SCIENCE

Grade 7

Learner's Material

(Unit 1 AND Unit 2)

For Students

Grade 7 Science: Matter

QUARTER 1

DIVERSITY OF MATERIALS IN THE ENVIRONMENT

Department of Education

University of the Philippines
National Institute for Science and Mathematics Education Development

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Quarter 1
Student Module
Grade 7 Science: Matter
Diversity of Materials in the Environment

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Suggested time allotment: 7 to 8 hours

MODULE 1 SOLUTIONS

Overview

In Grade 6, you have learned about different mixtures and their characteristics. You have done activities where you mixed a solid and a liquid or combined two different liquids. In the process of mixing, you have observed that these mixtures either form homogeneous or heterogeneous mixtures. You have seen that when all parts of the mixture have the same uniform appearance and properties, it is homogeneous.

You also learned that when different parts of the mixture can be identified, it is heterogeneous. An example of a heterogeneous mixture is ice cubes (solid phase) placed in a glass of soft drink (liquid phase). Different phases can be identified. When all the ice cubes are melted, only one liquid phase is seen. It is now homogeneous.

Homogeneous mixtures are called solutions. When you put sugar into water, the solid becomes part of the liquid and cannot be seen. You can say that the sugar dissolves in water or the sugar is soluble in water. Solutions may be solids dissolved in liquids or gases dissolved in liquids. There are also solutions where a gas is dissolved in another gas, a liquid in another liquid or a solid in another solid. Gaseous, liquid, and solid solutions are all around you. Many commercial products are sold as solutions.

In this module, you will identify common properties of solutions using different methods. You will also learn how to report the amount of the components in a given volume of solution. Towards the end of the module, you will investigate the factors that affect how fast a solid dissolves in water. At the end of Module 1, you will be able to answer the following key questions.

What common properties do solutions have?
Are solutions always liquid?
Will all solids dissolve in water?
How fast do solids dissolve in water?

Activity 1
What Solutions do You Find in Your Home?

Objectives

After performing this activity, you should be able to:

1. describe the observable characteristics or properties of common solutions found at home or in stores; and

2. present the data gathered in table form to show the different properties of common solutions.

You may make a table similar to the one below.

Products or Solutions Found at Home or in Stores	Characteristics

You noticed that you did not see solid particles or liquid droplets in the samples of solutions. Most of the solutions, which are in liquid phase, are colorless.

The solutions that you have observed consist of two components called the solvent and the solute. Generally, the component present in small amount is called the **solute**. The solute and the solvent dissolve in

each other. Usually the solvent is the component present in greater amount. So in a sugar solution, sugar is the solute and water is the solvent.

You observed in Activity 1 that a solution is not always a liquid; it can be solid, liquid, or gas. In addition, solutions may either be found in nature or are manufactured.

Naturally Occurring Solutions

Examples of solutions that occur naturally are natural bodies of water like the seas and ocean, blood plasma, air, and some mineral ores.

Many materials in nature can be used efficiently only when these are in the form of solutions. For example, plants cannot absorb minerals from the soil unless these minerals are in solution. Components of the food that you eat go into solution during digestion. The nutrient particles in solution can pass through the digestive tract and dissolve in the blood.

Seawater is a solution having a higher percentage of salt and minerals than other sources of water like ground water or rivers. Rainwater is a solution containing dissolved gases like oxygen and carbon dioxide. The water you drink contains dissolved minerals like sodium, potassium, magnesium and calcium and dissolved gases like oxygen and carbon dioxide.

Air is a mixture of gases. Dry air consists of about 78% nitrogen, 21% oxygen, 1% argon, about 1% water vapor, 0.04% carbon dioxide and traces of argon, helium, neon, krypton, and xenon. Water vapor is present in different amounts depending on the location. Air above big bodies of water contains more water vapor than air above deserts. Humidity is a measure of the amount of water vapor in air.

Useful solutions are found not only in nature; many solutions are made for a specific purpose.

Manufactured/Processed Solutions

Almost every household uses vinegar for cooking and cleaning purposes. Vinegar usually contains about 5% acetic acid in water. Some vinegar are clear homogeneous mixtures (solutions). Other kinds of vinegar are colloidal.

Gasoline is a solution made up of different substances called hydrocarbons. It is important that gasoline contains no solid particles that may clog the vehicle engine.

A metal alloy is a solid solution made up of two or more metals or non metals. For example, steel is an alloy of copper and tin. Brass is an alloy of copper and zinc.

Other examples of solutions that are processed include wine and liquor, brewed coffee and tea.

In the next activity, you will predict what will happen when you mix a sample solid or liquid in a given volume of water. Investigate to find out if your predictions are correct. Explain your predictions using the evidence you have gathered from your investigation.

Activity 2
What are the Properties of Solutions?

When you finish this activity you should be able to:

1. compare the evidence gathered with the predictions you made; and
2. describe the properties of solutions based on observations.

Materials Needed:

- 6 cups water
- 6 pieces, spoons
- either of the following: cheesecloth (*katsa*), old, white T-shirt or filter paper
- 2 tablespoons each of the following: sugar, salt, mongo seeds, powdered juice, cooking oil, vinegar
- 12 clear bottles or cups
- 2 pieces each, measuring spoons (½ tsp and 1tsp)
- 2 pieces each, measuring cups (½ cup and 1cup)
- 3 funnels or improvised funnel made from 500 mL plastic bottle
- 1 funnel rack

Procedure:

1. Predict which among the given samples will dissolve in water. Write your predictions in column 2 of Table 1.

2. Put one cup of water in each of the cups.

3. Add ½ teaspoon of each of the six samples. Use the teaspoon to dissolve as much of each sample as possible. Use a different teaspoon for each of the cups.

Q1. Describe the mixture that resulted after mixing. Write your answer in column 3.

Q2. How many phases do you observe? Write your answer and observations in column 4.

Q3. Identify the solute in each of the mixtures. Write your answers in the blank: _____

_____

Q4. What is the solvent in each of the mixtures? _____

Table 1. Data table for Activity 2

(1) Sample solid or liquid	(2) Will dissolve in one cup water (yes or no)	(3) Appearance	(4) Number of phases	(5) Can be separated by filtration (yes or no)	(6) Solution or not?
Sugar					
Salt					
Mongo seeds					
Powdered juice					
Cooking oil					
Vinegar					

4. Filter the mixture with filter paper using a setup similar to Figure 1. You may use *katsa* or old, white T-shirt with the improvised funnel from plastic bottle.

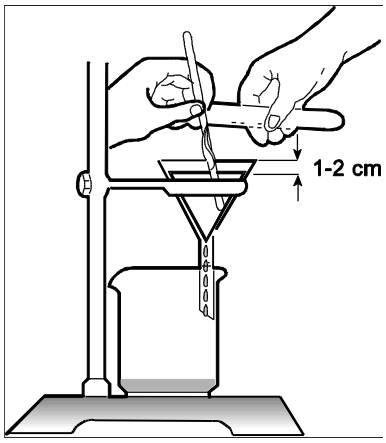

*Figure 1. A filtration setup. The funnel is supported on an iron ring and the filtrate is received in another container.**

*Philippines. Department of Education. (2004). Chemistry: Science and Technology textbook for 3rd year. (Revised ed.). Quezon City: Author.

Q4. In which mixture were you able to separate the components (solute and solvent) by filtration? Write your observations in column 5 of Table 1.

Q5. Which of the samples are solutions? Write your answer in column 6.

In Activity 2, you found out that a solution is formed when a solute dissolves in a solvent to form a single phase that appears uniform throughout. A solution is clear. In a solution, the particles are too small that they cannot be seen by the unaided eye. The particles in solution are smaller than the pores of the filter paper or the cheesecloth and so these can pass through the filter.

Each part of a solution retains its characteristic properties. When a sugar solution is filtered, the filtrate tastes sweet. The sweetness of sugar is present in any part of the sugar solution.

Based on the results of Activity 2, there are common properties that solutions have.

Based on the two activities you have done, can you conclude that solutions have the following characteristics?

1. **It is homogeneous. It is a mixture of one phase only. The components are so well mixed that all parts of the solution appear the same. Solutions have the same composition and properties throughout.**

2. **The solute cannot be separated from the solvent through filtration because these are so small that they pass through the filter paper or cheesecloth.**

3. **A solution is often clear and transparent.**

There are other ways of identifying a solution. You will learn these methods in Grades 8 and 9.

In Activity 3, you will find out how much solute can dissolve in a given amount of solvent and find out the type of solution based on whether there is excess solute or not.

At higher grade levels, you will learn more of the detailed processes that happen when a solute dissolves in a solvent.

Activity 3
What is the Evidence that a Solution is Saturated?

After performing this activity you will be able to:

1. determine how much solid solute completely dissolves in a given volume water; and
2. describe the appearance of a saturated solution.

Materials Needed

- 6 teaspoons sugar
- 1 cup of water
- 1 measuring cup (1cup capacity)
- 1 measuring spoon (½ tsp capacity)
- 2 small clear, transparent bottle
- 2 stirrers
- 1 thermometer

Procedure:

1. Put 20 mL (approximately 2 tablespoons) of water in a small clear transparent bottle. Add ½ teaspoon of sugar and stir.
   Q1. What is the appearance of the solutions? Write your observations. _____

2. To the sugar solution in step #1, add ½ teaspoon sugar, a small portion at a time and stir the solution to dissolve the sugar. At this point, you have added 1 teaspoon sugar.

3. Add ½ teaspoon of sugar to the sugar solution in step #2 and stir the solution. At this point, you have added one and ½ teaspoons of sugar.

4. Continue adding ½ teaspoon sugar to the same cup until the added sugar no longer dissolves.

   Q2. How many teaspoons of sugar have you added until the sugar no longer dissolves? _____ teaspoons

   Note: In this step, you will observe that there is already excess sugar which did not dissolve.

   Q3. So, how many teaspoons of sugar dissolved completely in 20 mL of water? _____ teaspoons

   Note: This is now the maximum amount of sugar that will completely dissolve in 20 mL of water.

In Activity 3, you have observed that there is a maximum amount of solute that can dissolve in a given amount of solvent at a certain temperature. This is what is called the **solubility** of the solute. From your everyday experience, you also observe that there is a limit to the amount of sugar you can dissolve in a given amount of water.

The solution that contains the maximum amount of solute dissolved by a given amount of solvent is called a **saturated** solution. If you add more solute to the solvent, it will no longer dissolve. The solution has reached its saturation point. The presence of an excess solid which can no longer dissolve is evidence that the solution is saturated.

A solution is **unsaturated** when it contains less solute than the maximum amount it can dissolve at a given temperature. In Activity 3 Part A, it is difficult to conclude that the containers with all solids dissolved are unsaturated simply by observing them. Some of these may already hold the maximum amount of solute, which cannot be observed by the unaided eye. If they do, then these are classified as saturated solutions.

A more measurable way to find out the solubility of a solute is to determine the maximum amount that can be dissolved in 100 g of solvent at a specific temperature. There are available data from chemistry books that give the solubility of common solutes at particular temperatures. Figure 2 shows the solubility of table salt at 25°C.

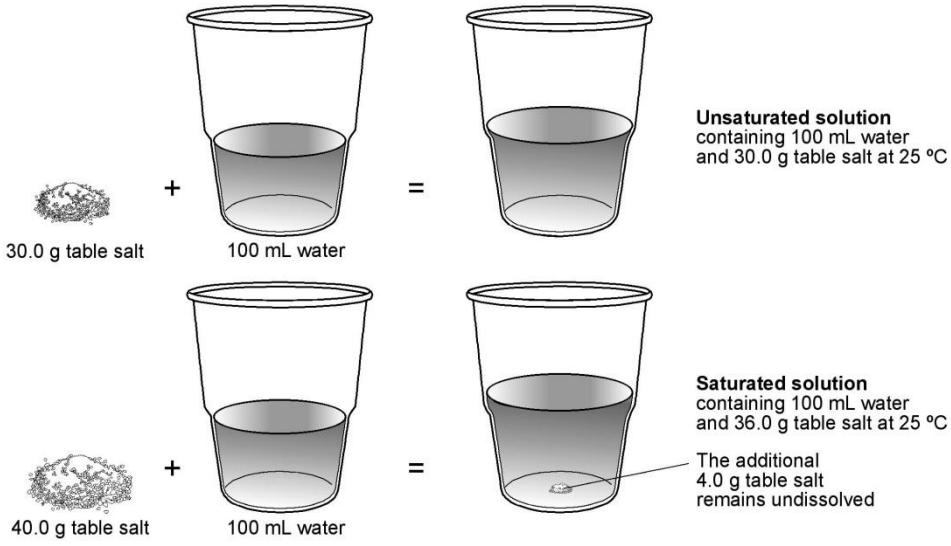

Figure 2. At 25°C, a saturated solution of table salt has only 36.0 g (3 tablespoons) dissolved in 100 mL of water. Any additional table salt will no longer dissolve.

Concentration of Solutions

The concentration describes the relative amounts of solute and solvent in a given volume of solution. When there is a large amount of dissolved solute for a certain volume of solvent, the solution is **concentrated**. A **dilute** solution has a small amount of dissolved solute in comparison to the amount of solvent.

You will be able to distinguish between concentrated and dilute solutions from a simple demonstration your teacher will perform. You will describe the concentrations of solutions qualitatively (by simply observing their appearance) and quantitatively (by comparing the number of drops per volume of water).

From Part 1 of the demonstration, you were able to describe the solutions as having quantitative concentrations of 1 drop/50 mL and 10 drops/50 mL. Qualitatively, you were able to distinguish the bottle with 10 drops/50 mL more concentrated (darker) than the bottle with 1 drop/50 mL.

Now that you have distinguished dilute from concentrated solutions qualitatively and quantitatively from your teacher's demonstration, you can express concentration in other ways such as:

(1) **percent by volume**, which is the amount of solute in a given volume of solution expressed as grams solute per 100 millliter of ***solution*** (g/100 mL), and

(2) **percent by mass,** which is the amount of solute in a given mass of solvent expressed as grams solute per 100 grams of ***solution***.

Labels of products sold often show the concentrations of solutes expressed as percent (%) by volume or mass. The alcohol used as a disinfectant is a solution of 70% ethyl or isopropyl alcohol, meaning 70 mL alcohol. There are also solutions sold as 40% ethyl or isopropyl alcohol.

Vinegar is often labeled as "5% acidity," which means that it contains 5 grams of acetic acid in 100 g of vinegar. The common antiseptic, *agua oxinada* is a 3% solution, that is, 3 grams hydrogen peroxide in 100 mL water.

The concentration of solid solutions, like gold jewelry, is expressed as *karat*. Pure gold is referred to as 24 karats. Jewelry that is said to be 18 karats contains 18 grams of gold for every 24 grams of the material, 6 grams

consist of the other metal like copper or silver. This material has a concentration of 75% gold, that is, [18/24(100)]. A 14 karat (14K) gold contains 14 grams gold and 10 grams of another metal, making it 58.3% gold.

The following sample problems show you that there is a way to know the exact ratio of solute to solvent, which specifies the concentration of a solution.

Sample problem 1

How many mL of ethyl alcohol are present in a 50 mL bottle of rubbing alcohol?

Calculation for sample problem 1

Since rubbing alcohol contains 70% ethyl alcohol, it means that 100 mL of rubbing alcohol contains 70 mL ethyl alcohol. So, the following calculations show that in 50 mL of rubbing alcohol, there is 35 mL ethyl alcohol.

$$50 \text{ mL rubbing alcohol} \times \frac{70 \text{ mL ethyl alcohol}}{100 \text{ mL rubbing alcohol}} = 35 \text{ mL ethyl alcohol}$$

All portions of a solution have the same concentration. The composition of one part is also the same as the composition of the other parts. But you can change the concentration of solutions. This means you can prepare different solutions of sugar in water of different concentrations (for example, 10%, 20%, or 30%). In the same way, you can prepare different solutions of salt in water.

Sample problem 2

A one peso coin has a mass of 5.5 grams. How many grams of copper are in a one peso coin containing 75% copper by mass?

Calculation for sample problem 2

75% by mass means 75 grams of copper in 100 grams of one peso coin.

So, a 5.4 grams one peso coin contains,

$$\frac{75 \text{ g copper}}{100 \text{ g coin}} \text{ x } 5.4 \text{ g coin} = 4.0 \text{ g copper}$$

Factors Affecting How Fast a Solid Solute Dissolves

In activities 4 to 6, you will investigate factors that affect how fast a solid solute dissolves in a given volume of water.

The Effect of Stirring

Your teacher demonstrated the effect of stirring in mixing a solid in water. You observed that stirring makes the solid dissolve faster in the solvent. Were you able to explain why this is so?

The Effect of Particle Size

In Activity 4, you will investigate how the size of the solid being dissolved affects how fast it dissolves in water.

Activity 4
Size Matters!

1. Write a hypothesis in a testable form. Describe a test you could conduct to find out which dissolve faster: granules (uncrushed) of table salt or the same amount of crushed salt.

2. Identify variables (for example, amount of table salt) that you need to control in order to have a fair test.

3. Identify the dependent and independent variables.

4. List all the materials you need, including the amount and ask these from your teacher.

5. Be sure to record your observations and tabulate them. Write everything you observed during the dissolving test.

6. What is your conclusion? Does the size of the salt being affect how fast it dissolves in water?

7. Does your conclusion support or reject your hypothesis?

8. Based on what you know about dissolving, try to explain your results.

To help you explain the process of dissolving, imagine that in a solution, the particles of the solute (table salt) and the solvent (water) are constantly moving. Water particles collide everywhere along the surface of the particles of table salt, especially on the corners and edges. This occurs at the surface of the solid solute when it comes in contact with the solvent. The particles on the corners and edges then break away from the crystal and become surrounded by the water particles. So the solute particles are separated by the solvent particles.

Can you now explain why smaller pieces of salt dissolve faster than larger ones? You may use an illustration or diagram in your explanation.

The Effect of Temperature

Temperature affects how fast a solid solute dissolves in water. Your solutions in Activity 3 were at room temperature. In Activity 5 you will investigate how fast coffee dissolves in cold and in hot water. At what temperature will sugar dissolve faster?

Activity 5
How Fast Does Coffee Dissolve in Hot Water? In Cold Water?

1. Discuss how your group mates how you will do your investigation. Write your hypothesis in a testable form. Describe a test you could conduct to find out how fast coffee dissolves in cold and in hot water.

2. Identify variables (for example, amount of amount of coffee) that you need to control in order to have a fair test.

3. Identify the dependent and independent variables.

4. List all the materials you need, including the amount and ask these from your teacher.

5. Do your investigation using the proper measuring devices. Be sure to record your observations and tabulate them. Write everything you observed during the dissolving test. These observations are the evidence from which you can draw your conclusions.

6. Identify variables (for example, amount of coffee) that you need to control in order to have a fair test.

7. Identify the dependent and independent variables.

8. List all the materials you need, including the amount and ask these from your teacher.

9. Do your investigation using the proper measuring devices. Be sure to record your observations and tabulate them. Write everything you observed during the dissolving test. These observations are the evidence from which you can draw your conclusions.

10. What is your conclusion? Does coffee dissolve faster in cold or in hot water? Use the observations and results you recorded to explain your answer.

11. Does your conclusion support or reject your hypothesis? Explain your results.

The Nature of Solute

In Activity 6, you will find out if: (1) sugar dissolves faster in hot than in cold water, and (2) salt dissolves faster in hot than in cold water.

Activity 6
Which Dissolves Faster in Hot and in Cold Water: Sugar or Salt?

1. Discuss with your group mates how you will do your investigation.

2. Write your hypothesis in a testable form. Describe a test you could conduct to find out answers to the given two questions above.

3. Identify variables (for example, amount of coffee) that you need to control in order to have a fair test.

4. Identify the dependent and independent variables.

5. List all the materials you need, including the amount and ask these from your teacher.

6. Do your investigation using the proper measuring devices. Be sure to record your observations and tabulate them. Write everything you observed during the dissolving test. These observations are the evidence from which you can draw your conclusions.

7. What is your conclusion? Does coffee dissolve faster in cold or in hot water? Use the observations and results you recorded to explain your answer.

8. Does your conclusion support or reject your hypothesis? Explain your results.

   The following questions can guide you:

   a. Does **sugar** dissolve faster in hot water than in cold water? Explain your answer, based on your observations from the investigation.

   b. Does **salt** dissolve faster in hot than in cold water? Explain your answer, based on your observations from the investigation.

   c. Which is affected more by increasing the temperature of the water—how fast salt dissolves or how fast sugar dissolves? Explain your answer.

You learned from Activity 5 that in general, a solute dissolves faster in water when you increase the temperature. But the effect of temperature is not that simple. The type or nature of the solute will affect how fast it dissolves in water.

You observed from Activity 6 that increasing the temperature either makes a solid dissolve faster or slower in water. For some solutes, increasing the temperature does not have any effect on how fast the solute dissolves.

Now that you have completed the activities in this module, you have learned the properties of a solution, the ways of reporting its concentration, as well as the effects of stirring, particle size, temperature, and type of solute on how fast a solid dissolves in water.

While learning about solutions, you also had the chance to gather information and gain new knowledge through the process of conducting science investigations. You also learned the importance of identifying the variables that had to be controlled in order to make a good plan for measuring and testing the variables you are concerned about.

What you have started doing in these investigations is what scientists usually do when they seek answers to a scientific question or problem. In the next modules, you will be challenged to ask more questions about materials around you. You will try to explain answers to your hypothesis (your suggested explanation) after you have done your investigation.

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Suggested time allotment: 5 to 6 hours

MODULE 2 SUBSTANCES AND MIXTURES

Many things around you are *mixtures*. Some are solid like brass and rocks, or liquid like seawater and fruit juices, or gas like air. Mixtures contain two or more components. These components may vary in size. The variation in size may tell whether a mixture is homogeneous or heterogeneous.

In Module 1, you learned about solutions — homogeneous mixtures. They have a uniform composition. This makes the appearance of the mixture the same all throughout. Thus, the components of a solution are difficult to distinguish by the unaided eye.

In this module, you will learn other examples of homogeneous mixtures. You will use these samples to differentiate them from *substances*.

How are mixtures different from substances?
How are they similar?

Separating Components of a Mixture

In the earlier grades, you experienced separating the components of a mixture. You have done this in varied ways. Try to recall some. What are the separation techniques do you remember? Were you also able to recall distillation and evaporation?

Different separation techniques make components of a homogeneous mixture more distinguishable, that is, those "unseen" components when they are in a solution become "seen". Just like in the activity below, distillation and evaporation will help you "see" the two major components of seawater — water and salt.

Activity 1
Seawater! See Water and Salts!

Objective

In this activity, you should be able to collect distilled water and salts from seawater.

Materials Needed

- seawater
- Erlenmeyer flask (sample flask)
- test tube (receiver)
- glass tube bent at right angle, with rubber/cork attachment (delivery tube)
- water bath
- small boiling chips
- spoon
- alcohol lamp
- tripod
- safety matches
- wire gauze (asbestos scraped off)
- evaporating dish (or aluminum foil)
- hand lens

Procedure

1. Prepare a distillation setup as shown in Figure 1. Place about 60 mL of seawater in the sample flask. Add 2-3 small boiling chips.

TAKE CARE! Handle properly the glassware and flammable materials.

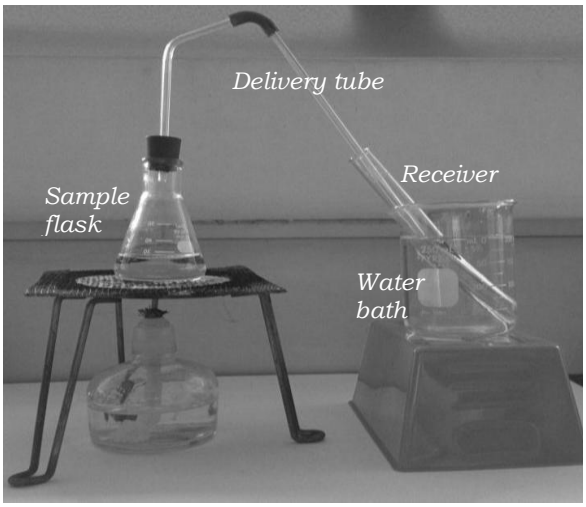


Figure 1. Simple distillation setup

2. Apply heat to the sample flask until you have collected about 15 mL of the distilled water (distillate).

Note: Make sure the source of heat is not removed while the distillation is in progress.

3. Taste a portion of the distillate. Compare the taste of the distillate with that of seawater.

Q1. What is the taste of the distillate? Is the taste the same as seawater?

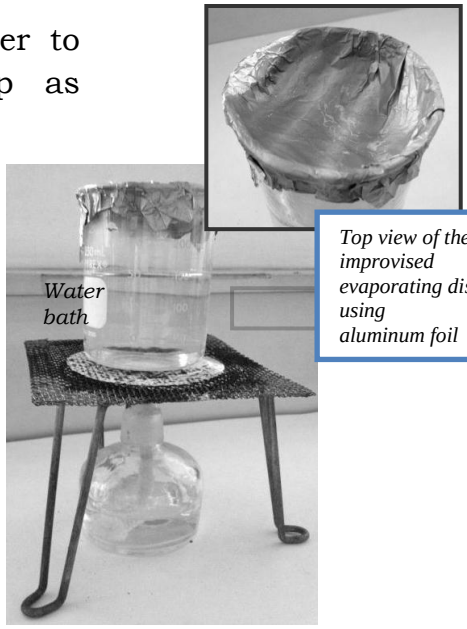
TAKE CARE!

Never taste any sample unless permitted by the teacher or stated in the activity procedure.

4. Set the rest of the distillate aside. You will use it in Activity 2. Label it properly.

5. While allowing the remaining seawater to cool, prepare an evaporation setup as shown in Figure 2.

6. Transfer the cooled liquid to the evaporating dish. Aluminum foil may be used as an alternative for evaporating dish. Note that the aluminum foil was shaped like a bowl so it can hold the sample.



Top view of the improvised evaporating dish using aluminum foil

Figure 2.
Evaporation using a water bath

7. Apply heat to the seawater until all the liquid has evaporated. Let it cool. Using a hand lens, examine what is left in the evaporating dish.

Q2. What do you see? Did you notice the solid that was left after all the liquid has evaporated?

TAKE CARE!

The evaporating dish may still be too hot to hold.

8. The solid that is left behind in the evaporating dish is called the **residue**. Taste a small portion of the residue.

Q3. What is the taste of the residue?

Distinguishing Substances and Mixtures

Seawater is a solution of many different solids, including table salt, in water. Since the solids are dissolved in water, decantation or filtration will not work in separating water from the dissolved solids. Other separation techniques are needed.

