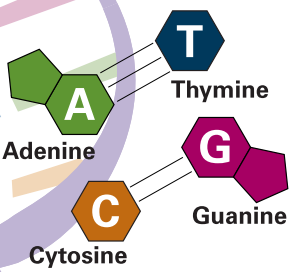
THE SCIENCE OF. . .™

alcohol

Teacher's Guide



Baylor College of Medicine

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BioEd℠

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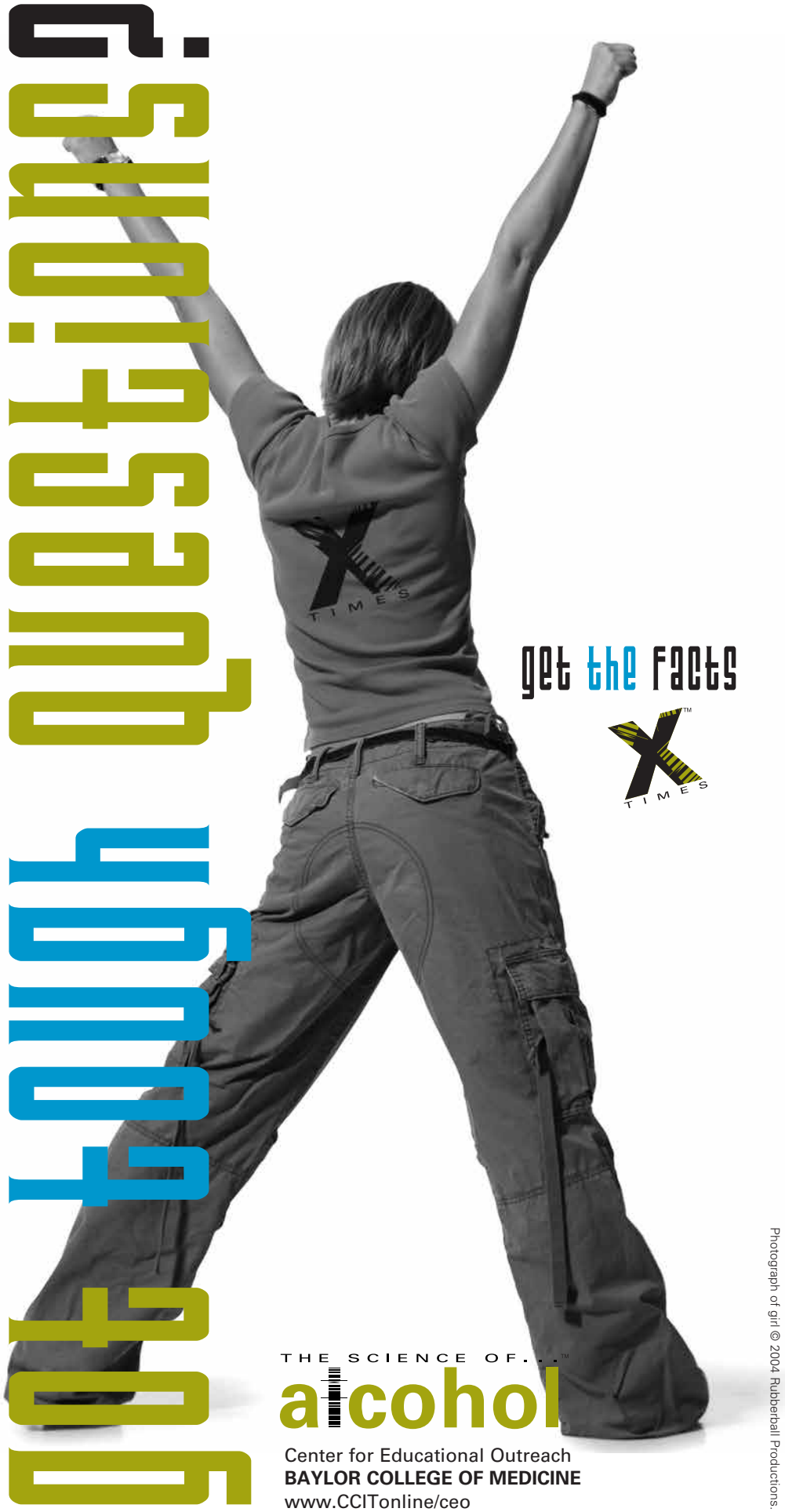
BioEd Education Materials

