the lack of it, had on the plants, since the amount of exposure to sunlight was the only factor that was different between the two plants—everything else should have stayed the same.

V. Just For Fun

In this experiment students will take two houseplants of the same kind and size and water one but not the other. Both plants should be placed near each other so all the parameters of the experiment are the same except for how much water the plants get.

Have the students review the experiment they performed in the *Observe It* section. Help them think about what modifications they need to make to come up with the steps for this experiment. Ask questions such as the following:

- *What do you think will happen to the plants?*
- *Which steps of the experiment will stay the same? Which steps will you change?*
- *After what length of time do you think you will notice a change in the plants?*
- *How frequently will you make observations?*
- *Do you think both plants should be kept near each other? Why or why not?*

Space is provided for beginning and ending observations. Students can choose to use additional paper to record more observations.

Experiment 19

See the Milky Way

Materials Needed

- colored pencils
- a dark, moonless night sky far away from city lights

Optional

- computer with internet access
- pictures of cities

Objectives

In this unit, students will use the model of a city to help them think about and observe the Milky Way Galaxy.

The objectives of this lesson are for students to:

- Observe a city to see that it typically has more buildings at its center than it does at the edges.
- Compare how observations made about a city's structure and organization can be used to better understand that of a galaxy.

Experiment

I. Think About It

Read this section of the *Laboratory Notebook* with your students.

Have students think about the density of buildings in the center of a city compared to their density on the edges of a city. Most cities have a greater number of close together buildings in the center and fewer, more widely spaced buildings on the outskirts. Have students think about how their observations of a city's structure can be used to model the structure of a galaxy.

Encourage open inquiry with questions such as the following.

- *How many buildings are in the downtown section of a city?*
- *How many buildings are at the edges of a city?*
- *Are the buildings in the downtown area typically taller/bigger or shorter/smaller than the buildings at the edges?*
- *Are the buildings in the downtown area typically closer together or farther apart than the buildings at the edges?*
- *How might the center of a galaxy like ours be compared to the center of a city?*
- *How might the edges of a city or the suburbs be compared to the edges of a galaxy?*
- *Do all cities have the same shape? Do all galaxies have the same shape? Why or why not?*
- *Do you think cities stay the same size? Do you think galaxies stay the same size? Why or why not?*

II. Observe It

Read this section of the *Laboratory Notebook* with your students.

To observe the Milky Way, choose a clear, moonless night far away from city lights. Allow some time for students' eyes to adjust to the dark and have them look with their eyes only.

For students in the Northern Hemisphere, the best time to view the Milky Way is in the late summer and early winter when the Milky Way will look brighter. In the Southern Hemisphere winter is the best time for viewing.

Best times and dates
for viewing the Milky Way in the Northern Hemisphere

Summer Milky Way Times & Dates		*Winter Milky Way Times & Dates*	
8 PM	October 14	8 PM	February 10
9 PM	September 29	9 PM	January 25
10 PM	September 14	10 PM	January 10
11 PM	August 30	11 PM	December 26
12 AM	August 15	12 AM	December 12
1 AM	July 31	1 AM	November 26
2 AM	July 16	2 AM	November 11

Best times and dates
for viewing the Milky Way in the Southern Hemisphere

Summer Milky Way Times & Dates		*Winter Milky Way Dates & Times*	
8 PM	April 8	8 PM	August 28
9 PM	March 24	9 PM	August 12
10 PM	March 9	10 PM	July 28
11 PM	February 21	11 PM	July 12
12 AM	February 5	12 AM	June 27
1 AM	January 22	1 AM	June 13
2 AM	January 7	2 AM	May 29

III. What Did You Discover?

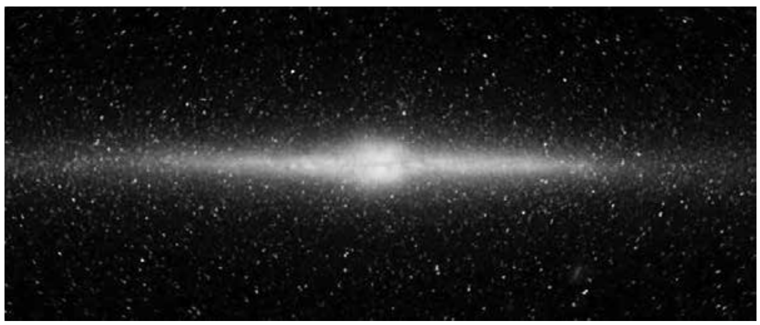
Read this section of the *Laboratory Notebook* with your students.

Help students think about their observations while answering these questions. There are no "right" answers to these questions, and it is important for the students to write or discuss what they actually observed.

IV. Why?

Read this section of the *Laboratory Notebook* with your students.

The Milky Way Galaxy contains a vast number of stars. The majority of stars in the galaxy reside in a flat disk, and there is a concentration of stars near the center. Our solar system is located within the flat disk of stars. Because Earth is located toward the outer edge of the galaxy, we can see a multitude of stars as we look through the galaxy toward the center. The band of light and stars we call the Milky Way appears as a band because we are looking edge-on through the disk of stars toward the galaxy center.



Artist's Rendition of Milky Way Galaxy as seen from outside and looking toward the center Credit: NASA/UMass/Caltech

V. Just For Fun

Help your students set up Google Earth:

❶ Go to http://earth.google.com and click "Download Google Earth."

❷ Click "Agree and Download."

❸ Once the file has been downloaded, follow the directions to install the program.

❹ Open the Google Earth program on your computer.

❺ Set up Google Earth in Sky mode by clicking on the planet symbol in the top menu bar and selecting "Sky" from the drop down menu. Or, at the top of the page, click "View," then "Explore," and then select"Sky."

❻ Type "Milky Way" into the search box. Once the Milky Way appears, you can zoom in and out using the +/- bar.

Students can also go to Google Images (www.google.com/imghp) and search on Milky Way Galaxy to find some beautiful photos and illustrations of the galaxy.

If your students are interested, you can have them use Google Earth to take a look at some of the planets.