In the activity above, you were able to separate the components of seawater through distillation and evaporation. One of these is distilled water. It is considered as a *substance*. But what makes distilled water a substance?

In the next activity, you will observe how a substance behaves while it is being boiled or melted. You will also find out that these behaviors will help you differentiate substances from mixtures. Moreover, some mixtures like substances are homogeneous. Given two unlabelled samples, one with water (a substance), and the other a mixture of salt in water; you would not be able to distinguish one from the other just by looking at them.

Activity 2
Looks may be Deceiving

Part A
Objectives

In this activity, you should be able to:

1. assemble properly the setup for boiling (see Figure 3);
2. describe the change in temperature of a substance during boiling;
3. describe the change in temperature of a mixture during boiling; and
4. differentiate between substances and mixtures based on how temperature changes during boiling.

Materials Needed

- distilled water
- seawater
- beaker (50-mL), 2 pcs
- aluminium foil, 2 pcs
- thermometer (with readings up to 110^{o}C)
- cork/rubber to fit thermometer
- iron stand/clamp
- alcohol lamp
- safety matches
- watch/timer
- graphing paper

Procedure

1. Place about 15 mL of distilled water into a beaker. Label it properly. Describe the appearance and odor of your sample. In your worksheet, write your descriptions in Table 1.

TAKE CARE! Handle properly the glassware and flammable materials.

2. Cover the mouth of the beaker with aluminum foil. Using the tip of your pen, poke a hole at the center of the foil. The hole should be big enough for the thermometer to pass through.

3. Prepare the setup as shown in Figure 3.

   Notes: Make sure that the thermometer bulb is just above the surface of the sample (about 1 mm). Also, make sure that the heat is evenly distributed at the bottom of the beaker.

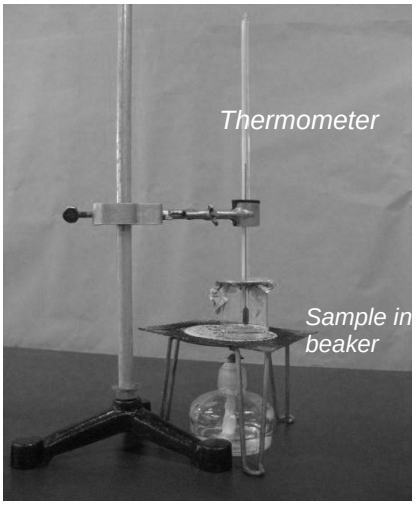


Figure 3.
Setup for boiling

4. Begin recording the temperature when the sample starts to boil vigorously. Record your temperature reading in Table 1 under the column, *Distilled water*.

5. Continue boiling and take at least 5 readings at intervals of 30 seconds after the liquid has started to boil vigorously. Note even the slight changes in temperature. Record your temperature readings in Table 1 under the column, *Distilled water*.

6. Stop heating when the liquid sample reaches half of its original volume.

7. Present your data for distilled water in a graph. Place the temperature reading along the y-axis and the time along the x-axis. Label the graphs appropriately.

Q1. Refer to the graph and your data for *distilled water*, what do you notice about its temperature during boiling?

Q2. How would you define a substance based on what you have observed?

8. Repeat steps 1 to 7 using seawater. This time, record your temperature readings in Table 1 under the column, *Seawater*. Note even the slight changes in temperature.

TAKE CARE!

Make sure that the beaker is cool enough to hold. Use another beaker for seawater. Rinse the thermometer and wipe dry before using it to test other samples.

Q3. Refer to the graph and your data for *seawater*, what do you notice about its temperature during boiling?

Q4. How would you define a mixture based on what you have observed?

Table 1. Temperature readings of the liquid samples during boiling at 30-sec interval

		Distilled Water	*Seawater*
Appearance/Odor			
Temperature (°C) at start of boiling			
Temperature (°C) after	30 sec		
	60 sec		
	90 sec		
	120 sec		
	150 sec		

Part B
Objectives

In this activity, you should be able to:

1. assemble properly the setup for melting (see Figure 6);
2. describe the appearance of a substance while it is melting;
3. describe the appearance of a mixture while it is melting; and
4. differentiate between substances and mixtures based on how they appear as they melt.

Materials Needed

- benzoic acid
- benzoic acid-salt mixture
- ballpen cap
- alcohol lamp
- tripod
- wire gauze
- safety matches
- watch/timer
- cover of an ice cream can (about 7-8 cm diameter)
- paper
- scissors/cutter
- marker pen

Procedure

1. Construction of an improvised melting dish from a cover of an ice cream can. This may be prepared ahead.

   a) Trace the outline of the cover of an ice cream can on a piece of paper. Cut the paper following the outline. Adjust the cut-out so it fits well in the inner part of the ice cream can cover. See Figure 4a.

   b) Fold the cut-out into 4 equal parts. Place the folded cut-out on top of the cover (inner part) of the ice cream can. See Figure 4b.

   c) Following the crease of the paper, trace lines using a marker pen into the cover. Remove the cut-out. See Figure 4c.

   d) In each radius, locate points which are equidistant from the center. Using the tip of a cutter, etch and mark these points as X_1, X_2, X_3, and X_4. See Figure 5.

4a *4b* *4c*

Figure 4. Guide in constructing an improvised melting dish

Your improvised melting dish should look similar as Figure 5. Samples will be placed at the X marks. This melting dish may hold as much as 4 samples at one time.

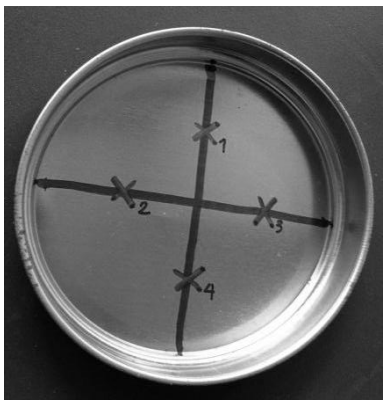


Figure 5.
Improvised melting dish

2. Prepare the setup as shown in Figure 6.

TAKE CARE! Handle properly flammable materials.

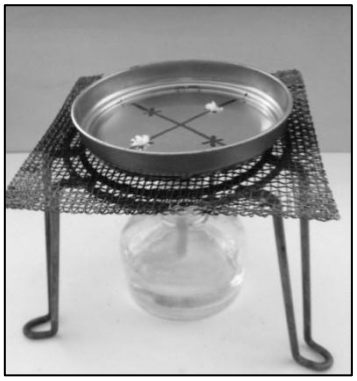


Figure 6. Setup for melting

3. Using the tip of a ballpen cap, place about a scoop of benzoic acid in X_1 and benzoic acid-salt mixture in X_4 marks of the improvised melting dish. Do not put anything in the X_2 and X_3 marks.

Note: The figure below illustrates how much one scoop of sample is.

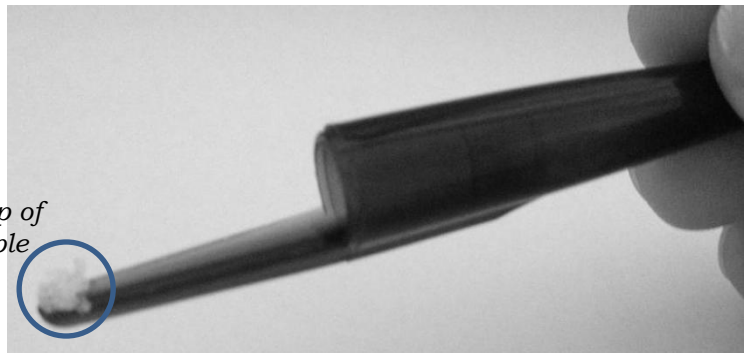


Figure 7. Ballpen cap as improvised spatula with a scoop of sample

4. Examine each sample. Describe the appearance. In your worksheet, write your descriptions for the two samples in Table 2.

5. Make sure that each sample receives the same amount of heat. Observe each sample as they melt.

TAKE CARE! Do not inhale the fumes/ vapor.

Table 2. Appearance of the solid samples

	Benzoic acid (X_1)	*Benzoic acid-Salt mixture* (X_4)
Appearance		

Q1. What did you observe while benzoic acid is melting?

Q2. How would you define a substance based on what you have observed?

Q3. What did you observe while benzoic acid-salt mixture is melting?

Q4. How would you define a mixture based on what you have observed?

The salt that you recovered in Activity 1 is mainly sodium chloride. It melts at 801°C. Imagine how hot that is! It is 8 times hotter than boiling water. Because of this and limited equipment, it will be difficult to perform this in a school laboratory. However, given that sodium chloride is a substance, what could be the expected observation as it melts?

In the next activity, you will apply what you have learned from this module in classifying unknown samples. This time, you have to decide which setup fits best with the sample you are given. You have to work out a procedure to identify if the sample is a substance or a mixture. Try to design the procedure first by recalling what you have done in the previous activities. Let these activities serve as guides which you can check side by side with your design. Take note of safety measures and wait for your teacher to give you the "go signal" before proceeding.

Activity 3
My Unknown Sample: Substance or Mixture?

Objective

In this activity, you should be able to design a procedure that will identify unknown samples as mixtures or substances.

Materials Needed

- unknown sample

Procedure

1. Design a procedure to identify if the unknown sample is a mixture or a substance. Limit the materials that you are going to use with what is already available.
2. Perform the activity that you designed after your teacher has checked your procedure.

Q1. What is your basis in identifying the unknown sample you have?

There are mixtures that are homogeneous which may be mistaken as substances. Being so, appearance may not be the best basis to differentiate substances from mixtures. However, there are ways to tell by noting how a sample behaves during boiling and melting. In the higher grade levels, you will learn why this is so.

During boiling, the temperature of a substance changes at the start then it becomes the same; while the temperature of a mixture is different at different times.

During melting, a substance melts completely/smoothly within a short time; while a mixture has portions that seem to be not melting.

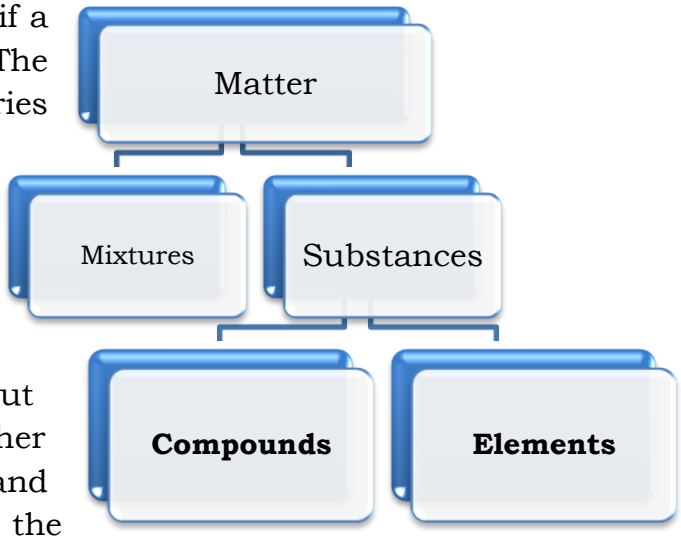
In the next module, you will learn more about **substances**. Collect as many product labels as you can, you will refer to them as you identify and classify the substances present in the product.

Suggested time allotment: 5 to 6 hours

MODULE 3 ELEMENTS AND COMPOUNDS

All substances are homogeneous. Some mixtures are also homogeneous. Being so, it is difficult to distinguish mixtures and substances based on appearance.

However, there are ways to tell if a sample is a mixture or a substance. The temperature of a liquid mixture varies during boiling but for a liquid substance, it does not. A solid mixture has portions that do not melt but a solid substance melts completely within a short time.



In this module, you will find out that substances may be further classified into two: **compounds** and **elements**. You will start with the primary characteristic that distinguishes them.

How are elements different from compounds? How are they similar?

Compounds

Like mixtures, compounds are also made up of two or more components. In Module 2, you separated the components of seawater through distillation. One of the products obtained was distilled water. Also, you have identified distilled water as a substance.

In the activity that you are about to do, you will again "see" for yourself components, but this time, what water is made of. With the passage of electric current, components of water may be separated from each other.

This process is called **electrolysis**. You will use an improvised electrolysis apparatus like the one shown in the figure below. Commonly available materials were used to construct this improvised apparatus.

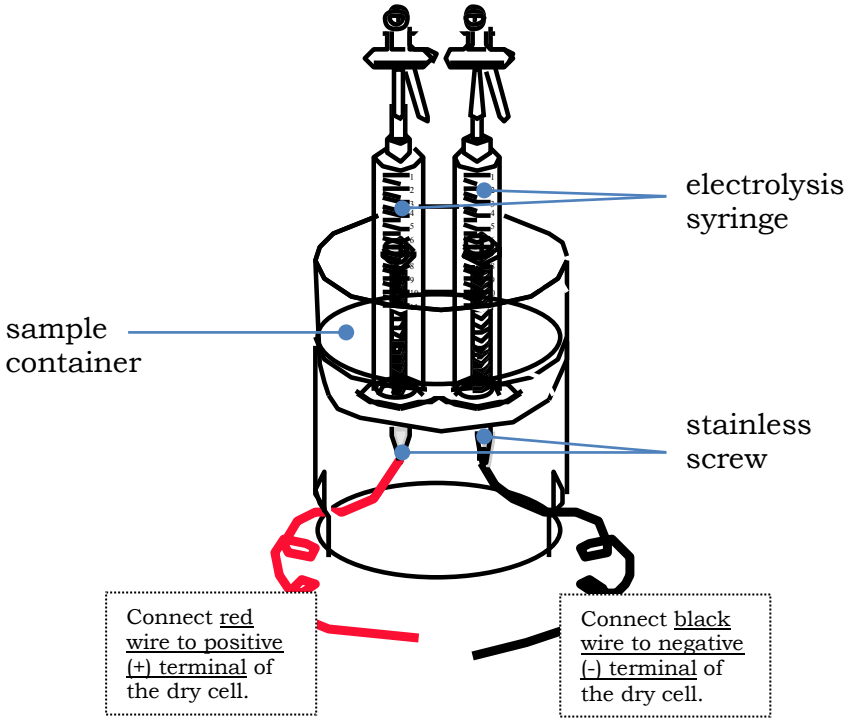


Figure 1. An improvised electrolysis apparatus

Activity 1
Water, "Wat-er" You Made Of?

Objectives

In this activity, you should be able to:

1. carry out the electrolysis of water; and
2. identify the components of water.

Materials Needed

- improvised electrolysis apparatus
- 5% sodium hydroxide (NaOH) solution
- connecting wires (black and red insulation)
- 9V dry cell
- test tube
- plastic syringes will serve as "collecting syringe"
- incense or bamboo stick
- safety matches

TAKE CARE!

Be careful in handling the sodium hydroxide.

Procedure

1. Fill the sample container of the electrolysis apparatus half-full with 5% sodium hydroxide (NaOH) solution.

2. Fill each "electrolysis syringe" with 5% sodium hydroxide (NaOH) solution up to the zero mark. To do this, insert the tip of the "collecting syringe" through the hole of the plastic straw and suck out the air. Refer to Figure 2. Initially, the plunger of the "collecting syringe" should be in the zero position. The *basic solution* will rise and fill the "electrolysis syringe" as you pull the plunger of the "collecting syringe".

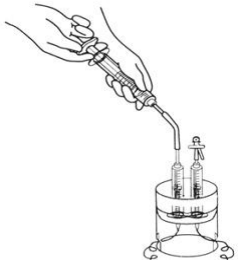
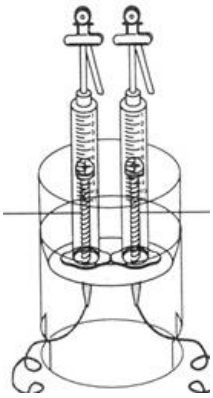


Figure 2. Filling up the "electrolysis syringe" with the sample

3. When the solution reaches the zero mark, fold the straw with the "collecting syringe". Refer to the figure on the right. Repeat the procedure for the other syringe.

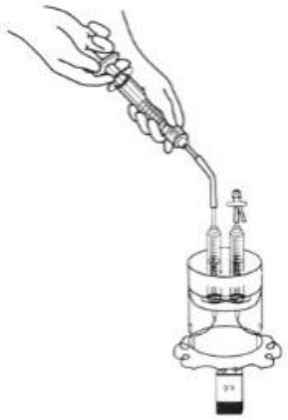


Note: In case the 10mL syringe is used for sucking out the air, you may need to repeat the suction of air to fill up the "electrolysis syringe" with the basic solution.

4. Attach the connecting wires to the bottom tips of the stainless screws. Attach the *black wire to the negative (-) terminal of the dry cell. Attach the red wire to the positive (+) terminal of the dry cell. The stainless screw that is attached to the black wire is the negative electrode; while the stainless screw that is attached to the red wire is the positive electrode.*

5. Once the wires are connected with the dry cell, electrolysis will start. Electrolyze until 6-8 mL of a gas is obtained at the **negative electrode**.

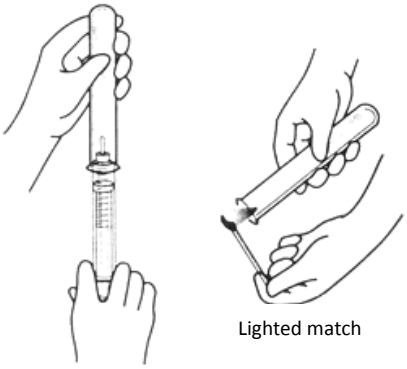
6. Draw out the gas at the **negative electrode** with the "collecting syringe". To do this, insert the tip of the "collecting syringe" into the straw on the side of the **negative electrode**. See figure on the right. Remove the clip and draw out the gas.



Note: The plunger of the "collecting syringe" should be at the zero mark before drawing up the gas.

While drawing out the gas, you will notice that the solution will rise up and fill the "electrolysis syringe" again. Make sure that the "collecting syringe" will only contain the gas generated. However, take this chance to refill the "electrolysis syringe" with the solution. When the level of the solution reaches the zero mark in the "electrolysis syringe", slowly lower down the "collecting syringe" and immediately cover its tip with your finger.

7. Refer to the figure on the right. Inject the collected gas into an inverted test tube and again cover the mouth of the test tube with your thumb. Immediately test the gas collected with a lighted match or bamboo stick/ incense.



Q1. What happened when you placed a lighted match near the mouth of the test tube?

8. Continue to electrolyze until 6-8 mL of the gas is obtained at the **positive electrode**.

9. Refer to the figure on the right. Draw out the gas from the **positive electrode** and immediately inject into a test tube held in upright position. Immediately test the gas collected by thrusting a glowing (no flame) bamboo stick all the way down towards the bottom of the test tube.

Note: Extinguish any flame from the burning stick but leave it glowing before thrusting it inside the test tube.

Q2. What happened when you thrust a glowing bamboo stick inside the test tube?

_____

Electrolysis decomposed water, a compound, into hydrogen and oxygen. Hydrogen and oxygen are *elements*. As you have seen from the activity above, compounds are substances that consist of two elements. As you encounter more compounds, you will find out that there are compounds that may be composed of more than two elements.

In the activity above, you noted that oxygen, the gas collected in the positive electrode, made the lighted stick burn more vigorously. This means oxygen supports burning. Hydrogen, the gas you collected in the negative electrode, gave a popping sound when a glowing stick was thrust into it. The sound comes from the rapid burning of hydrogen in the presence of air.

Note how different the properties are of hydrogen and oxygen from water. Hydrogen burns and oxygen supports burning while water extinguishes fire. Hydrogen is a gas at room temperature; so is oxygen. Water, on the other hand, is a liquid at room temperature. The compound (in this case, water) that is composed of elements (in this case, hydrogen and oxygen) has properties that are distinctly different from the elements. In other words, when elements combine to form compound, a different substance is formed. In the higher grade levels, you will learn how this combination of elements happens.

Elements

There are 118 elements. Each element has different set of properties. No two elements have the same set of properties. Just like the two elements that were generated in Activity 1 — *hydrogen* and *oxygen*. Even though they are both in gaseous state at room temperature, they behave differently when exposed to a flame or spark of flame. Hydrogen gives off a “pop” sound when ignited; while oxygen induces a brighter spark. This difference in behavior implies a difference in property. In effect, hydrogen and oxygen are different substances, or to be more specific, they are different elements.

118 is quite a big number! Thanks to the works of our early scientists, they were able to systematically organize all of the 118 elements in what we call the **periodic table of elements** or sometimes simply referred as periodic table. You will find one at the back page of this module. Amazingly, they were able to logically arrange the elements in the table enabling one to have an idea of the properties of several elements by knowing other elements related to them. This means that there is no need to memorize the periodic table but it is an advantage to be familiar with it. Thus, in the next activity, you will accustom yourself with the periodic table.

Activity 2
The Periodic Table: It's Element-ary!

Objectives

In this activity, you should be able to:

1. be familiar with the layout of the periodic table;
2. know some information about the elements that may be found in the periodic table; and
3. identify the group number an element it belongs to.

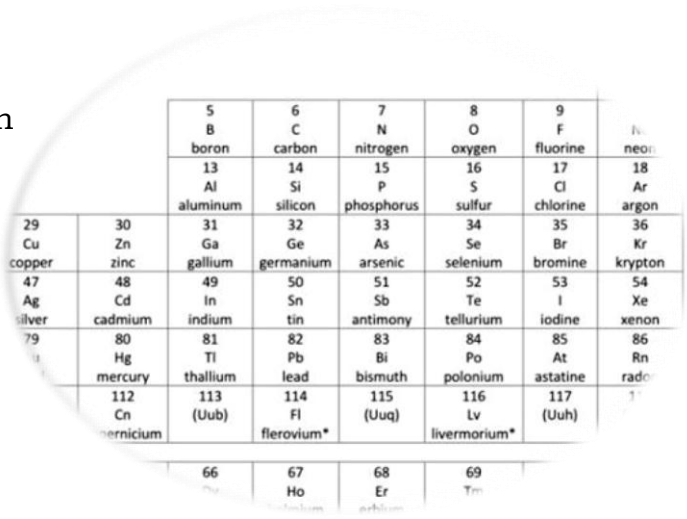
Material Needed

- periodic table of elements

Procedure

1. Every element has a **name**. In each box of the table, you will find only one name. One box corresponds to one element.

   Using the partial figure of the periodic table on the right, find where oxygen is.



2. For the next questions, please refer to the periodic table of the elements found at the back page of this module. Write your answers for each question in Table 1.

   a. Scientists agreed to give **symbols** for each element. This is very helpful especially to those elements with long names. Instead of writing the full names, a one-letter or two-letter symbol may be used. You can find these symbols in the periodic table too. It is written inside the same box for that element. For instance, *O* is the symbol for oxygen.

Q1. What are the symbols for elements with long names such as beryllium, phosphorus, germanium, and darmstatdtium?

Table 1. Name and symbol of some elements and the group number it belongs to.

Name	Symbol	Group Number

Note: Please add rows as necessary

   b. Notice that most of the one-letter symbols are the first letters of these elements.

Q2. What are the symbols for boron, nitrogen, fluorine and vanadium?

   c. For the two-letter symbols, most of them start with the first letter of the element. Notice that the second letter in the symbol may be any letter found in the element's name. Notice as well that only the first letter is capitalized for the two-letter symbols.

Q3. What are the symbols for lithium, chlorine, argon, calcium and manganese?

d. There are symbols that use letters that were taken from the **ancient name** of the element. Examples of ancient names are ferrum (*iron*), argentum (*silver*), hydrargyrum (*mercury*) and plumbum (*lead*).

Q4. What are the symbols for iron, silver, mercury, and lead?

e. In the earlier grade levels, you already encountered elements. You studied rocks and learned that some are composed of silicon and magnesium. Some even have gold.

Q5. What are the symbols for silicon, magnesium and gold?

f. When you were recycling materials, you segregated the objects according to what these are made of. Some of them are made from aluminum, copper, tin or carbon.

Q6. What are the symbols for these 4 elements?

g. In nutrition, you were advised to eat enough bananas because it is a good source of potassium.

Q7. What is the symbol for potassium?

h. In each box, you will find a number on top of each symbol. This is the atomic number. In the higher grade levels, you will learn what this number represents. For now, use it as a guide on how the elements are sequenced.

Q8. What is the element's name and symbol that comes before titanium? How about that comes after barium?

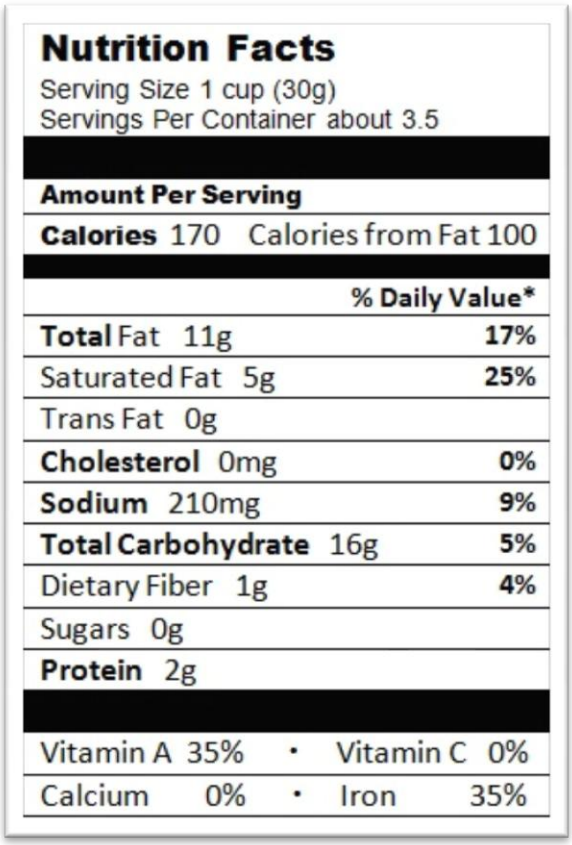
i. Elements that are in the same column have similar properties. For this, each column is called a **family** and has a family name. However, at this point, you will refer first to each family with their corresponding **group number**. Notice that the columns are numbered 1 to 18 from left to right.

Q9. In which group does each of the elements listed in Table 1 belongs to?

There are many elements present in the food you eat —whether it is a natural food like a banana or those processed like banana chips, biscuits, milk, and juice. These are mostly nutrients which the human body needs in order to function well. Some of these are *calcium, magnesium, zinc,* and *selenium*. Find these elements in the periodic table. Can you name more? Did you also find them in the periodic table?