BioEd's The Science of Alcohol teaching unit tackles the tough subject of alcohol and alcoholism with candor backed by cutting-edge scientific research. The unit consists of *X-Times*, an in-depth student magazine geared for today's sophisticated kids, and *The Science of Alcohol: Teacher's Guide*, jam-packed with integrated, hands-on activities guaranteed to make students think about alcohol in a totally different way.

For more information about *X-Times* and other BioEd educational units, contact the Center for Educational Outreach at Baylor College of Medicine by calling 713-798-8200, 800-798-8244 or by email at edoutreach@bcm.edu.



Pre-assessment

Students will complete a pre-assessment to evaluate existing knowledge and beliefs about alcohol. They will not be aware that all of the items on the assessment are false. The pre-assessments should be kept and revisited at the end of the unit, at which time students will have opportunities to re-examine their responses. See post-assessment. Class time: 20 minutes.

ACTIVITY 1

Hey, What About Alcohol?

Students (and adults) have many misconceptions about ethyl alcohol and how it affects the human body. There are many different chemicals that are classified as alcohols. **Ethyl alcohol**, also called **ethanol**, is one member of the alcohol family. Ethyl alcohol is a byproduct of fermentation—a natural chemical process used by some organisms, such as yeast, to obtain energy from carbohydrates. Ethyl alcohol readily mixes with water.

Human beings have been drinking beer for almost 7,000 years, and wine for approximately 5,000 years.

Different kinds of intoxicating beverages, such as wine, beer or liquor, have different concentrations of ethyl alcohol. One 12-ounce serving of beer, one 5-ounce glass of wine and 1.5 ounces of 40-proof liquor all have about the same amount of alcohol.

Ethyl alcohol is processed by the body at a finite rate, depending on gender, weight, genetic characteristics, food consumption, etc. If the rate of intake exceeds removal, the amount of alcohol in the bloodstream will increase. Although, in the short term a small amount of alcohol can act as a stimulant, excessive consumption acts as a depressant and slows down the sensory and motor systems. Alcohol use over many years also has long-term health effects, such as liver disease. How a person responds to alcohol depends on his or her genetic makeup, general state of health, gender and body size, among other factors. Similarly,

Science Standards

EARTH & SPACE SCIENCE

- Water is a solvent.

LIFE SCIENCE

- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination, and for protection from disease.
- Disease is the breakdown in structures or functions of an organism

SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES

- Alcohol and other drugs are often abused substances. Such drugs change how the body functions and can lead to addiction
- The potential for accidents and the existence of hazards imposes the need for injury prevention. Safe living involves the development and use of safety precautions and the recognitions of risk in personal decisions. Injury prevention has personal and social dimensions.
- Students should understand the risks associated with social hazards, such as transportation, and personal hazards, such as drinking.
- Individuals can use a systematic approach to thinking critically about risks and benefits.
- Important personal and social decisions are made based on perceptions of benefit and risk.

Answer Key

An answer key for the pre- and post-assessments are located on page 55.

THE ALCOHOL FAMILY

Methanol, also known as wood alcohol, is used in antifreeze and as a solvent. Isopropyl alcohol, or isopropanol, is used as a cleaner and a disinfectant, and is the main ingredient in rubbing alcohol. Butanol is used as a solvent, fuel, and paint thinner. Ethyl alcohol is the only alcohol that is safe for human consumption and only in small amounts.

Using Cooperative Groups in the Classroom

Cooperative learning is a systematic way for students to work together in groups of two to four. It provides organized group interaction and enables students to share ideas and to learn from one another. Students in such an environment are more likely to take responsibility for their own learning. Cooperative groups enable the teacher to conduct hands-on investigations with fewer materials.

Organization is essential for cooperative learning to occur in a hands-on science classroom. Materials must be managed, investigations conducted, results recorded, and clean-up directed and carried out. Each student must have a specific role, or chaos may result.