In the next activity, you will find out how these elements are present in the food you eat. From the product labels, information about the contents of the food is written — named as *Nutrition Facts* and *Ingredients*.

The *Nutrition Facts* is a list of the different nutrients provided by the food product with their corresponding percentage share on the daily recommended dietary allowance. Refer to the figure on the right. Notice that some of these nutrients are elements such as calcium. Is this food a good source of calcium?

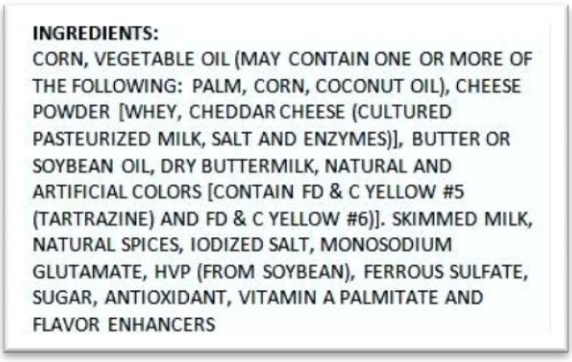


Nutrition Facts

Serving Size 1 cup (30g)
Servings Per Container about 3.5

Amount Per Serving	
Calories 170	Calories from Fat 100
	% Daily Value*
Total Fat 11g	**17%**
Saturated Fat 5g	**25%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 210mg	**9%**
Total Carbohydrate 16g	**5%**
Dietary Fiber 1g	**4%**
Sugars 0g	
Protein 2g	
Vitamin A 35% •	Vitamin C 0%
Calcium 0% •	Iron 35%

On the other hand, *Ingredients* give you a list of the materials that have been added to make the food product. These materials are the sources of the nutrients. These are the ones that are taken in by the body. Refer to the figure below. Find the ingredient *ferrous sulfate*. Ferrous is derived from the Latin name of *iron*. Refer to the figure on the right. This is the *Nutrition Facts* which corresponds to the food product having these ingredients. Find the nutrient *iron*. How much iron does this food product give as part of the recommended dietary allowance? From this product label, you can tell that you will be getting as much as 35% of *iron* that you need for the day and you will get it as *ferrous sulfate* — a compound of iron.



INGREDIENTS:
CORN, VEGETABLE OIL (MAY CONTAIN ONE OR MORE OF THE FOLLOWING: PALM, CORN, COCONUT OIL), CHEESE POWDER [WHEY, CHEDDAR CHEESE (CULTURED PASTEURIZED MILK, SALT AND ENZYMES)], BUTTER OR SOYBEAN OIL, DRY BUTTERMILK, NATURAL AND ARTIFICIAL COLORS [CONTAIN FD & C YELLOW #5 (TARTRAZINE) AND FD & C YELLOW #6)]. SKIMMED MILK, NATURAL SPICES, IODIZED SALT, MONOSODIUM GLUTAMATE, HVP (FROM SOYBEAN), FERROUS SULFATE, SUGAR, ANTIOXIDANT, VITAMIN A PALMITATE AND FLAVOR ENHANCERS

Activity 3
The "Matter" on Labels

Objectives

In this activity, you should be able to:

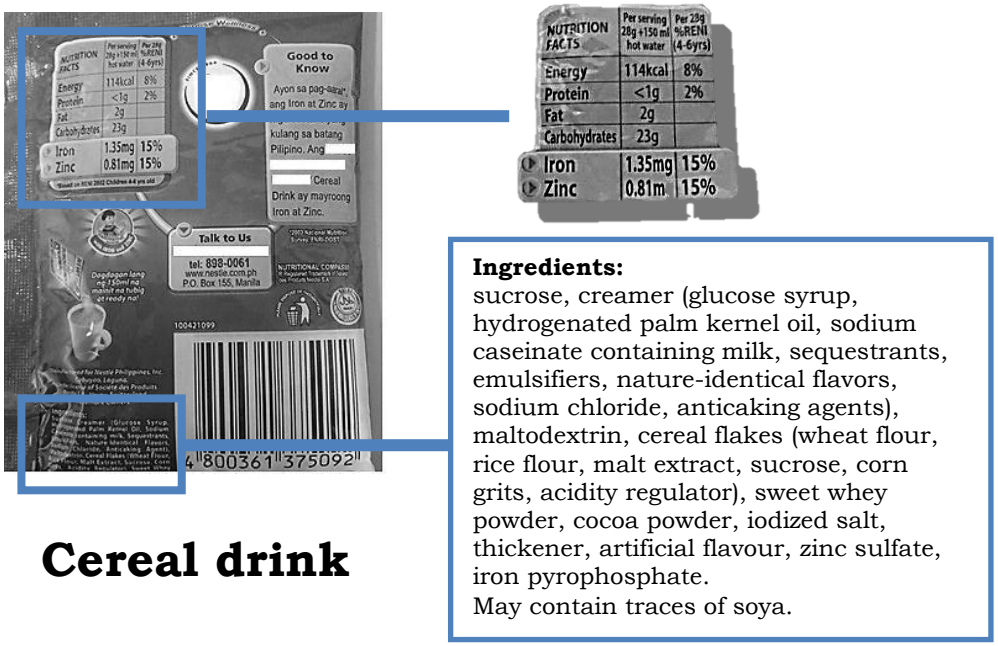
1. name elements that are listed in the *Nutrition Facts* of a food label;
2. recognize that the elements listed in the *Nutrition Facts* are not added as the elements themselves;
3. infer the food ingredient that could be the source of those listed elements; and
4. recognize that most of these food ingredients are examples of compounds.

Materials Needed

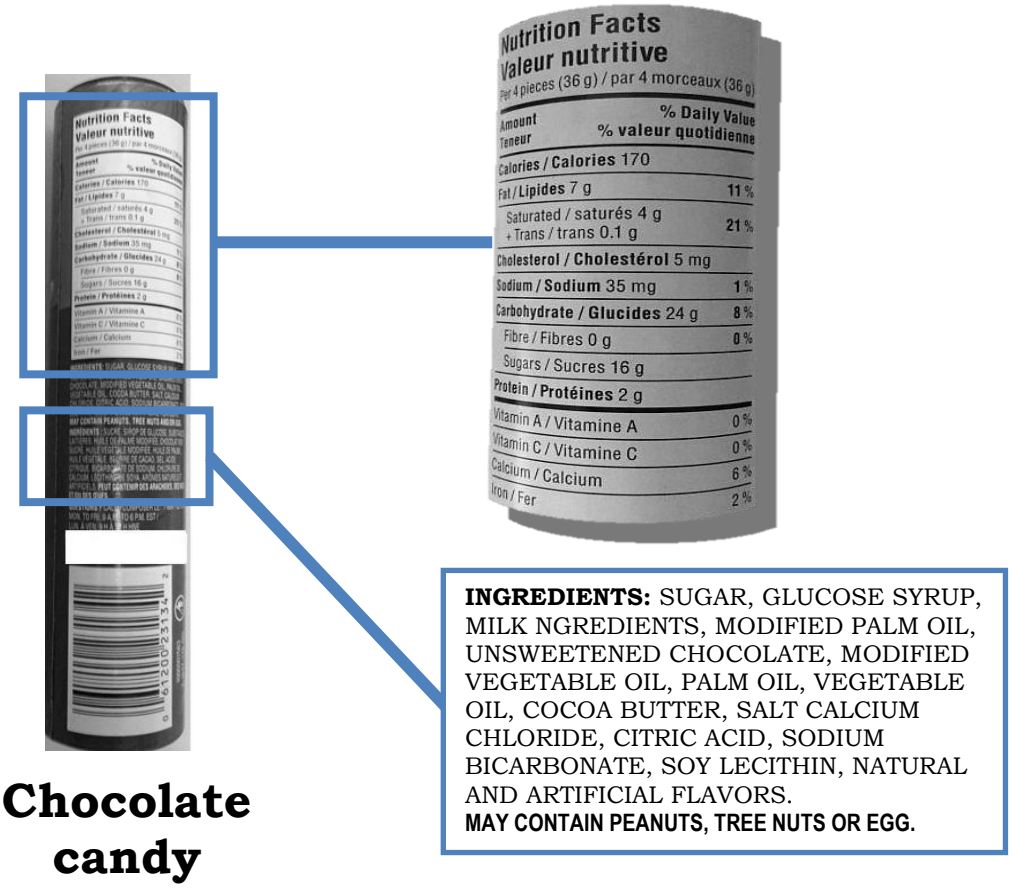
- food labels

Procedure

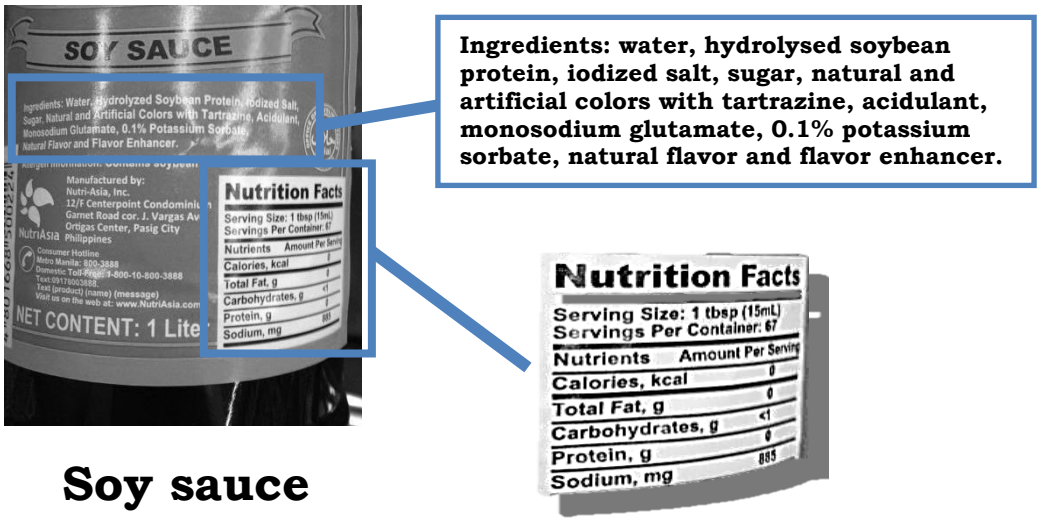
1. Refer to the labels of different food products below.



Cereal drink



Chocolate candy



Soy sauce

2. List down in Table 3 the compounds in the product label and the constituent elements. There are cases that you will need to look up the constituent elements because they may not be obvious from the compound name (e.g., citric acid, oil).

Table 3. Compounds and their constituent elements written in the food labels

Food Product	Compound	Constituent Element
Cereal Drink		
Chocolate candy		
Soy sauce		

Note: Please add rows as necessary

3. The elements iron and zinc are listed in the *Nutrition Facts* for the cereal drink. Find out from the *Ingredients* the source of these elements.
4. Name three elements present in the *Ingredients* of the cereal drink which are not listed in the *Nutrition Facts*.

As you have learned from the activity above, the elements in food are in combination with other elements and the resulting compounds are referred to as **minerals**. Thus, you are not eating the elements themselves.

A product label that lists *sodium* as a nutrient does not mean that you will be eating the element *sodium*. It means that the composition of one of the ingredients includes *sodium*. In the case of soy sauce, the ingredient is *monosodium glutamate*.

Photo credits:
http://www.visualphotos.com/image/1x7465368/sodium_reacting_with_water_chemical_reaction

It is very rare and most of the time dangerous if you take in the element itself. In Activity 1, you have seen that water did not give off a "pop" sound nor induced a bright spark when exposed to a spark or flame, unlike its constituent elements hydrogen and oxygen, respectively. This means that the properties of compounds are different from the properties of the elements it is made up of. There are cases that the properties of a compound pose less risk than its constituent elements. An example is *sodium* and one of its compounds. *Sodium* is an element that burns when it comes in contact with water. Refer to the photo above. Imagine the danger that you are in to if you will be eating *sodium* as an element. However, *sodium chloride*, which is a compound made up of the elements *sodium* and *chlorine,* does not burn when it comes in contact with water. In fact, sodium chloride is sometimes used with water as common food ingredient. Perhaps, you are already

familiar with this. Does table salt ring a bell? Sodium chloride is commonly called as table salt. As you know, it is safe to eat. Do take note though that it should be consumed in the right amount. Excessive consumption of sodium chloride may lead to kidney failure. This stresses the importance of reading product labels. This will let you know how much of a nutrient you get from a food product. Refer to Figure 3. How much calcium do you need to consume in a day? How about magnesium? Avoid taking them beyond these recommended amounts. It may lead to sickness, and even death. It is imperative that you are aware of what makes up the food that you are eating. You may also refer to Table 2 below for food sources of some minerals when preparing your meal.

Recommended nutrient intakes[a] — minerals

Group	Calcium[b] (mg/day)	Selenium (µg/day)	Magnesium (mg/day)	Zinc[c] (mg/day)		
				High bioavailability	Moderate bioavailability	Low bioavailability
Infants						
0–6 months	300[d] 400[g]	6	26[d] 36[h]	1.1[d]	2.8	6.6
7–12 months	400	10	54	0.8[d] 2.5[j]	4.1	8.4
Children						
1–3 years	500	17	60	2.4	4.1	8.3
4–6 years	600	22	76	2.9	4.8	9.6
7–9 years	700	21	100	3.3	5.6	11.2
Adolescents						
Females						
10–18 years	1300[k]	26	220	4.3	7.2	14.4
Males						
10–18 years	1300[k]	32	230	5.1	8.6	17.1
Adults						
Females						
19–50 years (premenopausal)	1000	26	220	3.0	4.9	9.8
51–65 years (menopausal)	1300	26	220	3.0	4.9	9.8
Males						
19–65 years	1000	34	260	4.2	7.0	14.0
Elderly						
Females						
65+ years	1300	25	190	3.0	4.9	9.8
Males						
65+ years	1300	33	224	4.2	7.0	14.0
Pregnant women						
First trimester	m	m	220	3.4	5.5	11.0
Second trimester	m	28	220	4.2	7.0	14.0
Third trimester	1200	30	220	6.0	10.0	20.0
Lactating women						
0–3 months	1000	35	270	5.8	9.5	19.0
3–6 months	1000	35	270	5.3	8.8	17.5
7–12 months	1000	42	270	4.3	7.2	14.4

Figure 3. Recommended mineral intake (WHO, 2004)

Table 2. Some elements essential to life*

Element	Source	Function	Deficiency condition
Macrominerals			
Calcium (Ca)	Milk, cheese, canned fish with bones, sesame seeds, green leafy vegetables	Essential to formation and maintenance of bones and teeth; regulates nerve transmission, muscle contraction, and blood clotting	Rickets in children; diseases of the bones in adults such as softening of the bones and decrease in bone mass
Magnesium (Mg)	Nuts, legumes, cereal grains, dark green vegetables, sea food, chocolate	Catalyst in the synthesis of energy-carrier molecules; involved in the synthesis of proteins and relaxation of muscles	Fluid loss due to too much alcohol intake; heart failure due to spasms
Potassium (K)	Orange juice, bananas, dried fruits, potatoes	Maintains regular heartbeat, water balance and cell integrity; needed in nerve transmission, carbohydrate and protein metabolism	Sudden death during fasting, poor nerve function, irregular heart beat
Selenium (Se)	Liver, meat, grain, vegetables	Part of enzymes; antioxidant	Keshan disease (heart disease)
Sodium (Na)	Meat, table salt, salt- processed food	Regulates amount of body fluid; involved in nerve transmission	Headache, physical weakness, thirst, poor memory, appetite loss
Sulfur (S)	Some proteins	Component of biomolecules and ions	
Zinc (Zn)	Liver, shellfish, meat, wheat germs, legumes	Part of insulin and some 154 enzymes	Anemia, stunted growth
Microminerals or Trace elements			
Chromium (Cr)	Liver; animal and plant tissues	Needed for glucose utilization	Loss of insulin efficiency with age
Copper (Cu)	Liver, kidney, egg yolk, whole grains	Helps in the formation of hemoglobin; part of 11 enzymes	Rare
Fluorine (F)	Sea food, fluorinated drinking water	Strengthens bone and tooth structure	Dental decay
Iron (Fe)	Liver, meat, green leafy vegetables, whole grains, cocoa beans	Component of hemoglobin and myoglobin	Anemia, tiredness, and apathy
Iodine (I)	Sea food, iodized salts	Part of thyroxin, regulates rate of energy use	Goiter
Manganese (Mn)	Liver, kidney, wheat germ, legumes, nuts	Cofactor for a number of enzymes	Weight loss, occasional dermatitis

*Source: Chemistry S&T Textbook for Third Year, 2009

It is also an advantage if you know the different names of the elements and compounds. Take the case of the food product label below.

Refer to the *Nutrition Facts* of the cereal product on the right. It tells that this cereal product provides the nutrient, *sodium*.

Nutrition Facts
Fakta Khasiat

Serving Size / Saiz Hidangan: 45g
Serving Per Package / Hidangan Sebungkus: 8

	Per 45g serve Hidangan Setiap 45g	Per 100g Setiap 100g
Energy / Tenaga	165kcal	366kcal
Protein	5.8g	12.8g
Total Fat / Jumlah Lemak	0.8g	1.8g
Saturated Fat / Lemak Tepu	0.2g	0.5g
Trans Fatty Acid / Asid Translemak	0g	0g
Cholesterol / Kolestrol	0.0mg	0.0mg
Total Carbohydrate / Karbohidrat	33.8g	75.0g
Dietary Fibre / Serat	1.1g	2.5g
Sugars / Gula	8.3g	18.5g
Sodium / Natrium	360.0mg	800.0mg
Vitamin A	270.0mcg	600.0mcg
Thiamin (B1)	0.5mg	1.2mg
Riboflavin (B2)	0.6mg	1.3mg
Niacin (B3) / Niasin	6.8mg	15.0mg
Vitamin B6	0.8mg	1.7mg
Vitamin B12	0.5mcg	1.2mcg
Folic Acid / Asid Folik	75.2mcg	167.0mcg
Vitamin C	11.3mg	25.0mg
Iron / Besi	3.7mg	8.3mg

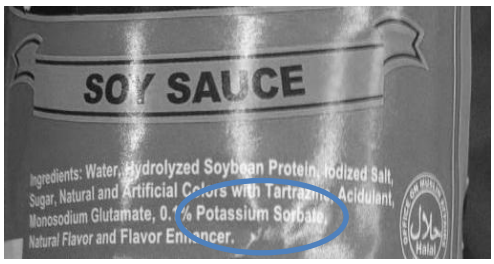
INGREDIENTS/RAMUAN

Milled Rice, Wheat, Sugar, Gluten, Wheat Flour, Skim Milk Powder, Iodized Salt, Malt Extract, Vitamins (A, B1 [Thiamin], B2 [Riboflavin], Niacin, B6, B12, Folic Acid, C, E [Tocopherol]), Mineral (Iron). Contains gluten, soy bean and milk. May contain traces of almond (tree nut) and peanut.

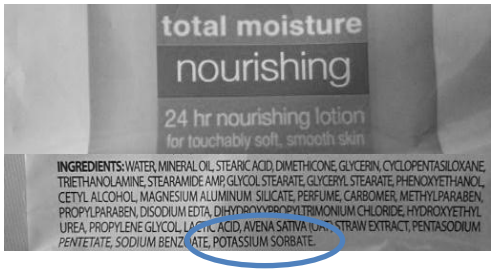
Now, refer to the *Ingredients*. Do you find any ingredient that could be a source of *sodium*? It may seem not, at first. However, knowing that the other name for *sodium chloride* is *salt*, you can now identify one source ingredient for the *sodium* that is listed in the *Nutrition Facts*.

Note that there are instances that the *Nutrition Facts* is incomplete. You may find an element unlisted but once you check the *Ingredients*, you can tell that the food product could be a source of that element. Refer to the label of the cereal drink you used in Activity 3. Is sodium listed in the *Nutrition Facts*? Is there an ingredient that could be a source of *sodium*? When you read product labels, make sure you do not miss out on these information. This will help you decide if the product is worth buying.

Any ingredient added to food <u>should be safe</u> to eat in terms of quality and quantity. By quality, these ingredients must be **food grade**. A substance undergoes a process before it becomes food grade. It is only after that, a substance may be safely added as a food ingredient. If it is a **non-food grade** substance then it should not be added to products that are meant to be ingested.



Refer to the product labels for a soy sauce and a lotion. Notice that *potassium sorbate* is a common ingredient. It has the same function for both products, that is, it acts as a preservative so the product would last longer. However, it is important to note that <u>food grade potassium sorbate was added in soy sauce</u>; while a <u>non-food grade potassium sorbate may be added in the lotion</u>.



Notice that the product label does not indicate if the ingredient is food grade or not. However, there are government agencies that make sure the food products that are sold in the market uses only food grade ingredients.

In the next activity, you will encounter another substance that is common to materials that are not meant to be ingested. However, this substance was made food grade before it was added as a food ingredient. This substance is *iron*. This food grade iron is sprayed onto the food or added as a powder to the mixture. Because it is the elemental iron that was added as a mixture, its properties are retained. One of these is its magnetic property. Thus, you can recover the iron present in the food product by using a magnet.

Activity 4
The Iron-y of Food

Objective

In this activity, you should be able to recover iron from a food product.

Materials Needed

- processed food product rich in reduced iron
- magnetic stirrer (magnet with white coating)
- blender
- water
- beaker
- measuring cup
- forceps

Procedure

1. Place one cup of the food sample in a blender. Add one cup of water.

2. Transfer the crushed sample to a beaker. If the mixture is too thick, add more water.

3. Make sure that the magnetic stirring bar is clean. Place it in the beaker containing the mixture.

TAKE CARE!

Do not eat the food samples and the iron that will be extracted in the activity.

4. Stir the mixture for about 15 minutes in a magnetic stirrer.

   Note: If the magnet does not seem to move, the mixture might still be thick. If this happens, add enough water.

5. Using the forceps, retrieve the magnetic stirring bar from the mixture. Take a closer look at the magnetic stirring bar.

Q1. Do you notice anything that clings to the magnetic stirring bar?

6. Let the magnetic stirring bar dry. Scrape off whatever has clung to it. Bring a magnet close to the dried material. Observe what happens.

Q2. What can you infer about the identity of the dried material? What made you say so?

As you have seen, elements are part of almost anything around us — food, clothes, rocks, and even this paper you are currently reading from. Elements are said to be the building blocks of matter. They are like blocks that you can put together and build something new. When you build something new from these elements, you call them as compounds.

Compounds are made up of elements.
Elements are the simplest form of matter.
Both elements and compounds are substances.

With the 118 elements, imagine how many combinations of elements you can make into compounds and how diverse the materials around us can be.

In Modules 4 & 5, you will learn more about the compounds and elements. You will work on different samples of compounds and elements and explore their properties.

PERIODIC TABLE

1	2	3	4	5	6	7	8	9
1 **H** hydrogen								
3 **Li** lithium 0.1080	4 **Be** beryllium 0.3130							
11 **Na** sodium 0.2100	12 **Mg** magnesium 0.2260							
19 **K** potassium 0.1390	20 **Ca** calcium 0.2980	21 **Sc** scandium 0.0177	22 **Ti** titanium 0.0234	23 **V** vanadium 0.0489	24 **Cr** chromium 0.0774	25 **Mn** manganese 0.0069	26 **Fe** iron 0.0993	27 **Co** cobalt 0.1720
37 **Rb** rubidium 0.0779	38 **Sr** strontium 0.0762	39 **Y** yttrium 0.0166	40 **Zr** zirconium 0.0236	41 **Nb** niobium 0.0693	42 **Mo** molybdenum 0.1870	43 **Tc** technetium 0.0670	44 **Ru** ruthenium 0.1370	45 **Rh** rhodium 0.2110
55 **Cs** cesium 0.0489	56 **Ba** barium 0.0300		72 **Hf** hafnium 0.0312	73 **Ta** tantalum 0.0761	74 **W** tungsten 0.1890	75 **Re** rhenium 0.0542	76 **Os** osmium 0.1090	77 **Ir** iridium 0.1970
87 **Fr** francium 0.0300	88 **Ra** radium		104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium
			57 **La** lanthanum 0.0126	58 **Ce** cerium 0.0115	59 **Pr** praseodymium 0.0148	60 **Nd** neodymium 0.0157	61 **Pm** promethium	62 **Sm** samarium 0.096
			89 **Ac** actinium	90 **Th** thorium 0.0653	91 **Pa** protactinium 0.0529	92 **U** uranium 0.0380	93 **Np** neptunium 0.0082	94 **Pu** plutonium 0.0067

Key

atomic number
Symbol
name
electrical conductivity**

*newly named elements, as of June 2011. For more information, please access http://iupac.org/publications/pac/83/7/1485/

**electrical conductivity values ($x10^6$/Ohm-cm)

OF ELEMENTS

			13	14	15	16	17	18
			5 B boron	6 C carbon 0.0006	7 N nitrogen	8 O oxygen	9 F fluorine	2 He helium / 10 Ne neon
			13 Al aluminum 0.3770	14 Si silicon	15 P phosphorus	16 S sulfur	17 Cl chlorine	18 Ar argon
10	11	12						
28 Ni nickel 0.1430	29 Cu copper 0.5960	30 Zn zinc 0.1660	31 Ga gallium 0.0678	32 Ge germanium	33 As arsenic	34 Se selenium	35 Br bromine	36 Kr krypton
46 Pd palladium 0.0950	47 Ag silver 0.6300	48 Cd cadmium 0.1380	49 In indium 0.1160	50 Sn tin 0.0917	51 Sb antimony 0.0288	52 Te tellurium	53 I iodine	54 Xe xenon
78 Pt platinum 0.0966	79 Au gold 0.4520	80 Hg mercury 0.0104	81 Tl thallium 0.0617	82 Pb lead 0.0481	83 Bi bismuth 0.0087	84 Po polonium 0.0219	85 At astatine	86 Rn radon
110 Ds darmstatdtium	111 Rg roentgenium	112 Cn copernicium	113 (Uub)	114 Fl flerovium*	115 (Uuq)	116 Lv livermorium*	117 (Uuh)	118 (Uuo)

63 Eu europium 0.0112	64 Gd gadolinium 0.0074	65 Tb terbium 0.0089	66 Dy dysprosium 0.0108	67 Ho holmium 0.0124	68 Er erbium 0.0117	69 Tm thulium 0.0150	70 Yb ytterbium 0.0351	71 Lu lutetium 0.0185
95 Am americium 0.0220	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

Suggested time allotment: 5 to 6 hours

MODULE 4

ACIDS AND BASES

In Module 1, you identified common properties of solutions using different methods. You learned how to report the amount of the components in a given volume of solution. You also found out that not all solutions are liquid. Some of them are solids and others are gases. Towards the end of the module, you investigated the factors that affect how fast a solid dissolves in water.