The Teaming Up! model* provides an efficient system for cooperative learning. Four "jobs" entail specific duties. Students wear job badges that describe their duties. Tasks are rotated within each group for different activities so that each student has a chance to experience all roles. For groups with fewer than four students, job assignments can be combined.

Once a cooperative model for learning is established in the classroom, students are able to conduct science activities in an organized and effective manner. The job titles and duties are as follows.

Principal Investigator
- Reads the directions,
- Asks the questions
- Checks the work

Maintenance Director
- Follows the safety rules
- Directs the cleanup
- Asks others to help

Reporter
- Records observations and results
- Explains the results
- Tells the teacher when the group is finished.

Materials Manager
- Picks up the materials
- Uses the equipment
- Returns the materials

many different factors influence whether a person will abuse or become dependent on alcohol.

SETUP

Read "Using Cooperative Groups in the Classroom," (see box, p. 2). Prepare name tags for each group of four students. Place all materials in a central location for each group of students to collect.

MATERIALS

Each student will need:
- Poster, white
- Pen, pencil, markers
- Copy of student sheet

PROCEDURE

1. Ask students, *What do you know about alcohol?* Tell students that they will be taking a preassessment to determine prior knowledge and address any misconceptions before they begin the unit of study.
2. After the students have completed the preassessment, ask students if they have any questions. Do not answer the questions, but record them on a chart to be posted in the classroom. Tell students that as the unit progresses they will discuss questions and record answers on the chart.
3. Collect completed student sheets and save for use with the post-ssessment activity.

ACTIVITY 1

What do You Know?

Are the following statements true or false? Circle "T" for True or "F" for False.

TRUE	FALSE	STATEMENT
T	F	1. Excess consumption of alcohol acts as a stimulant.
T	F	2. Alcoholic beverages contain only alcohol.
T	F	3. Alcohol, once consumed, goes directly to your kidneys for filtering.
T	F	4. All alcohol is safe for consumption.
T	F	5. Small amounts of alcohol normally do not affect neurons in the brain.
T	F	6. Alcohol has calories, and does provide some nutrients.
T	F	7. Alcohol makes an individual more outgoing and articulate.
T	F	8. When large amounts of alcohol are consumed, the liver processes less efficiently, but more quickly.
T	F	9. Besides beverages, there are not a lot of uses for alcohol.
T	F	10. The presence of food in the stomach increases the rate of absorption of alcohol into the bloodstream.
T	F	11. Drinking beer is safer than drinking liquor.
T	F	12. Alcohol rarely can affect parts of the brain that deal with learning and memory.
T	F	13. Any effects from drinking alcohol occur in the short-term.
T	F	14. Everyone eliminates alcohol at the same rate.
T	F	15. Alcohol is not a drug.

Name _____ Date _____

Science Standards

INQUIRY

- Different kinds of questions suggest different kinds of scientific investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models and theories.

PHYSICAL SCIENCE

- A substance has characteristic properties—such as density, a boiling point, and solubility—all of which are independent of the amount of the sample.

HISTORY & NATURE OF SCIENCE

- Scientists formulate and test their explanations of nature using observations, experiments, and theoretical and mathematical models.

DENATURING ALCOHOL

Other compounds, which affect taste or odor, often are added to ethyl alcohol (ethanol) to render it unfit for consumption. This process is called denaturing and the resulting liquid is referred to as denatured alcohol.

Overview

Students observe physical properties of four different chemicals (water, isopropyl alcohol, glycerin and liquid detergent), compare their observations and reach conclusions about the properties of each substance. Class time: 90 minutes.

ACTIVITY 2

Liquids: Physical Properties

This activity introduces students to one kind of alcohol, isopropyl (rubbing) alcohol, and provides them with an opportunity to compare its physical properties to three other liquids (glycerin, water and detergent). Surprisingly, **glycerol**, the major component in glycerin, also is a kind of alcohol, but with a much larger molecule. Detergent is a synthetic cleaning agent that acts like soap..

The following physical properties are observed and compared.

- **Evaporation time.** An estimation of how long it takes for one drop of a substance to evaporate completely. Evaporation is the process by which chemical particles or molecules escape into a vapor state from a liquid state or, more rarely, a solid state (a process known as sublimation). As the temperature of a liquid rises, more particles acquire sufficient energy to escape into the vapor state.
- **Shape of a single drop.** Droplets of some liquids maintain a rounded shape, while others tend to spread. Molecules that have a positive end and a negative end (known as polar molecules), such as water, are attracted to one another and form round drops due to surface tension. Molecules that have a more equalized distribution of charges are attracted less to one another and form flatter and more irregularly shaped drops.
- **Whether it can dissolve sugar.** Table sugar (sucrose) is a small molecule that will dissolve in some, but not all, liquids. Water, alcohol and glycerin molecules all have unequal distributions of electrical charges and will form a homogeneous mixture with sugar molecules. Sucrose will not dissolve in detergent, which has a structure that does not attract the electrically charged OH groups on sugar.

- **Distance traveled up a paper towel.** The tiny fibers in paper act as conduits for polar liquids, such as water, to climb upward against the force of gravity. This phenomenon, known as capillary action, results from the attraction (adhesion) of liquid molecules to the sides of a narrow tube or the outside of paper fibers. If the adhesion force of the liquid to the solid is greater than the force holding the liquid molecules together, the liquid molecules will creep up the tube or fibers. The climb of the molecules stops when the mass of the liquid column is too great for the adhesion force to support it against the pull of gravity.
- **Density.** A measure of how much mass is contained in a unit volume of a substance. Practically speaking, density can be expressed as a ratio of weight to volume. For example, the density of water is 1 gram per cubic centimeter (cm^3) when it is at a temperature of 4 degrees Celsius (note: a cubic centimeter of water is equivalent to one milliliter of water). At room temperature (72 degrees Fahrenheit or 20 degrees Celsius), the density of water is approximately 0.97 gm/mL. Liquids that are less dense than water will float on top of a layer of water; liquids that are more dense will sink below a layer of water. Specific gravity is the density of a substance divided by the density of water, which has a specific gravity of one. In other words, specific gravity is the same number or ratio as density when expressed as gm/mL, but without any units attached.

Setup

Prepare the Mystery Liquid by mixing equal parts of water with rubbing alcohol. You will need approximately 225 mL of water and 225 mL of alcohol to give each of six groups about 75 mL of the Mystery Liquid for testing. In the mixture of alcohol and water, some properties of each liquid will remain the same, some will be subtly different, and others will be changed completely. A mixture of water and alcohol will evaporate slowly, not form a rounded drop, dissolve sugar, have a different density than either alcohol or water (it falls between them), and have less ability than water to climb a paper towel.

Materials

Each group of four students will need:

- 75 mL each of water, isopropyl alcohol, glycerin, and detergent in 100-mL beakers or containers
- 75 mL of Mystery Liquid in a 100-mL beaker or container (mix 225 mL of water and 225 mL of rubbing alcohol to provide each of six groups about 75 mL of the Mystery Liquid for testing)
- Chem tray (clear plastic tray with indentations for conducting small-scale chemical tests or observations)
- 5 droppers
- 5 toothpicks
- 4 pairs of safety goggles
- 4 small cups or portion cup-size containers
- Hand lens and/or microscope (10–100x)
- Triple beam balance or electronic scale

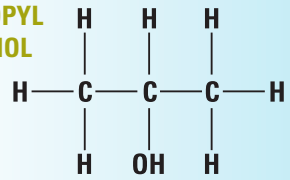
Safety Issues

All of the liquids used in this investigation are safe to handle, providing standard safety precautions are followed. Students should wear eye protection at all times. No liquids should be ingested. Hands should be washed if they come in contact with the liquids. Rubbing alcohol should be kept away from heat sources. Students with cuts or sores on their hands should wear gloves. Remember to review lab safety rules as well.