In Module 3 you learned about compounds. In Module 4 you will study a special and important class of compounds called acids and bases. Examples of acids are acetic acid in vinegar and citric acid in fruit juices. The solution used for cleaning toilet bowls and tiles is 10-12% hydrochloric acid. It is commonly called *muriatic acid*. These acids in these mixtures make the mixtures acidic. We can say the same about bases and basic solutions. An example of a base is sodium hydroxide used in making soaps and drain cleaners. Sodium hydroxide is also called *lye* or *caustic soda*. A common drain cleaner used in most homes in the Philippines is called *sosa.* Another base is aluminum hydroxide used in antacids. The bases in these mixtures make the mixtures basic.

In this module you will investigate the properties of acidic and basic mixtures using an **indicator,** a dye that changes into a specific color depending on whether it is placed in an acidic solution or in a basic one. Aside from knowing the uses of acidic and basic mixtures, you will also find out the action of acid on metals and think of ways to reduce the harmful effects of acids. Knowing the properties of acids and bases will help you practice safety in handling them, not only in this grade level, but in your future science classes.

How acidic or basic are common household materials?
Does water from different sources have the same acidity?
What is the effect of acid on metals?

Activity 1

How Can You Tell if a Mixture is Acidic or Basic?

How will you know if a mixture is acidic or a basic? In this activity, you will distinguish between acidic and basic mixtures based on their color reactions to an indicator. An **indicator** is a dye that changes into a different color depending on whether it is in acid or in base. There are many indicators that come from plant sources. Each indicator dye has one color in an acidic mixture and a different color in a basic mixture. A common indicator is ***litmus***, a dye taken from the lichen plant. Litmus turns red in acidic mixtures and becomes blue in basic mixtures.

You will first make your own acid-base indicator from plant indicators available in your place. This is a colorful activity. You may select a local plant in your community. You can use any of the following: violet eggplant peel, purple *camote* peel, red *mayana* leaves or violet *Baston ni San Jose*. These plant materials contain anthocyanins. These plant pigments produce specific colors in solutions of different acidity or basicity.

In this activity, you will:

1. Prepare a plant indicator from any of the following plants: violet eggplant peel, purple *camote* peel, red *mayana* leaves or violet *Baston ni San Jose;* and

2. Find out if a given sample is acidic or basic using the plant indicator.

TAKE CARE!

It is dangerous to taste or touch a solution in order to decide if it is acidic or a basic.

Part A. Preparation of Indicator*

In this part of Activity 1, you will prepare a plant indicator that you will use to determine if a given sample is acidic or a basic.

*University of the Philippines. National Institute for Science and Mathematics Education Development (2001). *Practical work in high school chemistry: Activities for students.* Quezon City: Author, pp. 29-33.

Materials Needed

- 1 pc mature, dark violet eggplant or camote leaves of *Mayana* or *Baston ni San Jose*
- alum (*tawas*) powder
- sharp knife or peeler
- small casserole or milk can
- plastic egg tray or small transparent plastic cups
- brown bottle with cover
- alcohol lamp
- tripod

Procedure

1. Peel an eggplant as thin as possible. (You may also use the skin of purple *camote* or the leaves of red *mayana or Baston ni San Jose.)*

   Cut the materials into small pieces and place in a small casserole or milk can. You may keep the flesh of the eggplant or *camote* for other purposes.

2. Add about ⅓ to ½ cup tap water to the peel depending on the size of the eggplant or *camote* used. Boil for 5 minutes. Stir from time to time.

3. Transfer the mixture into a bottle while it is still hot. There is no need to filter, just remove the solid portion. The mixture may change if left in open air for more than 5 minutes.

4. Immediately add a pinch (2-3 matchstick head size) of alum (*tawas*) powder into the solution or until the solution becomes dark blue in color. Stir well while still hot. This is now the indicator solution.

Note*: Alum will stabilize the extract. The extract will be more stable with alum but it is recommended that the solution be used within a few days. Keep the extract in the refrigerator or cool dark place when not in use.*

Part B. Determining the acidity or basicity of some common household items

In this part of the activity, you will find out if a given household material is acidic or basic using the plant indicator you have prepared in Part A.

Materials Needed

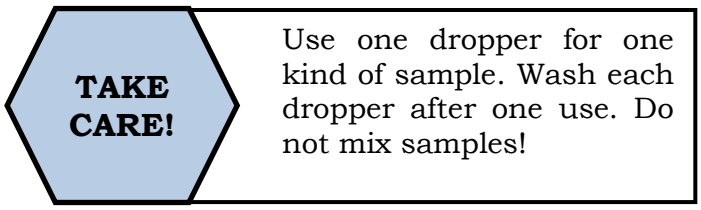
- plant indicator prepared in Part A
- vinegar
- distilled water
- tap water
- baking soda
- baking powder
- calamansi
- Other food/home items with no color:
  (toothpaste, shampoo, soap, detergent, fruit juice like buko juice, sugar in water, soft drink)
- 2 plastic egg trays or 12 small plastic containers
- 6 droppers
- 6 plastic teaspoons
- stirrer (may be teaspoon, barbecue stick or drinking straw)

Procedure

1. Place one (1) teaspoon of each sample in each well of the egg tray.

2. Add 8-10 drops (or ½ teaspoon) of the plant indicator to the first sample.

Note: If the sample is solid, wet a pinch (size of 2-3 match heads) of the solid with about ½ teaspoon of distilled water.



3. Note the color produced. Record your observations in column 2 of Table 1.

Table 1. Acidic or basic nature of household materials

Sample	Color of indicator	Nature of sample
calamansi		
tap water (water from the faucet)		
Distilled water		
vinegar		
sugar in water		
baking soda		
baking powder		
soft drink (colorless)		
coconut water (from buko)		
toothpaste		
shampoo		
soap		

4. Repeat step number 1 of Part B for the other samples.

5. Determine the acidic or basic nature of your sample using the color scheme below for eggplant or *camote* indicator and record the nature of each sample in Table 1.

   Strongly acidic: red to pale red
   Weakly acidic: blue
   Weakly basic: green
   Strongly basic: yellow

Part C. Determining the acidity or basicity of water from different sources

In this part of Activity 1, you will find out how acidic or basic the samples of water from different sources are.

Materials Needed

At least one cup water from each of the following sources of water:

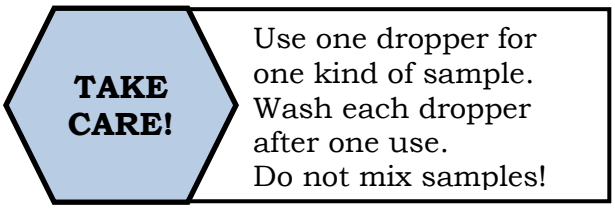
- plant indicator prepared in Part A
- rainwater
- river, lake or stream
- pond
- canal
- faucet
- deep well or hand pump
- bottled water (mineral water) or distilled water
- 2 plastic egg trays or 8 small plastic containers
- 6 droppers
- 6 plastic teaspoons

Procedure

1. Place one (1) teaspoon of each sample in each well of the egg tray.

2. Add 8-10 drops (or ½ teaspoon) of the plant indicator to the first sample.

Note: If the sample is solid, wet a pinch (size of 2-3 match heads) of the solid with about ½ teaspoon of distilled water.



3. Note the color produced. Record your observations in column 2 of Table 2.

Table 2. Acidic or basic nature of water from different sources

Water sample from source	Color of indicator	Nature of sample
rainwater		
river, lake or stream		
Pond		
Canal		
water from faucet		

4. Determine the acidic or basic nature of your sample using the color scheme below for eggplant or *camote* indicator and record the nature of each sample in Table 2.

   Strongly acidic: red to pale red
   Weakly acidic: blue
   Weakly basic: green
   Strongly basic: yellow

You can now operationally distinguish between acidic and basic mixtures using plant indicators. More than that, using the plant extract you have prepared allowed you to further determine the degree of acidity or basicity of a mixture, that is, you were able to find out how strongly acidic or basic the mixtures were. It should now be clear to you that the samples you used in Activity 1, Parts B and C are not called acids nor bases but rather these samples may have either acids or bases in them which make them acidic or basic.

Another method can be used to distinguish acidic from basic mixtures. It is through the use of the pH scale, which extends from 0 to 14. The pH scale was proposed by the Danish biochemist S.P.L. Sorensen. In this scale, a sample with pH 7 is *neutral.* An *acidic* mixture has a pH that is less than 7. A *basic* mixture has a pH that is greater than 7. In general, the lower the pH, the more acidic the mixture and the higher the pH, the more basic is the mixture.

It is useful for you to know the pH of some samples of matter as shown in Table 1 and illustrated in the pH scale drawn in Figure 1.

Table 3*. The pH values of some samples of matter

Sample of Matter	pH
Gastric juice	1.6-1.8
Lemon juice	2.1
Vinegar (4%)	2.5
Softdrinks	2.0-4.0
Urine	5.5-7.0
Rainwater (unpolluted)	5.6
Milk	6.3-6.6
Saliva	6.2-7.4
Pure water	7.0
Blood	7.4
Fresh egg white	7.6-8.0
Seawater	8.4
Laundry detergents	11
Household bleach	12.8
Drain cleaner	13.0

*Adapted from: Hill, J. W. & Kolb, D. K. (1998). *Chemistry for changing times*, 8th ed., p. 187.

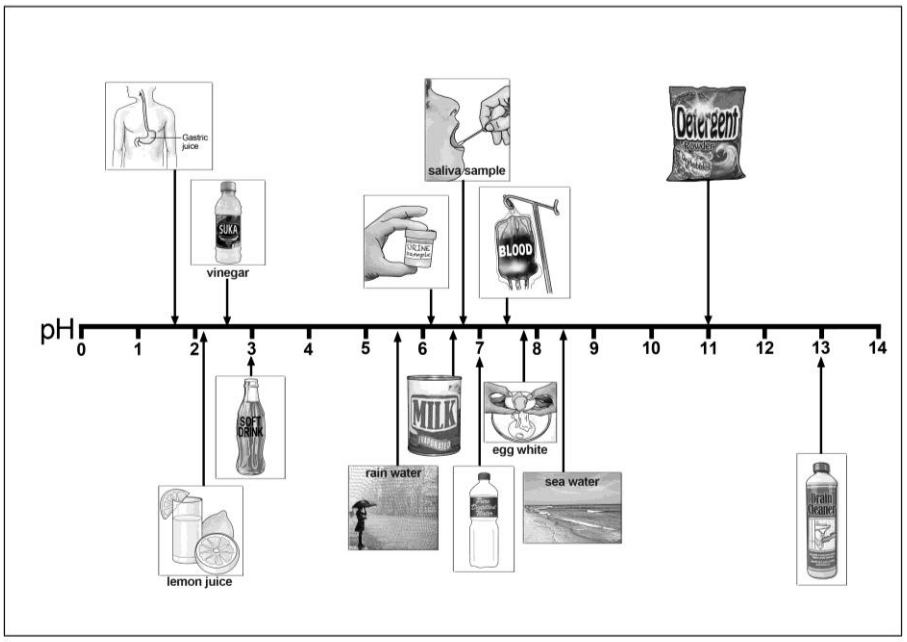


Figure 1. The pH values of some samples of matter.

Activity 2
Color Range, pH Scale!

In this activity, you will use the results in Activity 1, Parts B and C, to determine the pH of the solutions you tested. Use the following pH scale for eggplant indicator to determine the pH of the common mixtures you tested in Activity 1. Present your results in a table similar to Table 4.

The eggplant indicator shows the following color changes.

pH 1 2 3 4 5 6 7 8 9 10 11 12 13 14
red/ pale/ red blue /green /yellow

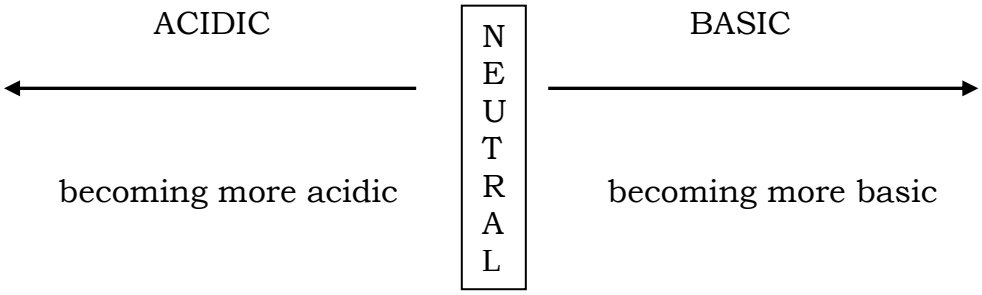


Table 4. pH of samples from Activity 1

Sample	pH based on eggplant/*camote* indicator	Acidic or Basic

Now that you are aware of the pH of some common mixtures, why do you think is it important to know about pH? The following facts give you some information on how pH affects processes in the body and in the environment, as well as in some products you often use.

Importance of pH

pH and the Human Body

Acids and bases perform specific functions to balance the pH levels in the body. When your body has too much carbon dioxide, the blood becomes too acidic. You breathe slowly. Breathing is slowed to increase the pH in the blood. If pH in the body is too basic, you will hyperventilate to lower the pH. This acid and base control is an important part of biological homeostasis (balance) in humans. In fact, human life is sustained only if the pH of our blood and body tissues is within a small range near 7.4.

Use of pH in Food Processing and Fruit Preservation

During food processing, pH is closely followed. Changes in pH affect the growth of microorganisms, which cause food spoilage. Most bacteria grow best at or near pH 7. To prevent the growth of harmful bacteria, pickling is an effective food preservation method because it lowers pH.

The control of pH is also needed in wine and jam preparation. A few species of bacteria grow in a basic medium of pH 9-10. This is the pH range of stale eggs. Most molds grow within the pH range of 2- 8.5. In acidic conditions, many fruits and products made from fruits are easily attacked by molds unless the fruits are properly protected.

Control of pH in Soil

The pH of soil is very important. Some plants grow well in acidic soil while others prefer basic soil. Farmers need to know the pH of their soil since plants will only grow in a narrow pH range. The pH also affects how much nutrients from the soil become available to plants.

Most plants in the Philippines grow in acidic soils. These plants are banana, *kaimito*, durian, pineapple, soybean, coffee, eggplant, squash, *kamote*, and rice. Other plants like grapes and *pechay* require basic soils. Some plants grow best in almost neutral soil like orange, peanut, watermelon, beans, cabbage, tomato, corn garlic, and onion.

pH of Rainwater

The average pH of rain is 5.6. This slightly acidic pH is due to the presence of carbon dioxide in the air. In many areas of the world, rainwater is much more acidic, sometimes reaching pH 3 or even lower.

Rain with a pH below 5.6 is called "acid rain." The acidic pollutants in the air that come from the burning of fuels used in power plants, factories, and vehicles produce gases which are acidic. These gases enter the atmosphere and dissolve in water vapor in the air. Some acid rain is due to natural pollutants like those from volcanic eruptions and lightning.

Maintaining pH of Personal Care Products

Most personal care products have pH kept at specific levels to avoid harmful effects on the body. This is true for hair products. For example, at pH 12, hair already dissolves, that is why hair removers usually have pH of 11.5 to12. Most shampoos are within the pH range of 4 to 6. This is because the pH of the product must be compatible with that of the hair, which is in the range pH 4 to 5. Hair is least swollen and is strongest at this pH range. But very often, using shampoo leaves the hair basic. So, in order to avoid eye irritation and stinging, shampoos for infants and children have a pH similar to that of tears (pH 7.4).

Hair has a protective covering called sebum. The use of conditioners after using shampoo puts back this oily coating and penetrates the hair shaft itself.

You may look up other references to learn more about the importance of knowing about pH.

Now that you have discussed with your teacher the importance of keeping the proper pH in the human body, in food processing and food preservation, in farming and in personal care products, it is also essential that you know the effects of acids on some common metals. An important property of acids is their tendency to react with certain metals. At higher grade levels, you will learn that the nature of the metal determines how it is affected by specific types of acid. However, in this grade level, you will simply investigate the effect of an acid on a common metal like iron.

Effect of an Acidic Mixture on Metal

What do you think will happen when an acid and a metal come in contact with each other? What happens after the metal has been in contact with the acid for some time? What changes take place?

In Activity 3, you will investigate the effect of an acid on a common metal like iron. In Module 1, you have learned that vinegar is about 5% acetic acid. You will be using vinegar in this investigation since it is safe to

handle and easily available. Vinegar will simply be an example that can show the action of an acidic solution when it comes in contact with a metal. There are other acids that affect metals but you will learn about them in Grades 8 and 9.

Activity 3
What Happens to a Metal when Exposed to an Acidic Mixture?

Objective

In this activity, you will find out the effect of an acidic mixture, like vinegar, on iron.

Materials Needed

- 3 pieces, small iron nails (about 2.5 cm long)
- 1 cup white vinegar (with 4.5 to 5 % acidity)
- 3 small, clear bottles or 100 mL beaker
- 1 cup water
- 2 droppers

Procedure

1. Prepare a table similar to the one below.

Setup	Observations		
	After one day	After 2 days	After 3 days
Iron nail (1)			
Iron nail (2)			
Iron nail (3)			

2. Clean and wipe dry all the iron nails and the bottles.

3. Place **one piece** of the iron nail in each bottle.

Q1. Why do you think are there three different bottles for each sample of iron nail?

4. Put two to three drops (just enough to barely cover the sample) of vinegar on top of the iron nail in each bottle.

5. After adding vinegar to all samples, put aside the bottles where you can observe changes for three days.

6. Write your observations after one day, two days, and three days on the data table in step #1.

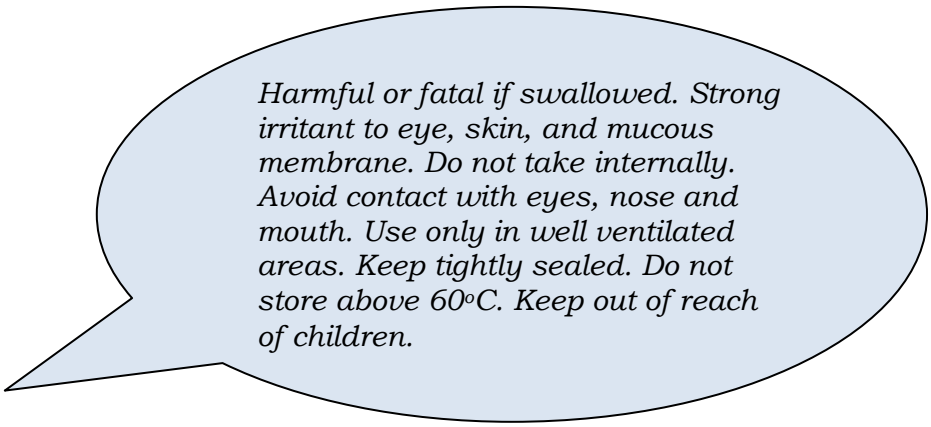
Q2. At the end of three days, describe completely what happened to each sample.

Q3. Give explanations for the results you have observed.

You have observed the action of vinegar, an acidic mixture, on metal such as iron in Activity 3. Do you think other types of acidic mixtures act in the same way with other metals? What about other types of materials? You will learn a lot more about the action of acids on metal and on different types of materials in Grades 8 and 9.

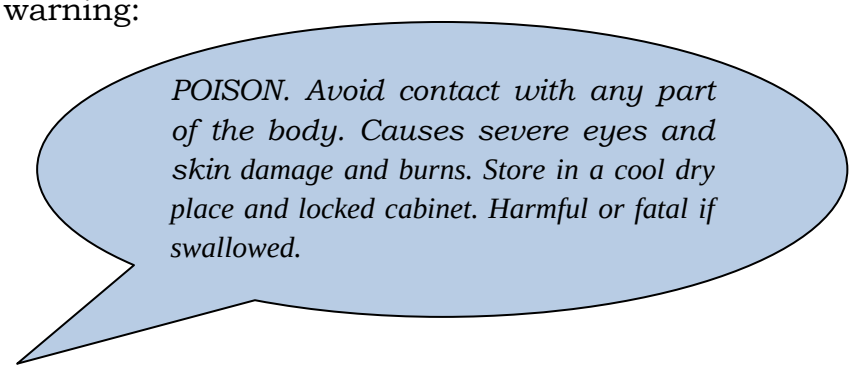
Safety in Handling Acids and Bases

Now that you know the properties of acidic and basic mixtures, you can handle them carefully. Acids and bases with high concentrations can cause serious burns. For example, hydrochloric acid (commonly called muriatic acid) is used in construction to remove excess mortar from bricks and in the home to remove hardened deposits from toilet bowls. Concentrated solutions of hydrochloric acid (about 38%) cause severe burns, but dilute solutions can be used safely in the home if handled carefully. You can find the following caution in a bottle of muriatic acid:



Acidic mixtures can easily "eat away" your skin and can make holes in clothes. However, since vinegar is only 5% acetic acid, it will not irritate the skin and destroy clothes.

Sodium hydroxide (commonly called lye or liquid *sosa)* is used to open clogged kitchen and toilet pipes, sinks, and drains. Its product label shows the following warning:



For your safety, you should make it a habit to read product labels before using them. It is also important to know the proper way of storing these products, as shown in the label of liquid *sosa*.

What happens when acids and bases combine?

Look back at the pH color chart of Activity 2. You will find a pH value that is not acidic or basic. Mixtures that are not acidic or basic are called ***neutral***. When an acid mixes with a base, water and salt are produced. Such a process is called **neutralization**.

If a basic mixture is added to an acidic mixture, the resulting mixture will no longer have the properties of the acidic mixture. In the same way, if enough acidic mixture is added to a basic mixture, the properties of the basic mixture are changed. This is because the acid and the base in each of the mixtures neutralize each other to produce a mixture with a different set of properties.

The process of neutralization has some uses in everyday life. The following are some examples:

- ***Treating indigestion.*** The acid in our stomach, gastric juice, is hydrochloric acid with low concentration. It helps in the digestion of food. If we eat too much food, the stomach produces more acid which leads to indigestion and pain. To cure indigestion, the excess acid must be neutralized by tablets called antacids. These contain bases to neutralize the excess acid in the stomach.
- ***Using toothpaste to avoid tooth decay***. Bacteria in the mouth can change sweet types of food into acid. The acid then attacks the outermost part of the tooth and leads to tooth decay. Toothpaste contains bases that can neutralize the acid in the mouth.

- ***Treating soil.*** You will recall in the earlier part of this module that some plants grow well in acidic soil while others prefer basic soil. Farmers need to know the pH of their soil. Most often, the soil gets too acidic. When this happens, the soil is treated with bases such as quicklime (calcium oxide), slaked lime (calcium hydroxide) or calcium carbonate. The base is usually spread on the soil by spraying.

- ***Treating factory waste.*** Liquid waste from factories often contains acid. If this waste reaches a river, the acid will kill fish and other living things. This problem can be prevented by adding slaked lime (calcium hydroxide) to the waste in order to neutralize it.

After completing this module, you learned about the properties of acidic and basic mixtures. You can now prepare indicators from plants anytime you need to use them. You are more aware of the use of the pH scale, which will become more helpful as you study science in higher grade levels. You now recognize the importance of knowing the acidity or basicity of common mixtures we use, as well as the relevant uses of the process of neutralization.

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Suggested time allotment: 5 to 6 hours

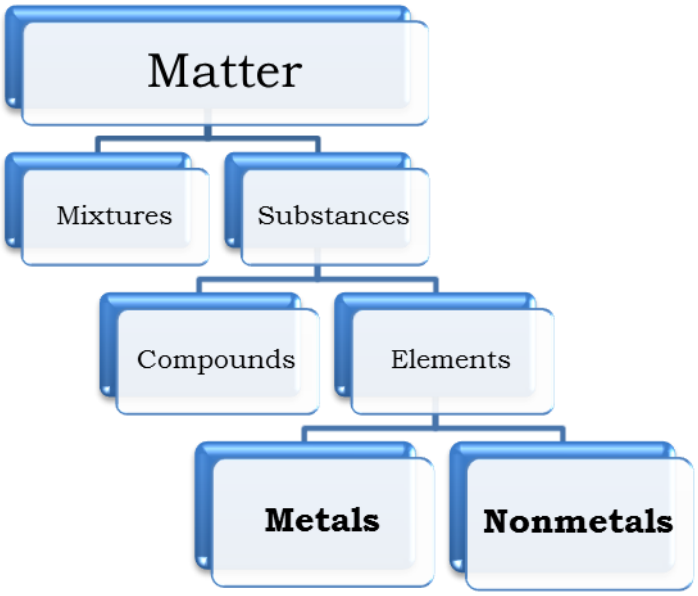
MODULE 5

METALS AND NONMETALS

Elements are the simplest form of substances. This means that whatever you do with an element, it remains to be the same element. Its physical state may change but the identity of the element will not. It may form compounds with other elements but the element will never form anything simpler than it already is.

There are already more than a hundred elements and are organized in a Periodic Table. Some of them are naturally occurring and some were produced in a laboratory.

In this module, you will find out more about the elements. You will see that majority of them are **metals**, while some are **nonmetals**. In addition to these are the **metalloids**, so called because they exhibit properties of both metals and nonmetals.



How are metals different from nonmetals?
How are they similar?

Properties of Metals

In the earlier grades, you segregated objects according to the material they are made of. You did this when you were starting the habit of 5Rs — recycle, reuse, recover, repair or reduce. Look around you. Which objects are made of metals? What made you say that they are metals?

Perhaps, you have been identifying a metal based on its appearance. Most of the time, metals are shiny. They exhibit a **luster** which is the reason that they are used as decorations.

Many metals are **ductile**. This means that metals can be drawn into wires. An example is copper. The ductility of copper makes it very useful as electrical wires. Gold is also a metal that is ductile; however, it is rarely used as an electrical wire. What could be the reason for this?

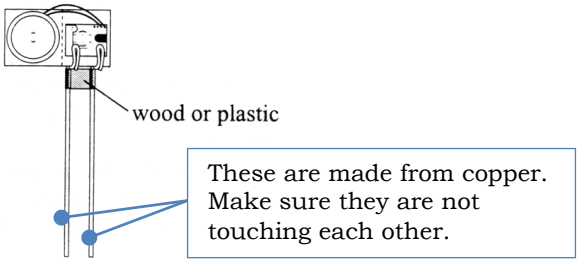
Some metals are **malleable**. This means that they can be hammered or rolled into thin sheets without breaking. An example is aluminum. It is passed into mills and rolled thinly to produce the aluminum foil used to wrap food. Most soda cans are made of aluminum, too.

Some metals are **magnetic**. This means that they are attracted by a magnet. The common ones are iron, nickel and cobalt. Get a magnet. Try them in different metals in your home or school. Were they all attracted to the magnet? What metals are these?

The general properties of metals are luster, ductility, malleability and magnetic properties. Metals exhibit these properties in varying degrees.

Other properties exhibited by metals

In the next activity, you will investigate the **electrical conductivity** of different materials. This property allows electricity to pass through a material. You will find out whether this property is exhibited by metals or nonmetals. You will use an improvised conductivity tester as the one shown on the right.



Activity 1
Which can Conduct Electricity, Metals or Nonmetals?

Objective

In this activity, you should be able to distinguish between metals and nonmetals based on its electrical conductivity.

Materials Needed

- samples of copper, aluminum, sulfur, iron and iodine
- white paper
- improvised conductivity apparatus

Procedure

1. Place a sample in a sheet of white paper. This will help you observe the samples better. In Table 1, note down the appearance of each of them.

Table 1. Electrical conductivity of different materials

Sample	Appearance	Electrical Conductivity
aluminum		
copper		
iodine		
iron		
sulfur		

Q1. Which of the samples look like metals? How about nonmetals?

2. Place the end tip of the improvised conductivity apparatus in contact with each sample. If the tester gives off a sound, the sample is said to be electrically conductive. Otherwise, it is electrically nonconductive.

Note: Do not let the end tips of the conductivity tester touch each other.

Q2. Which of the samples are electrical conductors? Which are not? Note them down in Table 1.

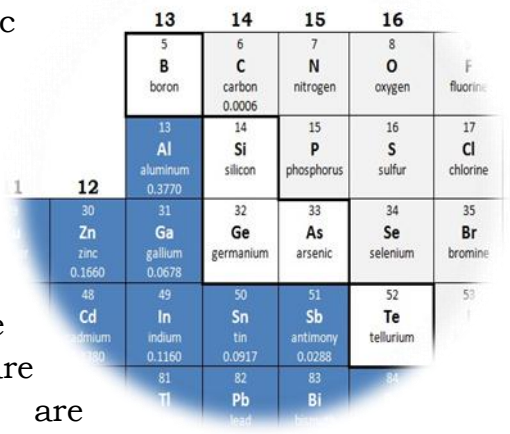
In the activity above, you determined qualitatively the electrical conductivity of each sample. However, if you wish to know the electrical conductivity values, a more sophisticated tester may be used such as the one in the figure below.

The metallic probe in the figure on the left is the one that comes in contact with the sample. It will measure then display the electrical conductivity value in the liquid crystal display (LCD) screen. Refer to the periodic table found at the back page of this module.

The electrical conductivity values are written at the bottom line of each box. It is expressed in $x10^{6}$ $Ohm^{-1}cm^{-1}$. What do you notice about the elements with electrical conductivity values?

Where are they located in the periodic table?

One amazing feature of the periodic table is that all the metals are placed in one side. Those that are on the other side (grayish shade) are the nonmetals.



Notice that there is a stair step line formed by some elements which somewhat divides the metals and nonmetals. These elements are the **metalloids**. They are elements exhibiting properties that are intermediate to metals and nonmetals. Name the metalloids. Name some metals. Name some nonmetals.

Which are electrically conductive, metals or nonmetals? Which element has the highest electrical conductivity value? What could be the reason for using copper as an electrical wire more than this element?

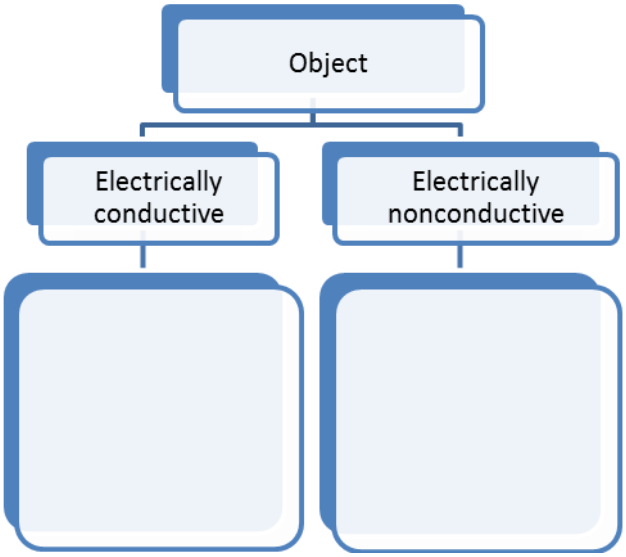
You might wonder why some metals do not have electrical conductivity values when supposedly all of them possess such property. Notice that these metals are the ones mostly found at the last rows of the periodic table. Elements in those rows are mostly radioactive. This means that the element is very unstable and exists in a very short period of time. In effect, it would be difficult to test for their properties. In the higher grade levels, you will learn that there are ways to infer the electrical conductivities of these elements.

Electrical conductivity clearly distinguishes metals from nonmetals but there is one exception. Refer to the periodic table. Which element is electrically conductive even if it is a nonmetal?

One form of carbon is graphite. It is commonly available as the black rod in your pencils. Get your sharpened pencil. Place the black rod in between the end tips of your improvised conductivity tester. Make sure that the black rod is in contact with the tips of the tester. What happened?

In the higher grade levels, you will learn why carbon (graphite) though a nonmetal is electrically conductive.

Look for other objects and test if they are made up of metal or nonmetal. Write down these objects in the appropriate box of the diagram below.



Were you able to find a cooking pot as one of your test objects? What element is it mainly made of?

Refer to Table 2. This table shows the thermal conductivity values of some elements expressed in Watt/centimeter-Kelvin (W/cmK). **Thermal conductivity** is the ability of an element to allow heat to pass through it. The higher the value, the better **heat conductor** an element is. Find the elements that are mainly used for the cooking pots. What can you say about the thermal conductivity of this element compared with the other elements? Is this element, a metal or nonmetal? In general, which are better heat conductors, metals or nonmetals? Based on Table 2, what other elements can be used as cooking pots? Note as well that the malleability of a metal is a consideration in using it as a material for cooking pot.

Table 2. Thermal conductivities of some elements

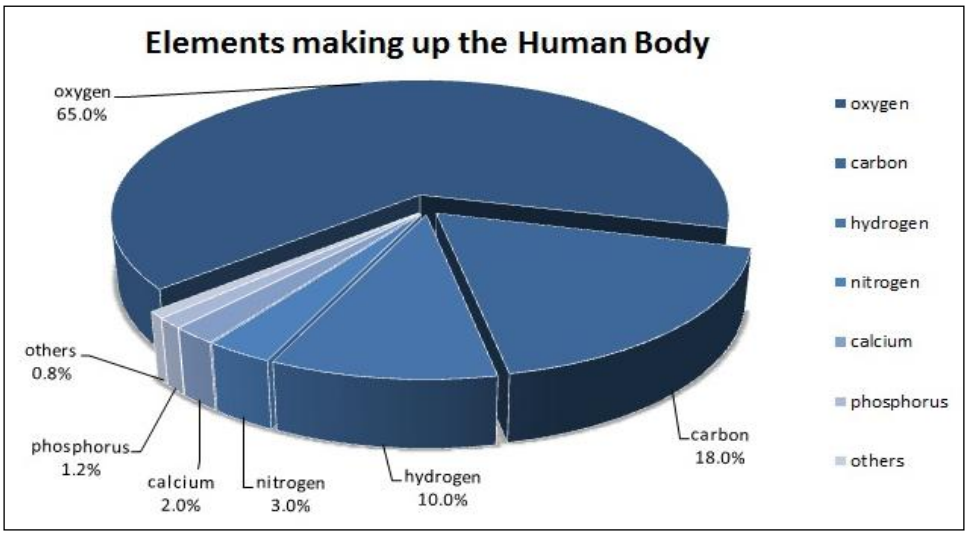
Element	Symbol	Thermal Conductivity* (W/cmK)
Copper	Cu	4.01
Aluminum	Al	2.37
Iron	Fe	0.802
Selenium	Se	0.0204
Sulfur	S	0.00269
Phosphorus	P	0.00235

*Kenneth Barbalace. Periodic Table of Elements - Sorted by Thermal Conductivity. EnvironmentalChemistry.com. 1995 - 2012. Accessed on-line: 3/14/2012 http://EnvironmentalChemistry.com/yogi/periodic/thermal.html

Metals and Nonmetals In and Around You

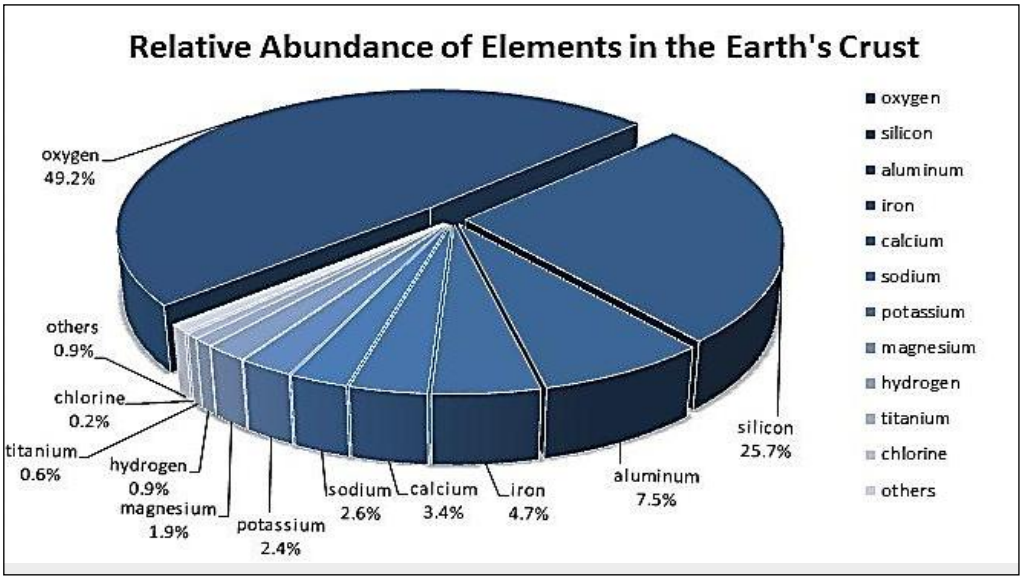
In the figure below, you will find the elements that your body is made up of. What element are you made up of the most? Is it a metal or a

nonmetal? Of all the elements reported in the graph, how many are metals? How about nonmetals?



Data taken from Burns, 1999

Refer to the figure below. The figure shows how much of one element is present in the Earth's crust relative to the other elements. What element is the most abundant in the Earth's crust? What comes second? Are these metals or nonmetals?



Data taken from Burns, 1999

Refer to the periodic table. What constitutes majority of the elements, metals or nonmetals?

Interestingly, even with the fewer number of nonmetals, their abundance is higher than metals. As you have seen above from the two

graphs, both living and nonliving systems are mainly composed of nonmetals.

As you learned in Module 3, elements form compounds. The percentage abundance of the elements reported in the graphs above accounts some elements that are present in compounds, much like the food ingredients you encountered in Module 3. For instance, sodium is present in sodium chloride. The 18.0% carbon that makes up the human body is mostly compounds of carbon such as the DNA that carries your genetic code.

Oxides of Metals and Nonmetals

Similarly, oxygen accounted in the graphs may also be in compounds. Some of these compounds are called **oxides**. These oxides may be formed when an element is burned. These oxides exhibit different acidities. In Module 4, you learned that there are indicators that you can use to determine such. One of these acid indicators is the litmus paper. What color does the litmus paper show when the sample is acidic? How about when the sample is basic?

In the next activity, you will separately burn a sample of a metal and a nonmetal. You will test the acidity of the oxide of a metal and that of the oxide of a nonmetal.

Activity 2
Acidity of the Oxides of Metals and Nonmetals

Objective

In this activity, you should be able to distinguish between metals and nonmetals based on the acidity of their oxides.

Materials Needed

- magnesium (Mg) ribbon
- sulfur (S)
- iron wire (holder)
- alcohol lamp
- test tube
- beaker
- litmus paper (red and blue)
- water
- cork
- watch glass
- dropper/stirring rod

Procedure

1. Get a piece of iron wire. Make a small loop at one end. Insert the other end into a cork to serve as a handle.

2. Get a piece of magnesium ribbon. Describe its appearance. Note this in Table 3.

Q1. Is magnesium a metal or a nonmetal?

3. Coil a small piece of Mg ribbon (about 2 cm) and place on top of the loop. Place the looped end of the wire into the flame of an alcohol lamp. Note what happens. Record your observations in Table 3.

TAKE CARE! Do not inhale the fumes/vapor.

4. Place 2 mL of water in a small test tube. Add the ash produced when you burned the Mg ribbon. Shake the test tube gently.

5. Get a watch glass and place a piece each of red and blue litmus papers.

6. Wet one end of a stirring rod with the solution and place a drop of this solution on a piece of blue litmus paper. Repeat the test on red litmus paper.

Q2. Which litmus paper changed in color? Describe the change. Note this in Table 3.

Q3. Is the oxide of magnesium acidic or basic?

Table 3. Data for Activity 2

	Observations			**Reaction of its oxide with litmus paper**
	Before heating	**During heating**	**After heating**	
Magnesium (Mg)				
Sulfur (S)				

7. Place 2 mL of water in another test tube. Clean the wire loop and dip in powdered sulfur (S).

Q4. Is sulfur a metal or nonmetal?

8. Place the looped end of the wire containing the sample over the flame. As soon as the sulfur starts to burn, put the loop into the test tube without touching the water. Remove the loop into the test tube once the sulfur is completely burned. Cover the test tube immediately and shake well.

9. Get a watch glass and place a piece each of red and blue litmus papers.

10. Wet one end of a stirring rod with the solution and place a drop of this solution on a piece of blue litmus paper. Repeat the test on red litmus paper.

Q5. Which litmus paper changed in color? Describe the change. Note this in Table 3.

Q6. Is the oxide of sulfur acidic or basic?

In this module, you learned about the properties of metals and nonmetals. These properties are the ones that determine their uses like aluminum's malleability to become soda cans, and copper's ductility to become electrical wires.

Most of the elements are metals. They are shiny, malleable and ductile but just in varying degrees — like electrical and thermal conductivity. Nonmetals are electrically nonconductive except for some forms of carbon.

It is important to note though that most objects are made not of a single material, rather of a combination of materials so they become fitter for a purpose. This is where your knowledge on the properties of materials comes in. Which materials do you combine to make it fit for a purpose? As you can see from the image in this module cover, the electrical wire made of copper was covered with rubber. Rubber is mainly made of compounds of nonmetals such as carbon, hydrogen and chlorine. As you have learned, nonmetals are nonconductors of electricity. Using a nonmetal to cover a metal makes it safer to use as an electrical wire.

As you advance to another grade level, there are more properties of matter that you will encounter. It is hoped that you will be able to maximize the properties of different materials to create new beneficial products or find other uses for them.

PERIODIC TABLE

1								
1 **H** hydrogen	2							
3 **Li** lithium 0.1080	4 **Be** beryllium 0.3130							
11 **Na** sodium 0.2100	12 **Mg** magnesium 0.2260	3	4	5	6	7	8	9
19 **K** potassium 0.1390	20 **Ca** calcium 0.2980	21 **Sc** scandium 0.0177	22 **Ti** titanium 0.0234	23 **V** vanadium 0.0489	24 **Cr** chromium 0.0774	25 **Mn** manganese 0.0069	26 **Fe** iron 0.0993	27 **Co** cobalt 0.1720
37 **Rb** rubidium 0.0779	38 **Sr** strontium 0.0762	39 **Y** yttrium 0.0166	40 **Zr** zirconium 0.0236	41 **Nb** niobium 0.0693	42 **Mo** molybdenum 0.1870	43 **Tc** technetium 0.0670	44 **Ru** ruthenium 0.1370	45 **Rh** rhodium 0.2110
55 **Cs** cesium 0.0489	56 **Ba** barium 0.0300		72 **Hf** hafnium 0.0312	73 **Ta** tantalum 0.0761	74 **W** tungsten 0.1890	75 **Re** rhenium 0.0542	76 **Os** osmium 0.1090	77 **Ir** iridium 0.1970
87 **Fr** francium 0.0300	88 **Ra** radium		104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium
			57 **La** lanthanum 0.0126	58 **Ce** cerium 0.0115	59 **Pr** praseodymium 0.0148	60 **Nd** neodymium 0.0157	61 **Pm** promethium	62 **Sm** samarium 0.096
			89 **Ac** actinium	90 **Th** thorium 0.0653	91 **Pa** protactinium 0.0529	92 **U** uranium 0.0380	93 **Np** neptunium 0.0082	94 **Pu** plutonium 0.0067

Key

atomic number
Symbol
name
electrical conductivity**

*newly named elements, as of June 2011. For more information, please access http://iupac.org/publications/pac/83/7/1485/

**electrical conductivity values ($x10^6$/Ohm-cm)

OF ELEMENTS

								18
								2 **He** helium
			13	14	15	16	17	
			5 **B** boron	6 **C** carbon 0.0006	7 **N** nitrogen	8 **O** oxygen	9 **F** fluorine	10 **Ne** neon
			13 **Al** aluminum 0.3770	14 **Si** silicon	15 **P** phosphorus	16 **S** sulfur	17 **Cl** chlorine	18 **Ar** argon
10	11	12						
28 **Ni** nickel 0.1430	29 **Cu** copper 0.5960	30 **Zn** zinc 0.1660	31 **Ga** gallium 0.0678	32 **Ge** germanium	33 **As** arsenic	34 **Se** selenium	35 **Br** bromine	36 **Kr** krypton
46 **Pd** palladium 0.0950	47 **Ag** silver 0.6300	48 **Cd** cadmium 0.1380	49 **In** indium 0.1160	50 **Sn** tin 0.0917	51 **Sb** antimony 0.0288	52 **Te** tellurium	53 **I** iodine	54 **Xe** xenon
78 **Pt** platinum 0.0966	79 **Au** gold 0.4520	80 **Hg** mercury 0.0104	81 **Tl** thallium 0.0617	82 **Pb** lead 0.0481	83 **Bi** bismuth 0.0087	84 **Po** polonium 0.0219	85 **At** astatine	86 **Rn** radon
110 **Ds** darmstatdtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **(Uub)**	114 **Fl** flerovium*	115 **(Uuq)**	116 **Lv** livermorium*	117 **(Uuh)**	118 **(Uuo)**

63 **Eu** europium 0.0112	64 **Gd** gadolinium 0.0074	65 **Tb** terbium 0.0089	66 **Dy** dysprosium 0.0108	67 **Ho** holmium 0.0124	68 **Er** erbium 0.0117	69 **Tm** thulium 0.0150	70 **Yb** ytterbium 0.0351	71 **Lu** lutetium 0.0185
95 **Am** americium 0.0220	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

Suggested time allotment: 4 hours

MODULE 1 FROM CELL TO ORGANISM

Overview

There are different materials in the environment. There are also diverse kinds of living things. This module will discuss different kinds of living things and what they are made up of.

Organ systems work together to help organisms meet their basic needs and to survive. The digestive system helps organisms get energy from the food they eat. The circulatory system moves the nutrients that come from digested food, along with blood, to the different parts of the body. How do you think do the other organ systems work together? Do plants have organ systems, too?

Organ systems are made up of organs that have related functions and are grouped together. For example, the mouth, esophagus, stomach, and intestines are organs of the digestive system. The heart, arteries and veins are some parts that make up the circulatory system. Are there organisms that do not have organs?

This module introduces you to the different structures that make up an organism. These structures are formed from the grouping together of parts whose functions are related. You will also discover in this module that organs themselves are made up of even smaller parts. Anything that happens to these small parts will affect the functioning of the organs, organ systems, and the whole organism.

What are organisms? What makes them up?

Activity 1

What makes up an organism?

Objectives

In this activity, you should be able to:

1. identify the parts that make up an organism,
2. describe the function of each part, and
3. describe how these parts work together in an organism.

Materials Needed

- Writing materials
- Posters and pictures of organisms, organ systems, organs, tissues, and cells

Procedure

Read the selection below and answer the questions that follow.

You are an organism just like the plants and animals.

Photos: Courtesy of Michael Anthony B. Mantala

Figure 1. Pictures of a human being, plant, and an animal

Have you ever asked yourself what makes you up and the other organisms around you? Figure 2 shows a model of a human torso.

Q1. What parts of the human body do you see?

Q2. To which organ systems do these parts belong?

Figure 3 shows some organ systems that you may be familiar with.

Q3. Can you identify these organ systems?

Q4. How do these organ systems work together?

Photo: Courtesy of Michael Anthony B. Mantala
Biology Laboratory, UP NISMED

Figure 2. A model of a human torso

Photo: http://fc.amdsb.ca/~melanie_mccowan/S04B36342.2/human-_body.jpg

Figure 3. Some Organ Systems

The circulatory system is one of the organ systems that make up an organism. It is made up of the heart, blood vessels, and blood.

Figure 4 shows a model of a human heart. Your heart is about the size of your fist. It pumps and circulates blood to the different parts of the body through the blood vessels.

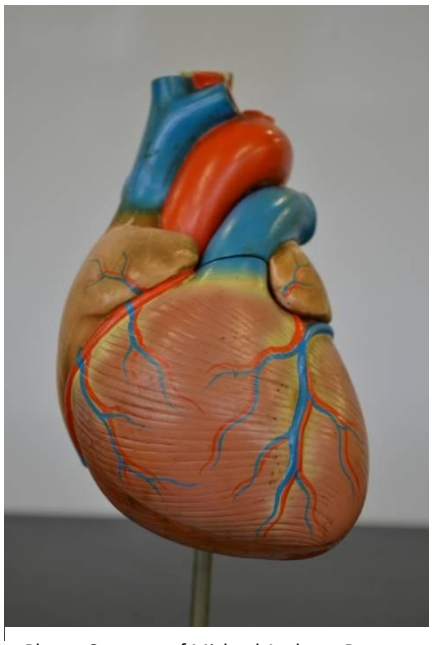


Photo: Courtesy of Michael Anthony B. Mantala

Figure 4. A model of a human heart

Certain diseases affect the heart and cause it to function improperly. To learn more about these diseases and what they do to the heart, interview relatives or neighbors who have heart problems or who know of people who have the disease. You can also use the internet and the library to read articles about how certain diseases affect the heart, its parts, and the whole organism.

Q5. Refer to Figure 4. What parts of the human heart do you see?

Q6. What do you think will happen to the heart if any of these parts were injured or diseased?

Q7. If these parts of the heart were injured or diseased, what do you think will happen to the organism?

The excretory system is another organ system that makes up an organism. It is made up of different organs that help the body eliminate metabolic wastes and maintain internal balance. These organs include a pair of kidneys. Figure 5 shows a model of a human kidney. What shape does it look like?

Photo: Courtesy of Michael Anthony B. Mantala
Biology Laboratory, UP NISMED

Figure 5. A model of a human kidney

The kidneys are made up of even smaller parts. Some parts eliminate wastes that are no longer needed by the body; other parts function in the reabsorption of water and nutrients.

Like the heart, certain diseases also affect the kidneys and their function. To learn more about these diseases and what they do to the kidneys, interview relatives or neighbors who have kidney problems or who know of people who have the disease. You can also use the internet and library resources to read articles or news clips about how certain diseases affect the kidneys – and the other organs of the body – and the whole organism.

Q8. Refer to Figure 5. What parts of the human kidney do you see?

Q9. What do you think will happen to the kidneys if any of these parts were injured or diseased?

Q10. If these parts of the kidneys were injured or diseased, what do you think will happen to the organism?

Q11. What procedure can a medical doctor do to correct an injury to these organs?

Organs are made up of tissues. The heart, kidneys, and the parts that make them up are made up of tissues. Figure 6 shows a picture of a muscle tissue. This tissue is made up of cells - the basic units of structure and function in organisms.

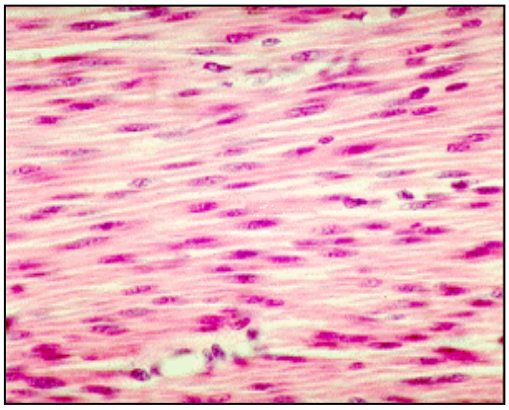


Photo: http://www.uoguelph.ca/zoology/devobio/miller/013638fig6-17.gif

Figure 6. Muscle tissues

Q12. What do you think will happen to the organs if these tissues were injured or diseased?

Q13. If these tissues were injured or diseased, what do you think will happen to the organ systems?

Q14. If these tissues were injured or diseased, what do you think will happen to the organism?

Plants are also made up of organ systems: the root and shoot systems. The root system absorbs water and nutrients; the shoot system moves them to the different parts of the plant.

Photo: Courtesy of Michael Anthony B. Mantala

Figure 7. An orchid showing shoot and root systems

Q15. In what ways are the functions of the organ systems of plants similar to those of animals?

Q16. In what ways are they different?

Figure 8 shows a picture of a flower. Flowers are the reproductive organs of plants. Together with the leaves and the stems, they make up the shoot system.

Photo: Courtesy of Michael Anthony B. Mantala

Figure 8. A Gumamela (Hibiscus) flower

Q17. In what ways are flowers similar to the reproductive organs of animals?

Q18. In what ways are they different?

Q19. How do the flowers, leaves, and stems help plants meet their basic needs?

Q20. What do think will happen to the plant if any of the parts that make up the shoot system were injured or diseased?

Figure 9 shows a picture of the roots of a tree. What parts do you think make up these roots?

Q21. Aside from absorbing water and nutrients, what other functions do the roots serve?

Photo: Courtesy of Michael Anthony B. Mantala

Figure 9. Roots of a tree

Figure 10 shows a model of a section of a root tip. When you get a small section of a root tip and view it under a microscope, you will see that it is made up of many layers of tissues. You will also see that these tissues are composed of similar cells that are arranged and grouped together to perform specific functions.

Q22. What do you think will happen to the roots if the tissues that make them up were injured or diseased?

Q23. If the roots were injured or diseased, what do you think will happen to the plant?