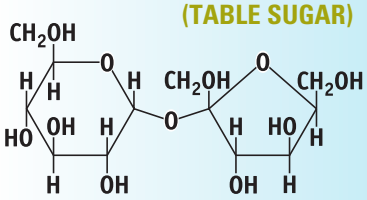
DENSITY

Density is a property of all matter. An object's density is a relationship between its mass and its volume (the amount of space it occupies). If two objects have the same volume, the one with the greater mass has the greater density. In general, if two objects have the same mass, the one with the smaller volume will have the greater density. If a substance floats in water, assuming that the substance does not dissolve in or react with water, its density is less than that of water. If the substance sinks, its density is greater than water.

ISOPROPYL ALCOHOL



SUCROSE (TABLE SUGAR)



A FAMILY OF CHEMICALS

Even though many people associate the word, "alcohol," with beverages containing ethyl alcohol (ethanol, also known as grain alcohol), alcohol actually is an entire family of chemicals. Common rubbing alcohol (isopropyl alcohol) is only one kind. The properties of many alcohols with smaller molecules, such as ethyl alcohol and isopropyl alcohol, are similar. Some of these properties are listed below.

- Clear liquids at room temperature.
- Less dense and evaporate at lower temperatures than water. (This property allows alcohols to be distilled. When a mixture of water and alcohol is heated, the alcohol evaporates first. The alcohol vapors are collected and condensed again to a liquid in a separate container.)
- Dissolve easily in water.
- Flammable (so much so that they can be used as fuels).

- Teaspoon of sugar
- Coffee filter or filter paper
- Labeling materials (e.g., sticky notes, pen)
- Paper towels
- Newspaper to cover work area
- Copy of Categorizing Substances and How Are Chemicals Different? student sheets

PROCEDURE

1. Give each group of students a copy of the Categorizing Substances page. Ask students to discuss and group the substances in the list and then share their grouping criteria with the class. OR have students use resources available in the library or on the Internet to learn about one or more of the substances on the list, before they attempt to place the substances in groups. Ask, *What might the substances have in common?* As students share their reasoning, create a list of possible groupings to revisit at the end of the activity.
2. Tell students that, working within their groups, they will observe, test and compare four similar-looking liquids using the "Comparison Observation Chart," and then use this information to identify a mystery liquid. Do not identify any of the liquids by name. Use numbers instead. The liquids are 1) glycerin, 2) water, 3) isopropyl (rubbing) alcohol and 4) detergent.
3. Groups will follow directions on the In The Lab student sheet and record the results of each test. Observations and tests will include investigating evaporation time, shape of drop, forming solutions, density and capillary action.
4. Before students begin the tests, review the worksheet with all the students. Clarify each test and answer any questions. Remind students that they are scientists and to follow proper lab safety rules. Students should wear protective eyewear when conducting the tests. Have materials ready for each group's Material Manager to pick up in a central area of the classroom.
5. Once all groups have completed the five tests, give them about 75 mL of the Mystery Liquid to identify. Tell them it is a mixture of two of the four liquids and that they must identify which two liquids are contained in the Mystery Liquid.

EXTENSIONS

- Ask students, *What if we poured all the substances into the same container? What would it look like? Would the order in which you pour the substances into the container make a difference? If so, which substance would be first and why?* Discuss. Explain that they are going to investigate how the densities of the four substances compare by creating a density column. Students may want to refer back to their measurements of density. What do the data tell them?
- Have students use their data to plan the order in which they will add each of the four substances into a large test tube, clear graduated cylinder, or other narrow tall container (like an olive jar). Based on the size of the container selected, give them appropriate amounts of each substance to add. Direct students to carefully pour liquids so that layers form. Make a sketch and label the layers of your density column. Ask, *What happened and why?* Ask groups if they can identify any of the substances in the column.

ACTIVITY 2

Categorizing Substances

Study the list of substances below. Group each substance into any specific categories you feel they belong in. Be prepared to describe how you created the categories.

Adhesives

Aftershave

Antifreeze

Baby oil

Body lotion

Cellophane

Cosmetics

Cough syrup

Dry cleaning fluid

Fabric softener

Food additive to improve texture

Hair spray

Hair conditioners

Lens cleaner

Liquid soap

Lubricant

Nitroglycerine

Nutrients for cultures in the production of antibiotics

Paint thinner

Perfume

Pesticides

Preservative in some medicines

Sweetener

Toothpaste additive

ACTIVITY 2

how are Liquids different?