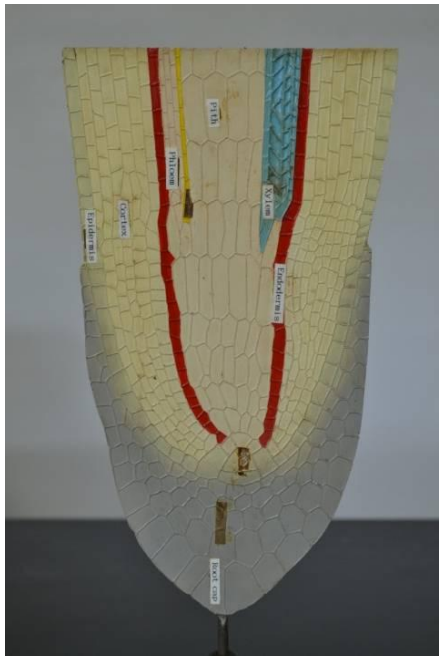


Photo: Courtesy of Michael Anthony B. Mantala
Biology Laboratory, UP NISMED

Figure 10. A model of a section of a root tip showing different plant tissues

Take a closer look at the models of animal and plant cells in Figure 11. Cells are the basic units of structure and function of all organisms. These cells are grouped together to form more complex structures: tissues, organs, and organs systems.

Animals and plants are very different organisms and yet, they are both made up of parts that are organized similarly.

Photo: Courtesy of Michael Anthony B. Mantala, Biology Laboratory, UP NISMED

Figure 11. Models of animal and plant cells

Q24. What do you think will happen to the tissues, organs, and organ systems if these cells were injured or diseased?

Q25. If the tissues, organs, and organ systems were injured or diseased, what do you think will happen to the organism?

Activity 2

Levels of organization in an organism

Objectives

In this activity, you should be able to:

1. identify the different levels of organization in an organism,
2. describe the parts that make up each level of organization and their functions, and
3. describe how the parts that make up a level of organization affect the higher levels of organization and the entire organism.

Materials Needed

- Writing materials
- Posters and pictures of organisms, organ systems, organs, tissues, and cells

Procedure

1. From the interviews you have made in Activity 1 and the articles you have read about certain diseases that affect the heart, kidneys, and the other parts of the body, complete the table on page 8. You may use Manila paper if the spaces provided in the table are not enough.

2. On the topmost row write a disease, which you have read about or learned from your interview, that affects parts of the human body.

3. In each of the boxes that correspond to the levels of organization, describe how the disease affects the parts that make up each level.

4. Opposite each level of organization, cut and paste pictures (you may use the pictures that come with the articles) that show how the disease affects the parts that make up the different levels. Another option is to show it through drawing.

Table. Diseases and their effects on the levels of organization in an organism

Disease:	
How does the disease affect each of the following levels of organization?	**Pictures/Drawings**
Organism	
Organ System	
Organ	
Tissue	
Cell	

After learning the different levels of organization in organisms, can you think of levels of organization that are bigger than the organism?

Putting them all up together…

Plants are organisms...

Photo: Courtesy of Michael Anthony B. Mantala

Humans and animals are organisms...

Photo: Courtesy of Michael Anthony B. Mantala

Plants are made up of organ systems...

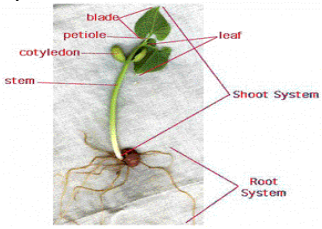


Photo: http://www.emc.maricopa.edu/faculty/farabee/biobk/bean_whole_morphology.gif

Humans and animals are made up of organ systems...

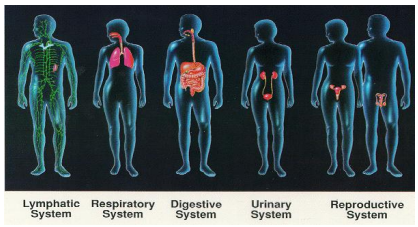
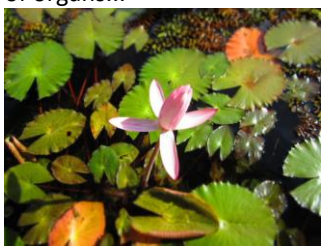


Photo: http://aarcaro.files.wordpress.com/2011/01/dwa5-organ-systems2.gif

Organ systems are made up of organs...



Organ systems are made up of organs...

Photo: http://aarcaro.files.wordpress.com/2011/01/dwa5-organ-systems2.gif

Organs are made up of tissues...

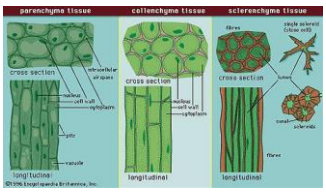


Photo: http://www.tantebazar.com/imgx/simple_plant_tissues.jpg

Organs are made up of tissues...

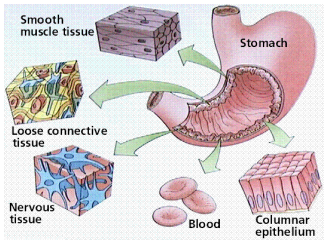


Photo: http://www.emc.maricopa.edu/faculty/farabee/biobk/stomTS.gif

Tissues are made up of cells... All organisms are made up of cells.

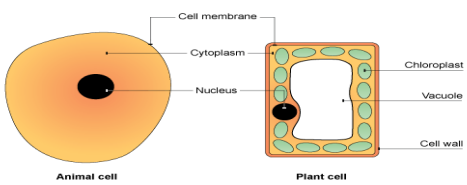


Photo: http://www.bbc.co.uk/ks3bitesize/science/images/

Reading Materials/Links/Websites

Bright Hub Education. (2009). Science Lesson Plan: Biological Organization. Middle School Science Lessons. Retrieved January 16 2012 from http://www.brighthubeducation.com/

Education. (2003). The Pyramid of Life (Levels of Biological Organization). Biology Demystified: A Self-Teaching Guide. Retrieved January 16, 2012 from http://www.education.com/

Scitable by Nature Education. (2008). Biological Complexity and Integrative Levels of Organization. Scitable Topicpage. Retrieved February 7, 2012 from http://www.nature.com/scitable

Suggested time allotment: 4 to 5 hours

MODULE 2

PLANT and ANIMAL CELLS

Overview

All organisms, big or small consist of **cells**. Some organisms are single-celled, composed of only one cell. Others are multicellular, possessing many cells that work together to form an organism. The moss plant for example, may be made up of hundreds or thousands cells. Your body has billions of cells while very large animals like elephants have trillions.

Most cells are so small that they can only be seen using the **microscope**. It is a special equipment to make small objects like cells look bigger. One kind of microscope used to study cells is called a **light microscope**. Light microscopes use diffused or artificial light to illuminate the object to be observed. From the simplest to the most powerful and sophisticated microscopes, scientists were able to gather information about cells. What you will see and learn about cells later have been revealed by microscopes. If your school has microscope, your teacher will teach you how to use it through activities you will perform.

In this module you will study plant and animal cells, their parts and functions.

Are all cells the same?
If not, in what ways are they different?

Cell Parts

Use the illustrations that follow to learn about parts of plant and animal cells.

Activity 1
Comparing plant and animal cells

Objectives

After doing this activity, you should be able to:

1. identify parts of the cell;
2. describe plant and animal cells;
3. differentiate plant cells from animal cells;
4. construct a Venn Diagram to show parts that are common to both and parts that are only found in either plant or animal cells.

Materials Needed

- sheet of paper
- ballpen or pencil
- Illustrations in Figures 1 and 2

Procedure

1. Study closely Figures 1 and 2. These are diagrammatic presentations of plant and animal cells and their parts.

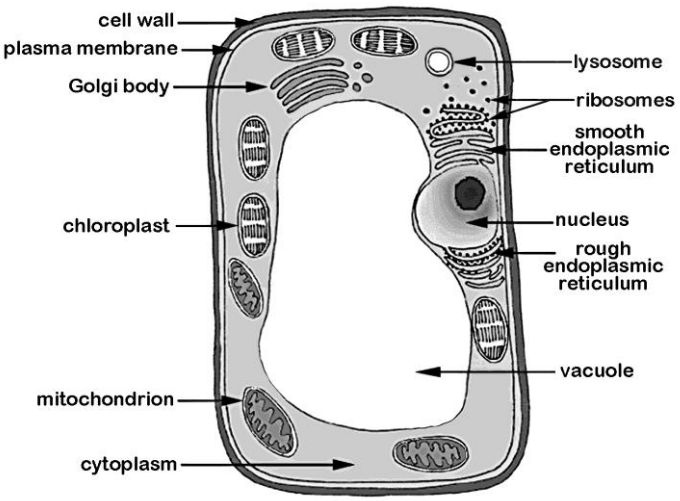


Figure 1. Parts of a plant cell

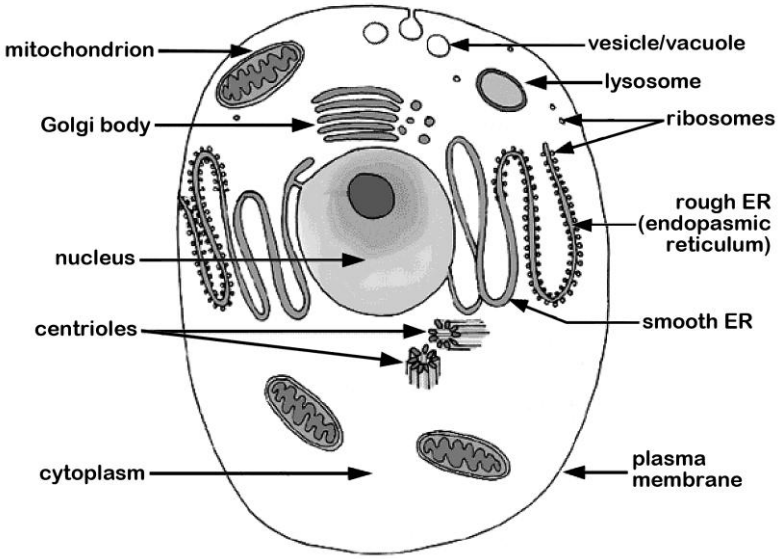


Figure 2. Parts of an animal cell

Q1. Compare the shape of a plant cell with that of an animal cell as shown in Figures 1 and 2.

Q2. Which cell parts are found in both cells?

Q3. Which are present only in animal cells?

Q4. Which are present only in plant cells?

A Venn Diagram shows relationships between and among sets or groups of objects that have something in common. It uses two circles that overlap with one another. The common things are found in the overlapping area, while the differences are in the non-overlapping areas.

2. Using the information you have gathered from Figures 1 and 2, construct a Venn diagram of plant and animal cells on a sheet of paper. Label the overlapping and non-overlapping areas.

3. Present and explain your Venn diagram to class.

Q5. Based on your observations and study of plant and animal cells, cite differences and similarities between them.

A cell has three basic parts: the nucleus, plasma membrane and cytoplasm. The **nucleus** is a part of cells which is easily seen. It is very important because it controls all the activities of the other parts that occur within the cell. The nucleus contains materials that play a role in heredity. You will discuss about these materials in the later modules and grade levels.

The **plasma membrane** encloses the cell and separates what is inside it from its environment. It also controls what goes into and out of the cell. The plasma membrane allows entry of materials needed by the cell and eliminates those which are not needed.

Q6. What do you think will happen to the cell if the plasma membrane does not function properly?

The **cytoplasm** consists of a jelly-like substance where all the other parts of the cell are located. It does not however, include the area where the nucleus is located. Many different activities of the cell occur in the cytoplasm.

You have seen that plant cells have **cell walls** and **chloroplasts** that are not found in animal cells. The cell wall is made of stiff material that forms the outermost part of plant cells. This gives shape and protection to them.

Recall in your elementary grades that plants make their own food. Chloroplasts are important in plant cells because it is where food is made. It contains chlorophyll which absorbs energy from the sun to make food for plants.

Q7. What is the purpose of the cell wall in plants?

Q8. Look at Fig. 1 again. Why are there several chloroplasts in the plant cell?

Vacuoles are present in both plant and animal cells. In plant cells, they are large and usually occupy more than half of the cell space. They play a role in storing nutrients and increasing cell size during growth. Some plant vacuoles contain poisonous substances. Vacuoles also store water, thereby maintaining rigidity to cells and provide support for plants to stand upright. Plant cell vacuoles are responsible for the crisp appearance of fresh vegetables.

Vacuoles in animal cells are small and are called **vesicles**. They serve as storage of water and food and also function in the excretion of waste materials.

Q9. How would vacuoles in plants serve as defense against animals that eat them?

You have observed that **centrioles** are only found in animal cells. These have a role in cell reproduction which you will take up in the higher grade levels.

You have been introduced to the basic parts of plant and animal cells. For functions of the mitochondrion, golgi body, endoplasmic reticulum (rough and smooth), lysosomes and ribosomes which are not discussed here, you will come to know about them in the other grade level modules.

If you have a microscope you can also study plant cells by doing the next activity. Read and do the activities in the section on "How to Use The Light Microscope" before performing Activity 2.

Activity 2

Investigating plant cells

Objectives

In this activity, you should be able to:

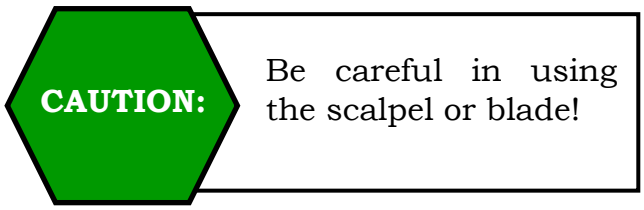
1. prepare a wet mount;
2. describe a plant cell observed under the light microscope;
3. stain plant cells;
4. identify observable parts of a plant cell;
5. draw onion cells as seen through the light microscope; and
6. explain the role of microscopes in cell study.

Materials Needed

dropper	tissue paper
cover slip	iodine solution
glass slide	light microscope
onion bulb scale	forceps or tweezers
scalpel or sharp blade	50-mL beaker with tap water

Procedure

1. Prepare the onion scale by following steps indicated in Figure 3. Use the transparent skin from the inner surface of the onion scale.



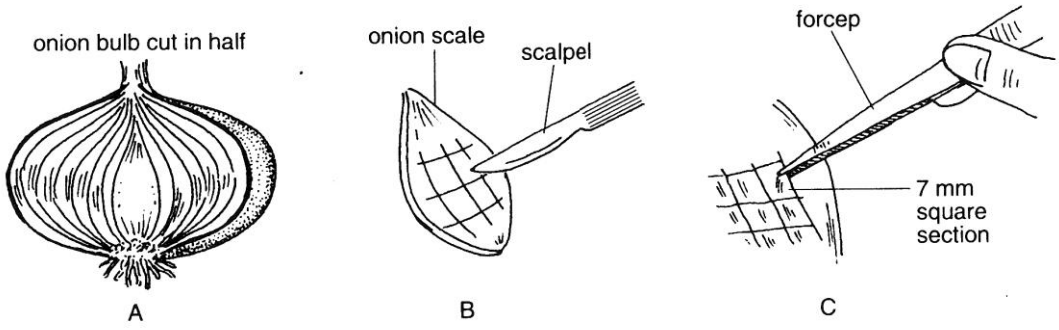


Figure 3. Preparing onion scale for microscopic study (Source: University of the Philippines. Institute for Science and Mathematics Education Development (2000). Sourcebook on practical work for teacher trainers: High School biology (vol. 2). Quezon City: Science and Mathematics Education Manpower Project (SMEMDP). p.164)

2. Following the procedure on how to make a wet mount described in "How to Use The Light Microscope", prepare one using the transparent onion skin from Step 1. Remember to place it on the glass slide with the inner surface (non-waxy side) facing up. Check too that the onion skin is not folded or wrinkled.

3. Examine the onion skin slide under the low power objective (LPO).

CAUTION: Do not tilt the microscope!

Q10. How much are these onion cells magnified?

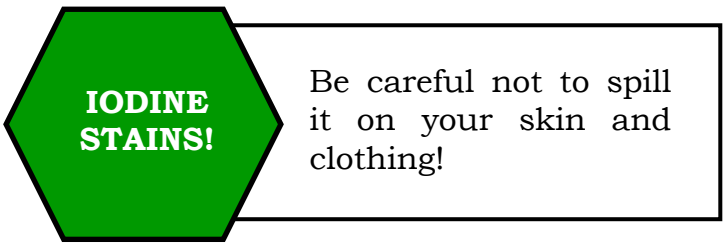
Q11. In this case, why is it not good to tilt the microscope?

4. Shift to the high power objective (HPO).

REMEMBER: Raise the objectives a little and look to the side while changing objectives!

Q12. Describe the onion cells.

5. Remove the slide from the stage. You can now stain the onion cells with iodine solution.



6. Using a dropper, place one or two drops of iodine solution along one edge of the cover slip. Place a piece of tissue paper on the other edge of the cover slip. The tissue paper will absorb the water, and iodine solution spreads out under the cover slip until the whole specimen is covered with stain (Figure 4).

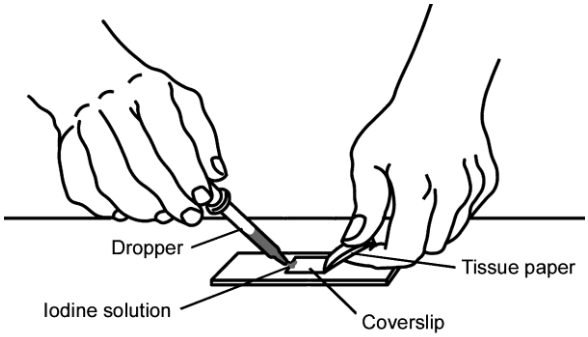


Figure 4. Staining onion cells (Source: Philippines. Department of Education. (2009). Science and Technology II. Textbook (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 23.

7. Examine the stained onion cells under the LPO and HPO.

Q13. Did you observe any change in the image of onion cells before and after staining?

Q14. How did the iodine solution affect the image of the onion cells?

Q15. What parts of the onion cell can you identify?

8. Draw three to four onion cells as seen under the HPO. Label the parts you have identified. Indicate how much the cells are magnified.

Q16. Of what importance is the contribution of the microscope in the study of cells?

You have learned that the cell makes up all organisms. And that organisms can be made up of just one cell or billions of cells. The module also introduced you to the microscope which has contributed to the valuable information about cell structure and function.

You also found out about the fundamental parts of the cell which are the nucleus, plasma membrane and cytoplasm. These parts play very important roles in the survival of cells.

Specifically, Activity 1 showed you the similarities and differences in parts of plant and animal cells and the functions of these parts. Other than the three parts first mentioned, the mitochondrion, rough and smooth endoplasmic reticulum, Golgi body, vacuole/vesicle, ribosomes and lysosome are common to them. In fact, these are also present in fungi and protists which you will study in the next module. You have observed in the illustrations that plant cells have a cell wall, and chloroplasts which are not found in animal cells. These have something to do with the nature of plants having tough stems and their being able to produce their own food. On the other hand, animal cells have centrioles which are not found in plant cells. You have seen too the rectangular shape of plant cells as compared to the more or less rounded one in animal cells shown in the illustrations you have studied. You will know and see more of the other shapes of plant and animal cells in the next grade levels.

The second activity was a good opportunity for you to have observed real plant cells using the light microscope. The use of stains in studying cells has made cell parts more easy to find, observe and identify.

Suggested time allotment: 2 to 3 hours

HOW TO USE THE LIGHT MICROSCOPE

If your school has microscopes read this section and perform the following activities.

The microscope is a tool which can help you see tiny objects and living organisms. It makes them look bigger. This ability of the microscope is called its **magnifying power** or **magnification**. The microscope also has the capacity to distinguish small gaps between two separate points which humans cannot distinguish. It is called its **resolving power** or **resolution**.

The light microscope uses diffused light from the sun or artificial light to illuminate the object to be observed. From its source, visible light passes through the small or thin specimen to be observed through the glass lenses. As light passes through the lenses, it is bent so specimen appears bigger when it is projected to the eye. The form and structure of the specimen can then be seen because some of their parts reflect light.

This section will introduce you to the parts of the light microscope and their functions. More importantly, it will teach you how to use it properly for successful cell study and other investigations.

What are the parts of the microscope and how does each part function?

How do you use the microscope?

Objectives

After performing this activity, you should be able to:

1. handle the microscope properly;
2. identify the parts of the microscope;
3. describe what parts of the microscope can do;
4. prepare materials for microscope study;
5. focus the microscope properly;
6. compare the image of the object seen by the unaided eye and under the microscope; and

7. compute for the magnification of objects observed under the microscope.

Materials Needed

- lens paper
- light microscope
- tissue paper or old t-shirt
- newspaper page
- glass slide and cover slips
- pencil
- dropper
- scissors
- tap water
- forceps or tweezer

Procedure

A. The Microscope, Its Parts and their Functions

1. Get the microscope from its box or the cabinet. Do this by grasping the curved **arm** with one hand and supporting the **base** with the other hand.

2. Carry it to your table or working place. Remember to always use both hands when carrying the microscope.

3. Put the microscope down gently on the laboratory table with its arm facing you. Place it about 7 centimeters away from the edge of the table.

4. Wipe with tissue paper or old t-shirt the metal parts of the microscope.

Q1. What are the functions of the base and the arm of the microscope?

5. Figure 1 shows a light microscope that most schools have. Study and use this to locate different parts of the microscope.

6. Look for the **revolving nosepiece**. Note that **objectives** are attached it. You should know that there are lenses inside the objectives.

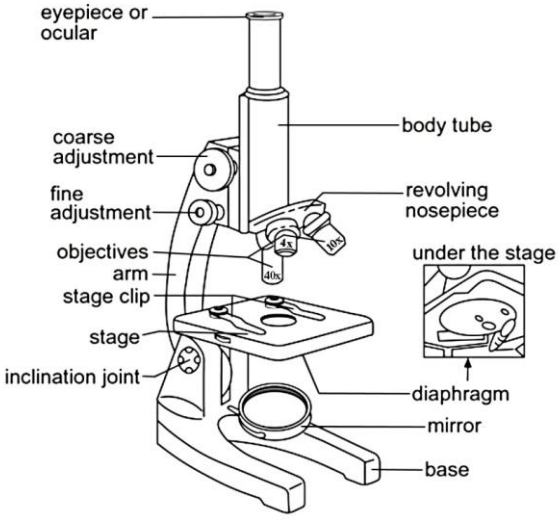


Figure 1. The light microscopes and its parts

Q2. What have you observed about the objectives?

Most schools have light microscopes with three objectives. Others have four. Usually, the shortest one marked 3x, 4x or 5x is called the **scanner**. The **low power objective** (LPO) is marked 10x or 12x while the **high power objective** (HPO) is marked 40x, 43x or 60x. The objectives magnify the object to be observed to a certain size as indicated by the 3x, 10x or 40x, etc. marks.

If the longest objective of your microscope is marked 97x or 100x or OIO or the word "oil" on it, then it has an **oil immersion objective** (OIO). This objective is used to view bacteria, very small protists and fungi. The OIO requires the use of a special oil such as quality cedarwood oil or cargille's immersion oil.

7. Find the **coarse adjustment**. Slowly turn it upwards, then downwards.

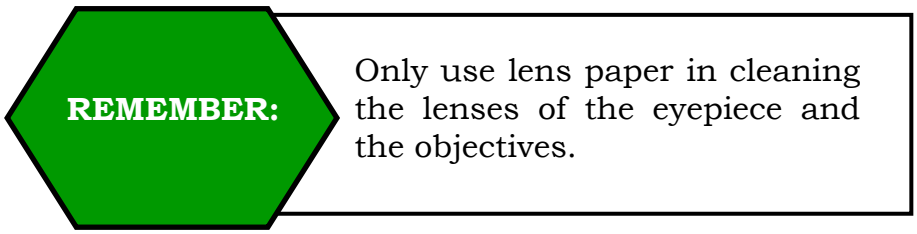
Q3. What is accomplished by turning the coarse adjustment upwards? downwards?

8. Looking from the side of the microscope, raise the **body tube**. Then, turn the revolving nosepiece in any direction until the LPO is back in position. You will know an objective is in position when it clicks. Note that the revolving nosepiece makes possible the changing from one objective to another.

Q4. What is the other function of the revolving nosepiece?

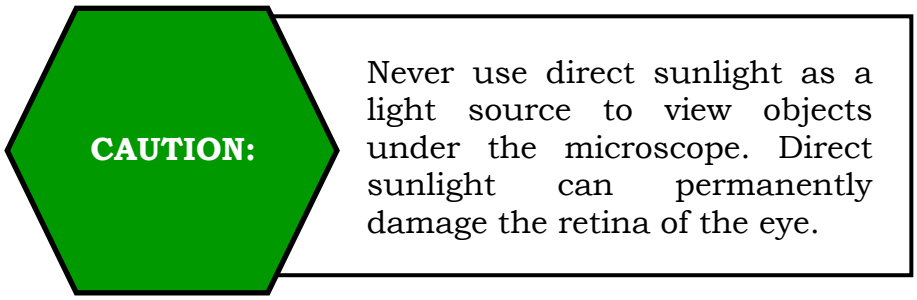
Q5. Which part connects the eyepiece to the revolving nosepiece with the objectives?

9. Locate the **eyepiece**. Notice also that it is marked with a number and an x. Know that the eyepiece further magnifies the image of the object that has been magnified by the objective. If the eyepiece is cloudy or dusty, wipe it gently with a piece of lens paper.



10. Look through the eyepiece. Do you see anything?

11. Now, locate the **mirror**. Then, position the microscope towards diffused light from the windows or ceiling light. Look through the eyepiece and with the concave mirror (with depression) facing up, move it until you see a bright circle of light.



The bright circle of light is called the **field of view** of the microscope. Adjust the position of the mirror so that it is not glaring to the eyes. Practice viewing through the microscope using both eyes open. This will reduce eyestrain.

Q6. What are the two functions of the eyepiece?

Q7. Describe the function of the mirror.

12. Locate the **diaphragm**. While looking into the eyepiece, rotate the diaphragm to the next opening. Continue to do so until the original opening you used is back under the hole in the stage.

Q8. What do you notice as you change the diaphragm openings?

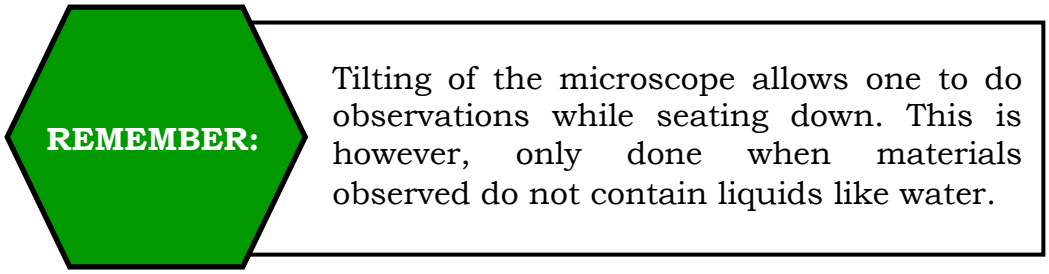
Q9. What can you infer as to the function of the diaphragm?

13. Find the **inclination joint**.

Q10. What parts of the microscope are being connected by the inclination joint?

14. Grasp the arm and slowly pull it towards you. Sit down and try looking through the eyepiece.

Q11. What does this movement do?



B. Making a Wet Mount

A **specimen** is a part or sample of any material e.g. plant, animal, paper or mineral, for study or examination under the microscope. Specimens should be small and thin for light to pass through them.

15. Cut out a small letter "e" from a newspaper page. Using forceps or tweezers place it in the center of a glass slide in an upright position.

Q12. What makes the letter "e" suitable for observation under the microscope?

16. Add a drop of tap water over the specimen. It will act as a mounting medium and make clear the image of the specimen. Position the cover slip at 45° with one side touching one edge of the water on the slide (Figure 2).

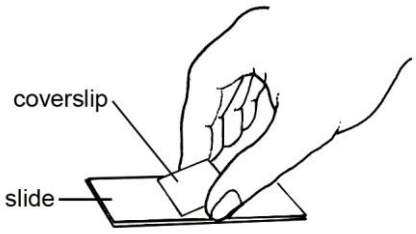


Figure 2. Making a wet mount

17. Slowly lower the other edge of the cover slip until it rests on the water and the printed letter. Bubbles are perfect circles you see on your preparation. Remove or minimize trapped bubbles by gently tapping the cover slip with the eraser-end of a pencil. Make the bubble move towards the edge of the cover slip.

C. Observing Specimens

18. Put the slide on the stage. Make sure that the letter is in the center of the hole in the stage and under the LPO. Hold it firmly with the stage clips.

19. Watching from the side, carefully lower the body tube until the end of the LPO almost touches the cover slip.

20. Look through the eyepiece. Slowly turn the coarse adjustment upwards to raise the objective until the letter "e" appears. Continue until you see the letter clearly. This would indicate that you have focused it already.

Q13. Describe the position of the letter as seen under the microscope.

Q14. Compare the image of the letter that you see using your unaided eye with what you see through the microscope.

21. Look through the microscope again. Slowly move the slide to the right, then to the left.

Q15. To which direction does the image move?

22. Move the slide to the center. To shift to the HPO, raise the body tube first. Looking from the side, turn the revolving nosepiece to put the HPO in place. Then, using the fine adjustment slowly lower the objective till it almost touches the cover slip. Looking through the eyepiece, turn the fine adjustment until you see the clearest image.

Q16. Why do you have to watch from the side when changing objectives?

Q17. Why should the fine adjustment knob be used only with the HPO?

Current microscope models are said to be **parfocal**. This means the image in clear focus under the low power objective, remains focused after shifting to HPO. If the microscope you are using is not parfocal, slightly turn the fine adjustment knob in either direction to get a clear picture.

23. Look through the eyepiece again. Then, shift to the LPO, and the scanner. Observe closely the image of the letter.

Q18. In which objective/s can you see the whole letter "e"?

Q19. What are the advantages of using the HPO? the disadvantages?

Q20. In which objective is the light darker? brighter?

D. Magnifying Power of the Light Microscope

Can you recall the functions of the objectives and the eyepiece?

The magnification of a specimen can be calculated by multiplying the number found in the eyepiece with the number found on the objective being used. So, if a specimen is viewed using a 10x objective and a 10x eyepiece it will be magnified 100 times.

24. Examine the numbers indicated on the eyepiece and scanner.

Q21. How much is the letter "e" you are now viewing under the scanner magnified? under the LPO? Under the HPO?

Q22. If a cell being observed has been magnified 200x under the HPO, what is the magnifying power of the eyepiece used?

Q23. In what ways would the microscope contribute to the study of different objects and organisms?

25. After using the microscope, lift the stage clips to remove the slide from the stage. Wash and wipe or air dry the slide and cover slip. Keep them in their proper places. Dispose trash or other materials properly.

You have just familiarized yourself with the light microscope, its parts and their functions. Similarly, you have practiced using it.

After every use of the microscope, prepare it for storage following these steps:

1. Turn the revolving nosepiece until the LPO is in place.

2. Lower down the body tube so that the end of the objective is approximately 1 cm above the stage.

3. Position the clips so that they do not extend beyond the sides of the stage.

4. Rotate the diaphragm until the smallest opening is in position.

5. Let the mirror stand on its edge with the concave side facing the user to protect it from dust.

6. Some microscope boxes have a socket for the eyepiece. In this case, remove the eyepiece from the body tube and place it in the socket.

7. Put back the microscope's plastic cover. If the original plastic cover has been lost or destroyed, use any clean plastic bag big enough to cover the microscope.

8. Carry the microscope as described in Step 1 of Procedure A. Put it back in its case or storage cabinet or return it to your teacher.

Knowledge about objects and organisms revealed by the microscope is of great value not only to students like you but also to everyone who wish to study and understand life. It is but important for you to know how to take care of this tool for an efficient and longer use. Here are some practices to achieve this:

1. Check the microscope before and after use. Report any missing or damaged part to your teacher.

2. Use a clean tissue paper or soft cloth like old t-shirt to clean the mechanical parts of the microscope.

3. Prevent liquids, especially acids and alcohol from spilling on any part of the microscope. Always use a cover slip in observing wet mounts.

4. Check for moisture (such as from condensation of human breath) in the eyepiece. This may happen due to prolonged observation of specimens. Wipe with lens paper.

5. Avoid tilting the microscope while observing wet mounts. Water might flow into the mechanical parts of the microscope causing them to rust. Select a chair with suitable height so that both forearms can be rested on the table during observation.

6. Never store the microscopes in a chemical laboratory or any place where there are corrosive fumes. Make sure there are silica get packs inside microscope boxes or storage cabinet to absorb moisture.

The microscope has become an important investigative tool in studying objects and organisms around you. Knowing its parts as well as proper manipulation and care will make your study of science effective, interesting and more meaningful.

Reading Materials/Links/Websites

Hwa, K. S., Sao-Ee, G., & Luan, K. S. (2010). My *pals are here! 6A science*. (International Ed.). Singapore: Marshall Cavendish.

Miller, K. R., & Levine, L. (2006). *Prentice Hall biology*. Upper Saddle River, NJ: Pearson.

Philippines. Department of Education. (2009). *Science and Technology II textbook*. (Rev. ed.). Pasig City: Instructional Materials Development Corporation.

Reyes, V.F., & Alfonso, L. G. (1979). *The microscope: Part 1*. Manila: Alemar-Phoenix Publishing House.

http://www.cellsalive.com/cells/cell_model.htm

www.microscope-microscope.org/activities/school/microscope-use.htm

www.biologycorner.com/bio1/microscope.html

Suggested time allotment: 4 hours

MODULE 3 LIVING THINGS OTHER THAN PLANTS AND ANIMALS

Overview

In this module, you will start examining life forms other than the plants and animals you studied in Grades 3 through 6. You will begin with the macroscopic forms or parts that you can see and move to the barely noticeable ones, using a magnifying lens. **If** your school has a microscope, you can observe the truly microscopic forms as well. These cannot be seen by the naked eye, not even through magnifying lenses.

These life forms are in the soil, water and air all around us. They are on our body and inside it, on the food we eat and the things we use. Many are useful to humans while some are harmful and may cause disease. In studying them, we develop inquiry skills and use a powerful observation device, the microscope, **if this is** available.

You and your classmates will perform two hands-on activities in this module, which entail observing, recording, communicating by drawing and writing, going out in the school grounds to collect specimens, inferring and answering questions.

In so doing, you expand your knowledge about the living world and appreciate the diversity in life forms.

What are the other living things besides plants and animals?
Which are useful to us? Which are harmful?

Activity 1

Are these also plants?

Objectives

In this activity, you will:

1. Observe life forms other than those you studied from Grades 3 through 6,
2. Use a magnifying lens to observe them,
3. Share what you know about these life forms with classmates and groupmates,
3. Compare them with known living things studied in Grades 3 to 6.

Materials Needed

- Live specimens from teacher
- Magnifying lens

Procedure

1. Look* at the live specimen shown by your teacher which is like the photo below:

Q1. Is it a plant? _____

Q2. What is its name?
_____

Q3. What is the reason for your answer in Q1? _____
_____

Photo by A. Encarnacion 2012

***Warning:** **Do not touch the specimen with your bare hands, taste or smell it, especially those of you who have known allergies and if the specimen is not eaten. It may be poisonous.**

2. Look at the second live specimen your teacher will show you. It is similar to the photo below:

Rotor, A.V. (2010) http://avrotor.blogspot.com/2010/03
downloaded 12 March 2012.

Q4. Is it a plant? _____

Q5. What is its name? _____

Q6. What is your reason for your answer in Q4? _____
_____

3. Compare the two specimens shown by your teacher.

Q7. How are they different? _____

Q8. How are they alike? _____

Q9. Do you know of other living things like the two above? _____.
If so, describe these living things. _____

Q10. How did you know about them? _____

Q11. Write their names if you know them. _____

4. Observe the third specimen to be shown by your teacher. She will show you something like this photo grabbed from an internet source.

http://www.treeboss.net/tree-trunk-splotches.htm
downloaded 21 March 2012

Q12. What do you think it is? _____

Q13. Is it a plant? _____

Q14. Give a reason for your answer in Q13._____
_____

5. Observe these three other things your teacher prepared for you to observe:

a. b. Or, c.

And, d.

Photo credits: potato by A. Encarnacion, old banana peeling and bread by R. Reyes, and http://www.hawaii.edu/reefalgae/invasive_algae/chloro/enteromorpha_flexuosa.htm downloaded 12 March 2012 for the "green stuff."

Warning: Do not touch (a), (b), or (c) with your bare hands. Do not smell or taste them either. Some sensitive individuals may be allergic to them.

6. Describe what you see in each (a) and (b) or (c).

Q15. (a) _____

Q16. (b or c) _____

7. Describe (d).

Q17. (d) _____

8. What do you think the growths on (a), and (b) or (c) are?

Q18. (a) _____ Q19. (b) or (c) _____

9. How about (d), what do you think it is?

Q20. _____

10. Discuss your answers with your classmates and teacher in class.

_____

What you saw are also living things. There are living things or organisms that cannot be readily identified by the usual parts of plants we recognize like roots, stems, leaves, flowers, or fruits though they may have the green color and some plant-like parts. There are also living things that we can see only when we use magnifying lenses. Tomorrow, we will go out and look for more of these kinds of living things which are not like the plants we learned about in the lower grades. Bring plastic gloves, and plastic bags at least one each.

Activity 2

What other living things are found in the school grounds?

Objectives

In this activity, you will:

1. Hunt for life forms that are doubtfully plants,
2. Collect specimens of these life forms,
3. Observe these life forms using a magnifying lens,
4. Describe/draw them,

5. Describe their habitats,
6. Infer their needs,
7. Compare with others observed in the previous activity, and
8. Group together those that have similarities.

Materials Needed

- Clear plastic bag
- Plastic gloves
- Forceps, tweezers or tongs
- Magnifying lens

Procedure

1. Bring the first three materials listed when you go out into the school grounds. Look for other things that are plant-like in the school grounds. Your teacher will suggest where to go and what to collect.

2. Go back to the classroom and observe what you collected with a magnifying lens.

Q1. Describe what you see. Draw it.

Q2. Describe the place where you found it. _____

Q3. What do you think it needs to live and grow? _____
_____

Q4. Does it look like any of the organisms you saw yesterday? _____
If so, which one? _____

3. Find out from your teacher the names of all the living things you observed in Activities 1 and 2.

Q5. How are they different from the living things you already know about and studied in the lower grades?

For your homework, find out from reference books and the internet under which big groups the living things you studied belong. Find out the other members of these groups, the characteristics they exhibit, their uses to humans, as well as negative effects. Put the information you collected in a table like the one below:

Name of organism	**Big group/ Other Examples**	**Characteristics**	**Uses/ Benefits**	**Harmful Effects**

What are the similarities among these groups? _____
_____

How are they different from each other? _____
_____

How are these big groups different from the groups of animals and plants studied in Grades 3-6? _____
_____

Discuss in class, with your classmates and teacher, the beneficial and harmful effects of members of these groups.

What you studied in this module are the big groups of Fungi, Algae and Bacteria which are different from the two big groups of Animals and Plants studied in Grades 3-6. You did not study many other members of these groups however. There are many more interesting members of these groups which you will learn about in the higher grades. Together, these three groups plus the groups of plants and animals studied in the previous grades make up the living world.

We are a part of this living world. We have to learn to live with different kinds of living things. Ensuring the survival of other kinds also ensures our own survival.

If your school has a microscope, you can do Activity 3.
It is an OPTIONAL activity.

Activity 3

What do these living things look like under the microscope?

Objectives

In this activity, you will:

1. Prepare slides of the growths on old banana peeling, and/or bread mold, *lumot,* and the bacterial colony you saw in Activities 1 and 2,

2. Observe these living things using a microscope,

3. Draw and describe these living things,

4. Be able to label the parts and describe the function of these parts based on reference photographs or drawings and library/internet research.

Materials Needed

- Slides and cover slips
- Dissecting needles (may be improvised)
- Dropper
- Cotton, gauze or clean absorbent cloth
- Clean water

Procedure

1. Get a small part of the white, cottony growth on the decomposing banana.

2. Spread it with a needle until only a thin layer is on the middle of the glass slide.

3. With the dropper, wet the spot with a drop of water.

4. Cover with the cover slip by putting down one side first and gently laying down the cover slip until it is flat over the specimen.

5. Place it on the microscope stage just under the low power objective (LPO).

Q1. Draw what you see.

6. Focus until clear, then shift to the high power objective (HPO).

Q2. Draw what you see.

Q3. Describe what you see under the LPO and HPO.

Q4. Label the parts based on a reference photo or drawing your teacher shows you.

7. Do the same for the growth on the bread, *lumot*, and Z on the potato.

8. Discuss your findings with your teacher and classmates.

Suggested time allotment: 5 to 6 hours

MODULE 4 REPRODUCTION: THE CONTINUITY OF LIFE

Overview

The beginning of a new life is truly a remarkable event. The sight of a chick making its way out of the cracked shell or a germinating seed slowly pushing through the soil can leave one fascinated. The ability of an organism to produce new individuals is one of the characteristics that distinguishes living things from nonliving things. This ability is called reproduction.

In the previous modules, you have already begun to explore the diversity of organisms. These organisms bring about the continuation of their own kind through reproduction. And although these organisms have different methods of reproduction, every method leads to the beginning of a new life.

This module will discuss the different modes of reproduction in representative plants, animals, and microorganisms. Investigations are included in this module to help you understand the different ways that organisms reproduce and differentiate the offspring resulting from each mode of reproduction.

What are the different modes of reproduction?
How can we use this knowledge in growing plants?

MODES OF REPRODUCTION

In order to continue their own kind, organisms must reproduce. Organisms may reproduce either asexually or sexually.

I. Asexual Reproduction

There are several ways by which organisms reproduce asexually. In the following activity, let us examine how potatoes reproduce.

Activity 1
Can you grow new plants from "eyes"?

A potato tuber is a specialized stem which functions as a food storage organ. Let us investigate how tubers can be used in growing new plants.

Objectives

After you have performed this activity, you should be able to:

a) describe how potatoes reproduce.
b) explain what vegetative reproduction is.
c) describe the advantages of growing plants using vegetative reproduction.

Materials Needed

- 1 potato
- 5 big cans filled with garden soil
  (you may use big cans of powdered milk)
- Trowel
- Knife

Procedure

1. Examine the potato. Can you see depressions? These are the "eyes" or buds.

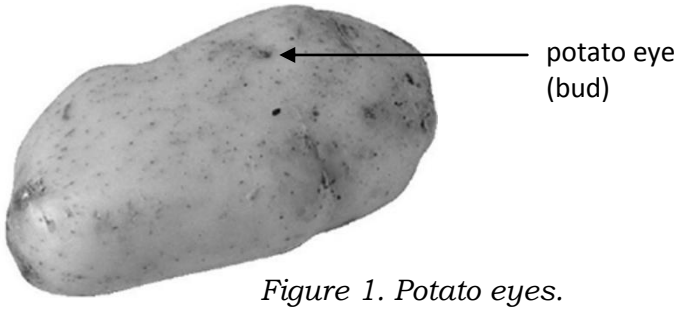


Figure 1. Potato eyes.

2. Cut the potato into pieces with each piece having an “eye”. Observe how the cut pieces look.

3. Set aside the cut pieces for 2-3 days. Draw and describe how the cut pieces look after 3 days.

4. After 3 days, plant each piece in a can, about 10-cm deep. Set the tuber so that the “eye” points upward.

Q1. Can you give a reason why it is better to plant the cut pieces with the “eye” pointing upward?

5. Set aside the cans in a shady area. Water the soil everyday to keep it moist.

Q2. How many “eyes” from each potato were you able to get?

Q3. How many new shoots grew from each potato “eye” you planted?

Q4. What is the advantage of using this type of propagation?

6. Report the progress of your work to your teacher. Discuss your work in class.

After this activity, you may transplant the potato plants in your school garden. You may harvest the potatoes within 10 weeks. Check how many potatoes you can harvest from one plant.

The activity that you have performed shows how potatoes are propagated vegetatively. From a single potato, several new potato plants can be produced. Potato “eyes” are axillary buds where shoots can emerge. **Vegetative reproduction** is a kind of **asexual reproduction** where a new individual, known as the offspring, is produced from a single parent.

Aside from potatoes, many economically important plants can be propagated vegetatively. The kalanchoe, a medicinal plant, can reproduce through its leaves (Figure 2). Plantlets can grow around the leaf margin.

Figure 2. Plantlets grow around the leaf margins of the Kalanchoe.

Do you know other examples of plants that can be propagated through vegetative reproduction?

In the lower grades, you have learned that during reproduction, certain traits are passed on from parent to offspring. These traits are in the form of codes contained in genes. Genes are found in chromosomes which are in turn located in the nucleus of cells.

In asexual reproduction, the parent and the resulting offspring have the same genes and this is the reason why they have the same traits. In other words, we can say that they are genetically identical.

Why do we use vegetative propagation to grow plants? Vegetative propagation results in plants that reach maturity faster than plants grown from seeds. Another good thing about vegetative propagation is that the same good agricultural traits such as taste, yield, and resistance to pests will be passed on from generation to generation. But one disadvantage is that the population might be wiped out if environmental conditions become unfavourable.

Let us now look at other types of asexual reproduction.

Activity 2

Can one become two?

While walking to school, have you noticed greenish growth on barks of trees or on slippery concrete walkways? What could this organism be? Let us observe closely what organism this might be.

Objectives

After you have performed this activity, you should be able to:

a) describe how *Protococcus* reproduce.

b) explain what fission is.

c) infer the characteristics of the offspring of *Protococcus*.

Materials Needed

- Scalpel or blade
- Microscope slide
- Cover slip
- Microscope
- Tap water in clean bottle
- Dropper

Procedure

Preparation for Activity

1. Look for barks of trees, stones, rocks, moist flower pots that have greenish growth.
2. Get the greenish growth by scraping the sides.
3. Soak the scrapings in water overnight to separate the soil particles and debris from the microorganisms.

Day 1

1. Put a small amount of scraping on a slide.
2. Add a drop of water.
3. With 2 dissecting needles, carefully tease or separate the scraping and mix it with the water.
4. Gently place a cover slip on the slide. Examine the scraping under the low power objective.

Look for a cell similar to the figure below.

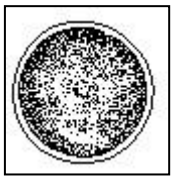


Figure 3. Protococcus is a round single-celled green alga.

5. Show your teacher the *Protococcus* cell that you have located.

6. *Protococcus* reproduces by dividing. Dividing cells are separated by a wall-like structure. Look for *Protococcus* cells that are dividing.

7. Shift to high power objective.

Q5. Draw the dividing *Protococcus* cells that you have identified.

This type of asexual reproduction is called **fission**. The cell divides to form two identical daughter cells. Each daughter cell continues to grow until it becomes as large as the parent cell.

Q6. Research on other examples of unicellular organisms that reproduce through fission.

Budding

Budding is another type of asexual reproduction. Yeast, hydra, and sponges reproduce this way. Figure 4 shows how yeast, a microorganism used in baking, reproduces by budding. In budding, a new individual may form as an outgrowth of the parent. The outgrowth separates from the parent and becomes a new individual.

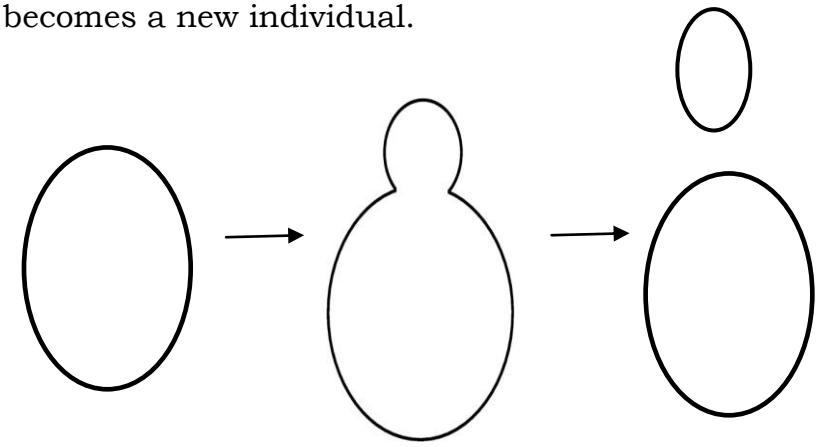


Figure 4. Budding in yeast.

Spore formation

Have you seen a piece of bread with mold growing on it? The black, round structure at the tip of a stalk is called a **spore case** which contains the spores. When the spore case opens, the tiny spores are released and may be carried by wind or water. Once the spore lands on a favourable environment, it develops into a new organism. Under the microscope, a bread mold with a spore case looks like the one in Figure 4.

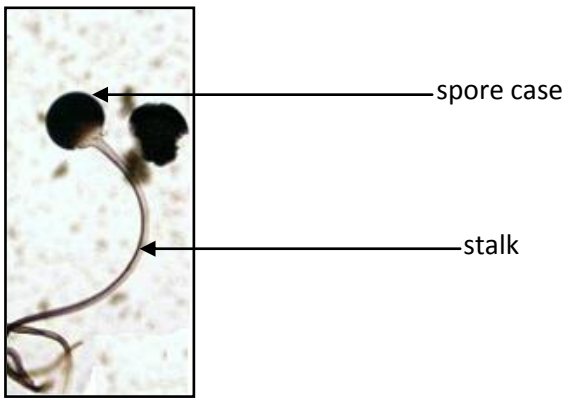


Figure 4. Bread mold spore case

Formation of spore is another type of asexual reproduction common among molds or fungi.

Regeneration

Animals can also reproduce by regeneration. Did you know that when a hydra is cut into several pieces, a process known as fragmentation, each piece can grow into another hydra? In certain types of starfish, an arm that breaks off from the body can develop into a new individual.

II. Sexual Reproduction

Sexual reproduction is a mode of reproduction that involves two parents. Parents produce reproductive cells called gametes through a type of cell division called meiosis. Meiosis will be discussed in detail in Grade 8.

Gametes from the two parents unite in a process called fertilization. The fertilized cell is referred to as a zygote which develops into a new organism.

Organisms reproduce sexually in a number of ways. Let us take a look at the different ways how representative microorganisms, plants, and animals reproduce sexually.

Conjugation

Some microorganisms undergo sexual reproduction by a process called conjugation. An example of a microorganism that reproduces by conjugation is *Spirogyra*, a green alga. *Spirogyra* can be found in freshwater habitats such as ponds and rivers.

During conjugation, a bridge forms between two cells of two *Spirogyra* filaments lying side by side. The contents of one cell pass into the other cell through the bridge, emptying the other cell. The contents of both cells combine in the other cell and form the zygote. This zygote is able to secrete a substance that forms a wall around itself for protection against unfavorable environmental conditions (e.g. when the pond dries up). When conditions become suitable for growth and development, the zygote grows into a new individual.

Sexual Reproduction in Flowering Plants

The flower is the reproductive organ in flowering plants. Flowers have structures that produce the gametes necessary for reproduction. Let us take a look at the parts of a gumamela flower.

Activity 3
Structure of a Gumamela flower

Objectives

After you have performed this activity, you should be able to:

a) distinguish the male and the female reproductive structures of a gumamela flower
b) describe the function of each structure in reproduction.

Materials Needed

- 2 gumamela flowers (1 fresh and 1 withered)
- 1 gumamela bud
- Hand lens
- Scalpel or Razor blade

Procedure

1. Examine the entire flower and the part of its stem.

Q6. Describe how the flower is attached to the stem.

2. Examine the bud, an unopened flower. Identify the sepals.

Q7. What is the function of the sepals in the unopened flower?

3. Remove the sepals and petals. The most important reproductive parts remain. Touch the stigma in a relatively fresh opened flower, in a bud and in a withered one.

Q8. On which flower does the stigma feel sticky?

Q9. Why do you think the stigma is sticky?

4. Cut through the ovary and examine the parts with a hand lens.

Q10. How many compartments do you find?

Inside the compartments are ovules which contain the egg cell (female gamete).

5. Touch the tip of a stamen or tap it lightly over a piece of white paper. The powdery materials at the tips are made up of pollen grains. Sperm cells (male gamete) are produced inside these grains.

6. Take a whole flower. Measure the distance between a pollen grain on a stamen and the ovary where the ovule is.

Q11. How do you think pollen grains reach the pistil?

Pollination brings together the gametes of a flower and it occurs when a pollen grain of the right kind lands on the stigma of the pistil. Each pollen forms a tube that grows down through the pistil and reaches the ovule in the ovary. One of the nuclei in the pollen tube unites with the egg nucleus in the ovule to form a zygote. The other sperm nucleus combines with another bigger nucleus in the ovule which develops into the endosperm.