Follow the directions below to observe, compare and test each liquid. Record your results.

A. **Does the liquid evaporate in air?** Place one drop of liquids 1-4 and the mystery liquid, respectively, in five different wells of your chem tray. Check for changes (evaporation) every minute and record any noticeable differences. Record the total time for the liquid to disappear completely, if possible

B. Does the liquid hold a rounded shape? Place three drops of the same liquid, respectively, in five different wells of your tray. Draw the shape of each liquid and record the actual size of the drop formed, on your data sheet. Stir with a toothpick and draw and record the drop again.

C. **Does the liquid dissolve sugar?** In the third set of wells, place eight drops of the same liquid. To each well, add a small pinch of sugar and stir with a toothpick. Observe using a microscope or hand lens. Record any changes and draw the drops. What is happening inside each liquid?

D. **What is the density of the liquid?** Label the beakers, 1 through 5, to correspond with the four different liquids and the mystery liquid. Find the mass of the cups in grams (gm) using the triple beam balance or electronic scale. Record your answers. Pour 50 mL of liquid into each beaker with the same number. Find the mass of each liquid in grams (gm) using the triple beam balance or electronic scale. The formula for density is mass/volume. Divide the measurement of mass in gm by a volume of 50 mL to find the density of each liquid. Record the densities. Be sure to subtract the mass of each cup from the total mass to determine the mass of the liquids only.

E. **Will the liquid travel up a paper towel?** Cut four 2 cm x 20 cm strips of coffee filter paper (or paper towel). Use the cups and liquids from step D. Carefully place about 1 cm of the filter paper in each liquid. Describe what happens when the strips are placed in the liquid. Do all the liquids move up the paper at the same rate? Why might this be happening? Measure the distance the liquid travels up the filter paper and record your measurement.

	A Liquid evaporation time (seconds)	**B1 Draw the drop of liquid before stirring**	**B2 Draw the drop of liquid after stirring**	**C1 Able to dissolve sugar**	**C2 Draw the drop of liquid with sugar**	**D Density of the liquid (gm/mL)**	**E Distance liquid traveled up a paper towel (mm)**
Liquid 1							
Liquid 2							
Liquid 3							
Liquid 4							
Mystery Liquid							

Overview

Students learn about solutions and how to prepare and describe solutions based on volume, as they compete to devise formulas that produce the longest-lasting bubbles. Class time: 45–90 minutes.

Safety Note: Students should wear goggles when creating and testing bubble solutions.

ACTIVITY 3

Solutions

Many products that we use every day actually are mixtures known as solutions. For example, the rubbing alcohol typically sold in drugs stores is a 70% solution of pure isopropyl alcohol and water. In this case, the relative amounts of each substance present in the mixture are described by volume. To make 100 mL of 70% isopropyl alcohol solution, one would combine 70 mL of isopropyl alcohol with 30 mL of water.

The amount of alcohol in beer, wine and other alcoholic beverages also is measured as a volume percentage of the total. The "proof" of an alcoholic beverage is twice the volume percentage of ethyl alcohol in water. Thus, a 20-proof beverage actually is 10% ethyl alcohol by volume. As seen in Activity Two, alcohol and water readily mix to form a solution.

Blood alcohol concentration (BAC) is a standard way of reporting the concentration of ethyl alcohol in a person's body. Instead of volume percentage, BAC relies on a weight-per-volume measure, which reports the amount of ethyl alcohol present as milligrams per 100 mL of blood. For instance, a BAC of 0.10 indicates that 1/10 of 1 percent (or 1/1000) of your total blood content is alcohol. The density of ethyl alcohol is 0.79 grams per mL. BAC is discussed in greater detail in Activity 5.

This activity provides an opportunity for students to become familiar with volume-to-volume solutions, as they compete to create a "bubble solution" recipe that yields the longest lasting bubbles. The activity also allows students to make and test predictions, based on evidence.

Setup

Cut plastic drinking straws in half prior to class, so that each student receives his or her own "bubble blower."