Sexual Reproduction in Humans and Animals

Humans (and all animals that reproduce sexually) have cells called gametes. Gametes are formed during meiosis and come in the form of sperm (produced by males) or eggs (produced by females). When conditions are right, sperm and egg unite in a process known as fertilization. The resulting fertilized egg, or zygote, contains genes from both parents.

Comparison of Asexual and Sexual Reproduction

In asexual reproduction, a single organism is the sole parent and the offspring is genetically identical to the parent.

In sexual reproduction, two parents produce offspring that have unique combinations of genes. Offspring of sexual reproduction differ genetically from their siblings and both parents.

Summary

1. Organisms must reproduce to continue their own kind.

2. There are two major modes of reproduction: asexual and sexual reproduction.

3. Asexual reproduction gives rise to offspring that are identical to the parent.

4. Individuals that reproduce through sexual reproduction need two parents, a male and a female, that produce egg cell and sperm cell.

5. Sexual reproduction gives rise to offspring that are a combination of the traits from its parents.

Suggested time allotment: 8 hours

MODULE 5 INTERACTIONS

Overview

The environment is a collection of living and nonliving things. Mosses growing on rocks, garden snails gliding on garden fences, and fish swimming in water are just a few examples of how living and nonliving things interact. The living components of the environment are also called organisms. The nonliving components make up the physical environment of these organisms.

Organisms that belong to the same species and live in the same place form a population. The moss that grows on rocks makes up a population. Populations that live in the same place and interact with each other form a community; goats grazing on grass, chickens feeding on grains, and lizards preying on insects make up a community.

Interactions between organisms and their environment are also a familiar sight: carabaos helping farmers till the soil, earthworms burrowing in the ground, and birds using twigs to build their nests. Organisms interact with each other and their environment to meet their basic needs and survive.

Some interactions are beneficial; others are harmful. There are also interactions in which populations of organisms are neither benefitted nor harmed. All these interactions take place in ecosystems.

In this module, you will discover more about ecosystems, the components that make them up, and the interactions that take place among the components of the environment.

How do organisms interact with each other and with their environment?

How is energy transferred from one organism to the other?

In Module 1, you have been introduced to the concept of levels of organization in organisms. This module will introduce you to levels of organization that are beyond the level of the organism.

Activity 1

What does it mean to be alive?

Objectives

In this activity, you should be able to:

1. identify the components of the environment,
2. compare living and nonliving things, and
3. describe how organisms interact with each other and with their environment.

Materials Needed

- Drawing and writing materials
- Rocks whose surface is grown with small plants
- Magnifying lens

Procedure

1. Visit your school garden or a pond near your school. On a separate sheet of paper, describe or draw the place.

Q1. What are the things that you see in your school garden or the pond?

Q2. Which of these things are living? Which of these things are nonliving?

Q3. Observe the things that you identified as living. What do they have in common?

Q4. Observe the things that you identified as nonliving. What do they have in common?

Q5. What interactions do you observe happening among the living and nonliving things?

Q6. What makes living things different from nonliving things?

2. Observe the rocks in your school garden or the pond near your school. Do they look like that shown in Figure 1? If so, use a magnifying lens to see the details of the small plants. These small plants make up a population.

Photo: Courtesy of Michael Anthony B. Mantala

Figure 1. Small plants growing on rocks

Q7. What do these small plants need that is provided for by the rock?

Q8. Where do you find these rocks that are inhabited by small plants?

Q9. What other things in the environment are inhabited by these small plants? Where do you find these things?

Q10. Why do you find them in these places?

Figure 2 shows a fence populated by small plants. They usually grow on fences during the rainy season.

Photo: Courtesy of Michael Anthony B. Mantala

Figure 2. Small plants growing on fences

Q11. Do you also see small plants growing on the fences of your school?

Q12. What other living and nonliving things did you see in the school garden or the pond? Do you see them in other parts of the school? Explain your answer.

Figure 3 shows a picture of populations of different kinds of plants. Together, they form a community.

Photo: Courtesy of Michael Anthony B. Mantala

Figure 3. Different kinds of plants

Q13. Do you know of a similar place near your school where you see communities of organisms?

Q14. Are the things you find in your school garden or the pond the same things that you find in the backyard of your house? Explain your answer.

Q15. How do living things interact with each other and with their environment?

Your environment is home to many kinds of living and nonliving things. You also see interaction between them like in the rocks and fences that are inhabited by small plants and algae. These rocks that are usually found in wet places provide anchorage and nutrients to the small plants and algae.

Activity 2

Housemates? Ecomates!

Objectives

In this activity, you should be able to:

1. describe interdependence among the components of the environment,
2. explain how organisms interact with their environment to survive, and
3. infer what happens to organisms if their environment is not able to provide them with their basic needs.

Materials Needed

- Eight (8) – 500mL wide-mouthed glass jars with covers
- Two (2) liters of water allowed to stand overnight
- *Hydrilla* (or other aquarium plants)
- Snails and guppies (or other aquarium fishes)
- Light source
- *Optional: Bromthymol blue solution (BTB) – an indicator that is used to test for the presence (or absence) of carbon dioxide*

Procedure

1. Fill each container with water until it is two thirds full.

   Optional: Add 15mL of BTB to each container. Note that this volume of BTB will depend on the amount of water in the container and how diluted the indicator is.

Setup	1 – With strong light	Setup	2 – Without light
A1	Water only (control)	**A2**	Water only (control)
B1	Water with snails and guppies only	**B2**	Water with snails and guppies only
C1	Water with *Hydrilla* only	**C2**	Water with *Hydrilla* only
D1	Water with snails, guppies, and *Hydrilla*	**D2**	Water with snails, guppies, and *Hydrilla*

3. Use the chart above to set up and label the containers.

4. Cover all the jars.

5. Copy Table 1 on a separate sheet of paper to record your observations of changes, if any, in the things that were placed in each of the containers.

6. Record data each day for three days. Also include in your data a description of the health or condition of the organisms and where they stay most of the time in the container.

   Optional: If you use BTB, get a 10 mL sample of water from each container then add 5 drops of the indicator. Observe for changes in color, if any. Do this each day for three days.

Table 1. Interactions among organisms and their environment

Setups	Observations		
	Day 1	**Day 2**	**Day 3**
A1			
A2			
B1			
B2			
C1			
C2			
D1			
D2			

Q16. Where did the snails and fish stay most of the time in each of the containers each day for three days? Explain your answer.

Q17. What happened to the organisms in each of the containers after three days?

Q18. In which container/s were the organisms still alive? Which organisms are these?

Q19. What do you think will happen to the organisms in each of the jars when left closed for a longer period of time? Why do you think so?

Questions 19-21 are additional questions if you used BTB.

Q20. In which container/s did you observe change in color on each day for three days?

Q21. Bromthymol blue changes color to yellow in the presence of carbon dioxide. Which jar/s contained carbon dioxide?

Q22. What explains the presence of carbon dioxide in this/these container/s?

Q23. How do plants and animals depend on each other?

The plants give off oxygen in the presence of light. The fishes and snails need oxygen to survive. Plants need carbon dioxide given off by the fishes and snails to survive.

What you observed in this activity are interactions that take place in an aquarium. There are other kinds of interactions and interdependence among organisms and their environment in bigger ecosystems.

Ecological Relationships

In the environment, there are plants, animals, and microscopic organisms such as bacteria and fungi. A group of organisms of the same kind living in the same place at the same time is called a population.

Q24. In figure 4 below, what populations of organisms do you see?

Photo: Courtesy of Rodolfo S. Treyes

Figure 4. An example of an ecosystem with different organisms

Populations that interact in a given environment form a community. In a community interactions within and among populations may have important influences to death rate and birth rates of the organisms and, in turn, on population growth and size -- these interactions may have positive, neutral, or even negative influences on interacting populations. Look at figure 5 below. What kind of interaction do the ants and aphids exhibit?

Source: http://www.suchitraimages.com/photography/page/3
http://www.veggiegardener.com/pests/aphids/

Figure 5. A. Interacting populations of ants and aphids.
B. An ant taking honeydew from the back of an aphid.

Aphids are small insects that suck liquid containing sugar from the conducting tissues of plants. These aphids get a certain amount of sugar and other nutrients from this liquid. However, much of the liquid called honeydew is released through the aphids' anus. The ants consume this honeydew as food. The ants, in turn, protect the aphids from their insect predators. Thus, both species benefit from each other. This interaction between the populations of ants and aphids is referred to as mutualism.

Some interactions among organisms are easier to determine than others, and some effects can easily be observed. Study the photographs that follow.

Figure 6 shows fern plants growing on a trunk of a *Narra* tree. What kind of relationship do you think do these two organisms have?

Photo: Courtesy of Rodolfo S. Treyes

Figure 6. Fern plants growing on a trunk of a Narra tree.

Epiphytes are plants that depend on other plants for support. Usually, epiphytes grow on trunks and branches of trees. Figure 6 shows an epiphytic fern that attached itself on a trunk of a *Narra* tree without harming the tree. The *Narra* tree is a host that provides a place for the fern to live. When it rains, the ferns get nutrients from rotting leaves and other organic materials that collect at the root base of the fern plant. This relationship is called commensalism -- one organism benefits from the host organism, while the host organism is neither positively nor negatively affected.

Q25. What other examples of commensalism can you give?

Figure 7 shows an insect larva and a leaf of a plant. *What kind of relationship do you think do these two organisms have?*

Photo: Courtesy of Rodolfo S. Treyes

Figure 7. A larva of an insect lives on the leaves of the plant and causes damage by eating the leaves.

The insect larva (the parasite) gets its nutrients by eating the leaves – thereby, damaging the plant (the host). This relationship is called parasitism. A parasite gets its nutrients from a living host harmed by the interaction. Another example of parasitism is the flea that thrives on a dog. The dog is harmed by the flea that feeds on its blood.

Q26. What other examples of parasitism can you give?

Activity 3

Which eats what?

Objectives

In this activity, you should be able to:

1. identify the predators and prey animals in the environment,
2. describe how the predators capture the prey animals for food, and
3. describe how predators and prey animals interact with each other in the environment.

Materials Needed

- worksheet
- pencil
- hand lens

Procedure

1. Observe each organism in the picture carefully. Fill in the appropriate box to each of the organism.

Organisms	Q27. **What organisms are involved?**	Q28. **Which is the eater? Which is eaten?**	Q29. **Which part of the body does the eater use to get its food?**
			
			

2. You may visit a school ground or garden to make more observations.

3. If you have observed other organisms that are not in the list, you may also add such observations to your worksheet. No need to put pictures; just write the common name of the organisms on the appropriate box.

Organisms	Q30. **Which organisms are involved?**	Q31. **Which is the eater? Which is eaten?**	Q32. **How does the eater get its food?**

Animals kill and eat other animals. This interaction is called predation. An animal that kills and eat other animals is called a predator. An animal that is killed and eaten by its predator is called a prey. Prey animals are usually smaller and less powerful than the predator that eats them.

In a given community, predators compete with other predators for prey animals. In the wild, a predator's prey may be another prey's predator. This means that while an animal hunts and feeds upon another animal, it can also become prey to a larger and stronger predator.

When two populations use the same resource, they participate in a biological interaction called competition. Resources for which different populations compete include food, nesting sites, habitat, light, nutrients, and water. Usually, competition occurs for resources in short supply.

Energy Transfer in the Ecosystems

Why does an organism eat another organism?

Plants, animals, and microorganisms must obtain energy to enable them to move, grow, repair damaged body parts, and reproduce.

Plants are capable of converting energy from the Sun into chemical energy in the form of glucose (food). The process is called photosynthesis; it uses water, carbon dioxide, and sunlight. Most plants make much more food each day than they need. Excess glucose is converted into starch by the plants and is stored either in the roots, stem, leaves, tubers, seeds, or in fruits, as shown in Figure 8.

Q33. Why are plants considered producers?
Q34. Are plants the only organisms in an ecosystem that can produce their own food?

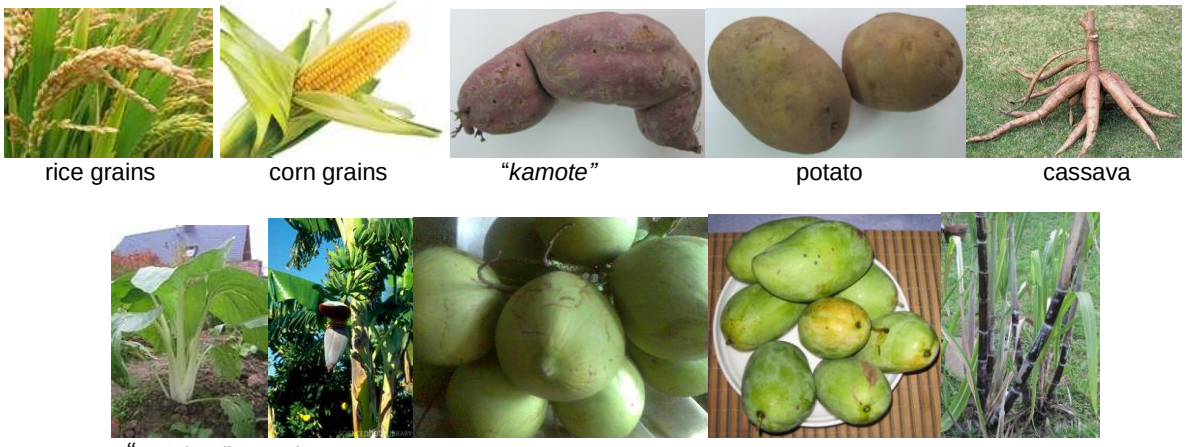
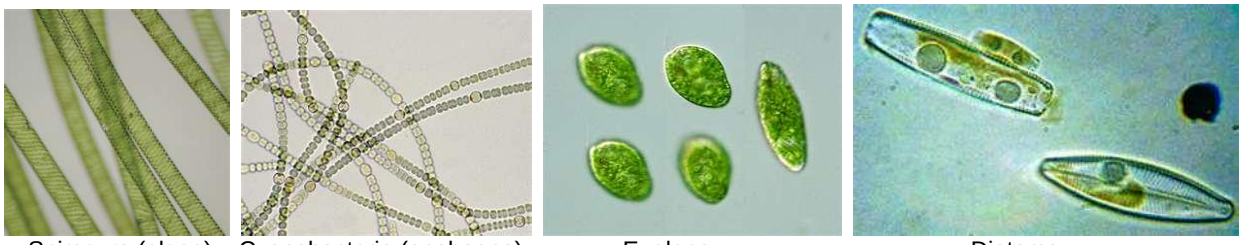


Figure 8. Different plant parts that store chemical energy in the form of starch or sugar. Sugar cane is an example of plant with high sugar content.

There are also microorganisms that can photosynthesize; examples of which are shown in Figure 9.



Spirogyra (algae) Cyanobacteria (anabaena) Euglena Diatoms

Figure 9. These photosynthetic microorganisms are present in ponds, in rice paddies, or any fresh water ecosystem.

Q35. How do animals and humans obtain energy to keep them alive?

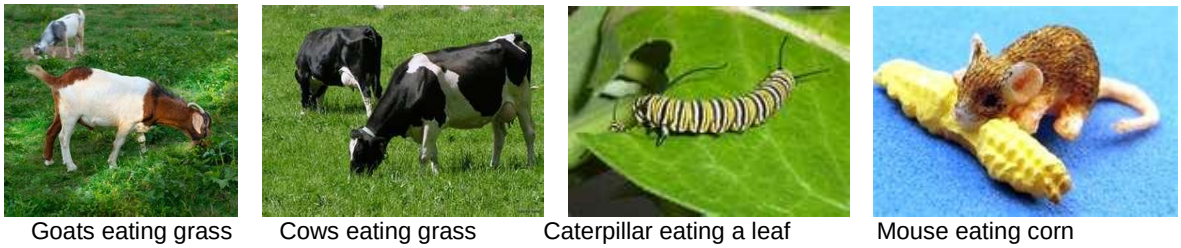
Humans and other animals are not capable of making their own food. They are dependent on the organic matter made by photosynthetic organisms. These organisms that include the plants and some microorganisms are considered as producers.

Animals and humans must eat either plants or other animals to obtain energy. Organisms that feed on other organisms are called consumers. Those that get their energy by eating plants only are called first order consumers.

Q36. In figure 10, which organisms are being eaten?

Q37. Which organisms are the consumers?

Q38. In your community, what other organisms do you know eat plants only?



Goats eating grass Cows eating grass Caterpillar eating a leaf Mouse eating corn

Figure 10. The first-order consumers are the animals that eat plants.

Some energy in the first-order consumer is not used by the consumer itself. This energy is made available to another consumer. A consumer that eats the plant-eaters for energy is called a second-order consumer, examples of which are shown in figure 11.

Snake eats corn-eating mouse

Chicken eats caterpillar

Figure 11. The second-order consumers are the animals that eat the plant-eaters.

Q39. In figure 11, which organisms provide energy to the snake and chicken?

A second-order consumer gets only a fraction of energy from the first-order consumer that it fed upon. A part of this energy is stored and may be passed on to another consumer. A consumer that eats a second-order consumer is called a third-order consumer, examples of which are shown in figure 12. *Human beings are third-order consumers.*

Figure 12. Third-order consumers are organisms that eat the second-order consumers. (A) A hawk eats a chicken; and (B) a crocodile eats a chicken, too.

A

Source: http://guysagi.wordpress.com/2011/02/28/mean-bird/

B

Source: http://roryheadmav.multiply.com/journal

Q40. Refer to figure 13 below. How does energy from the Sun reach the third-order consumers? Trace the flow of energy among organisms by filling up the boxes below. The arrow (⟶) pointing to the next box means "eaten by".

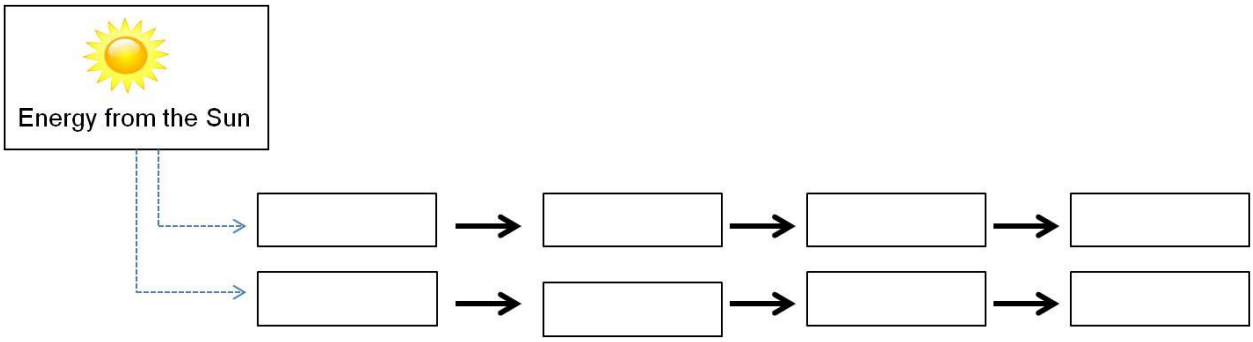


Figure 13. Tracing the flow of energy from the Sun to different organisms.

The transfer of energy can be sequenced. The sequence of energy transfer among organisms to obtain energy and nutrients is called a food chain (see figure 13). A food chain starts with the energy source, the Sun. The next link in the chain is the group of organisms that make their own food – the photosynthetic organisms (producers). Next in the sequence are the organisms that eat the producers; they are the first-order consumers. The next link in the chain is the group of animals that eat the first-order consumers; they are the second-order consumers. These organisms, in turn, are eaten by larger animals – the predators; they are also called, third-order consumers. Each food chain ends with a top predator – an animal with no natural enemies.

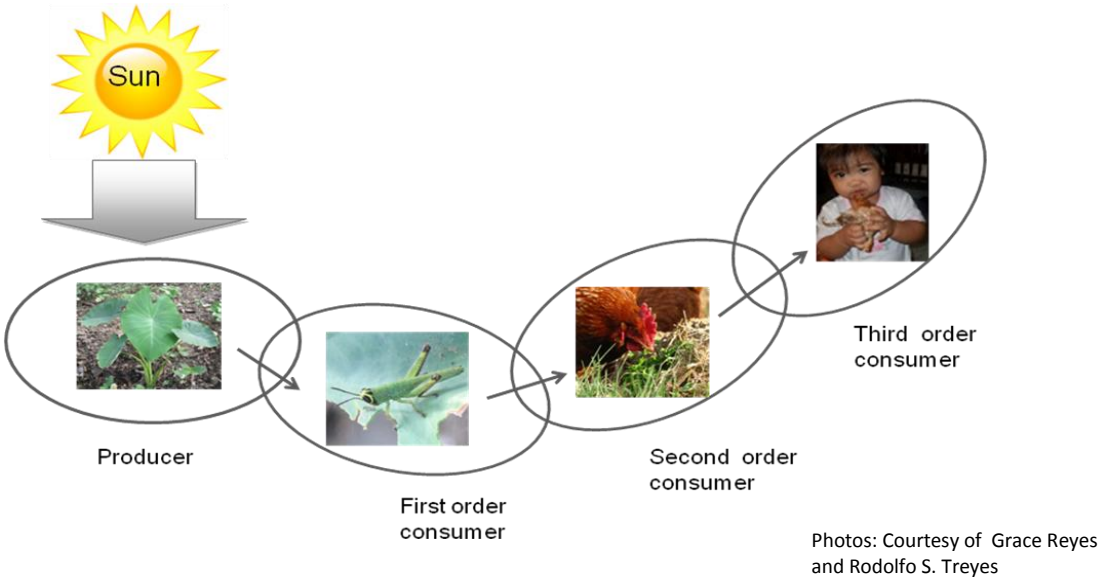


Figure 14. A transfer of energy shown in a food chain. The "gabi" plant produces its own food through photosynthesis. Grasshopper eats the leaves of "gabi" plant to get its energy and nutrients. The chicken eats the grasshopper. Then the chicken is eaten by humans.

Q41. List down the organisms found in your community. Classify them according to the following categories:

Organism	Producer	First-Order Consumer	Second-Order Consumer	Third-Order Consumer

Q42. Construct a food chain using the organisms listed on the table above.

When plants and animals die, the energy in their bodies can be transferred to another group of organisms. Consumers that look for and eat dead animals or plants are considered scavengers.

House flies, cockroaches, maggots and ants are scavengers (see figure 15). Earthworms feed on dead grass and leaves if they are above ground. They also feed on fruits, berries, and vegetables. If they are under the soil, earthworms may feed on algae, fungi, and bacteria.

Photos: Courtesy of Rodolfo S. Treyes

Figure 15. Common scavengers: housefly, earthworm, ants, and cockroach.

Once the scavengers are done with eating a dead organism, the decomposers (microorganisms) take over and consume whatever was left by the scavengers. Decomposers consume any dead plants and animals.

There are different kinds of decomposers performing different functions in the ecosystem. Some groups of bacteria prefer breaking down meat or waste from the consumers that eat meat.

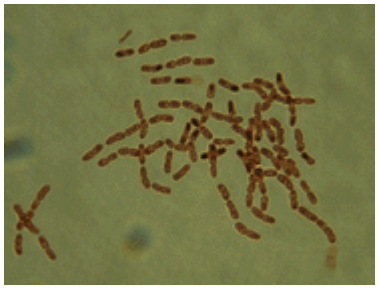


Figure 16. A group of bacteria.

What do you see on bread or rice that had been kept for some time? They have molds! Sometimes, you see a trunk of a tree with mushrooms growing on it (refer to figure 17). These are fungi and they are decomposers; they prefer to grow on starchy food, fruits, vegetables, and dead plants.

Photos: Courtesy of Rodolfo S. Treyes

Figure 17. Fungi growing on left-over rice and bread, fruit, and dead trunk of a tree.

Microorganisms that include bacteria and fungi break down proteins, starches, and other complex organic substances that were once part of living things. During the process of decomposition, decomposers release nutrients from the organic material back into the soil, making the soil available to plants and other producers.

Activity 4

What to do with food wastes?

At the end of this activity you will decide on the best way to deal with food wastes in your home or school. You will record your observations and draw inferences. You will construct food chains starting with the food wastes, which are actually dead organisms, and the living organisms found in the compost pots. You will supplement your observations and inferences with information found from the internet or in the library.

Materials Needed

- Two small, clear jars with covers (and with holes all over)
- At least three large clay flower pots,
- Soil
- Rubber gloves
- Trowel
- Microscope
- Slides and cover slips

- Magnifying lens
- Pole for aerating composting materials
- Wire covers for the clay pots

Procedure

1. Set up the composting pots and jars in advance. In one covered jar, put some food wastes. In the other covered jar, put a layer of soil at the bottom, followed by a layer of food wastes covered with a layer of soil. Repeat until the jar is full. Do the same for the clay pots, filling one first before moving to the second pot, until the third (or last pot) is full. Water the jar and pots with soil if the soil dries up.

2. **Do not water the jar of food wastes without soil.** Observe the food wastes and living organisms that you find in the jar daily. Record your observations on a table like the one below:

Day/Date	Observations about food wastes and living organisms

Note: Write your answers in your notebook. Add rows as needed.

3. Do the same for the jar with soil and the clay pots as soon as they are full. Include observations about the soil.

4. After a week, and every week thereafter, mix the contents of a clay pot to provide air to the organisms underneath the surface the soil.

5. Continue your observations until the food wastes can no longer be seen and everything looks like soil. This means that decomposition of the food wastes is complete or nearly so. You have made compost.

Q43. What organisms did you find in the compost jar or pot from Day 1? List them down in the order of appearance. You may draw those you cannot identify. (Write your answers in your notebook.)

Use the magnifying lens and microscope to examine very small and microscopic organisms. On Day 1, get small samples of the soil and make wet mounts to examine it under the microscope. Repeat this after a week and every week thereafter until the observations are concluded.

Q44. Draw the microscopic organisms you observe and try to identify them with the help of reference books.

Q45. Construct at least one food chain and one food web based on your observations.

Q46. What is the benefit of composting food wastes?

Q47. What other methods would you recommend to dispose of food wastes?

Energy transfer in an ecosystem follows a process. The ultimate source of energy for all living things is the Sun. The producers of the ecosystem take energy from sunlight and convert it to chemical energy. This energy is passed on to consumers and then to decomposers. The energy flows only in one direction and is not cycled back.

In contrast, the materials in the form of nutrients needed by living things are cycled between organisms and the environment. These materials are used up by the producers to make other forms of materials that are cycled among the consumers and finally returned to the environment by the decomposers. Energy flows and materials are cycled in the ecosystem. We live in a dynamic world, indeed!

Reading Materials/Links/Websites

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