Materials

Each group of four students will need:

- 500 mL of water in a container
- 100 mL of glycerin in a container
- 100 mL of liquid dishwashing detergent in a container
- 4 pairs of safety goggles
- 4 8-in. plastic plates

Science Standards

INQUIRY

- Different kinds of questions suggest different kinds of scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.

PHYSICAL SCIENCE

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

EARTH & SPACE SCIENCE

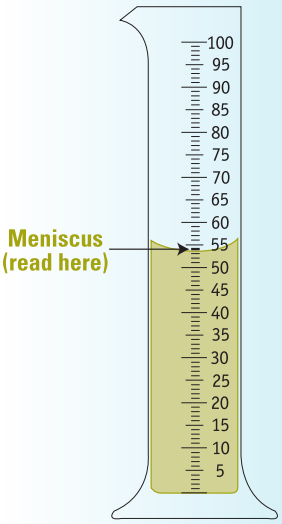
- Water is a solvent.

WHAT IS A SOLUTION?

A solution is a homogeneous (uniform) mixture of one substance with another, in which the mixing happens at the level of molecules or ions. The major component of a solution is known as the solvent; the minor component is called the solute. A colloid is when particles are mixed in a solution but do not dissolve and do not settle out. When the larger particles eventually settle out of the mixture due to gravity (or can be centrifuged out), the mixture is considered to be a suspension. Milk is an example of a colloid, while a mixture of soil and water is a suspension (the soil eventually will settle to the bottom of the container).

READING A GRADUATED CYLINDER

When measuring liquid volumes in a graduated cylinder you read the volume based on the location of the meniscus, not the very top of the liquid line. In a cylinder, liquid forms a curved surface. This curve is due to surface tension and capillary action, causing the liquid to "travel" up the sides of the cylinder. In the previous activity, you saw this occur with droplet formation (surface tension) and how far a liquid traveled up a paper towel (capillary action). The meniscus is the bottom point of this curved surface and is the accurate place to measure the volume of a liquid.



- 2 plastic drinking straws, cut in half (one per student)
- 4 clear plastic cups
- 4 plastic coffee stirrers
- 100- or 250-mL graduated cylinder
- Teaspoon
- Stopwatch or clock with second hand
- Paper towels
- Ballpoint pen or permanent marker
- Copy of the Properties of Solutions student sheet

PROCEDURE

1. Begin the class by blowing bubbles across the room. Ask students, *What do you need to blow a bubble? Have you ever made your own bubble solution? What do you think is in bubble solution? Do you think it is possible to change the properties of bubble solution by varying the ingredients?* Tell students to imagine that they work for a toy company. Their boss has designed a competition among teams of employees to see which team can develop a bubble solution formula that makes the longest lasting bubbles.
2. Ask students, *What is a solution?* Explain that a solution is a homogeneous mixture of two or more substances. Salt water, for example, is a solution of water and salt. Tell them that their formulations for bubble solutions will be solutions of water, liquid detergent and glycerin—a chemical in the alcohol family. Remind students of the last activity where they observed properties of four different liquids. As a group have them review the characteristics of the liquids and what role each might play in creating the longest lasting bubbles.
3. Instruct Materials Managers to pick up materials for their groups from a central location. Students will need a new or a dry plate to test each solution. Each student will need his or her own drinking straw. Also, give each group one copy of the Soap Bubble Challenge page.
4. Have students follow the instructions to create and evaluate bubble solution formulas. Challenge each group to devise a formula that produces the longest lasting bubbles. Remind students that they are limited to the materials given to them at the beginning of the lab, and that they must record all of the formulas and results from each test. Each formula should contain 100 mL total of solution.
5. If necessary, demonstrate how to use a graduated cylinder to measure small amounts of liquid accurately. Show students how to read the volume by finding the bottom of the curved surface (**meniscus**) of the liquid inside the cylinder (see illustration to the left). Students need to measure to the nearest milliliter.
6. Demonstrate how to test the bubbles by emptying one teaspoonful of bubble solution onto a plate, inserting a straw into the solution and blowing a bubble the approximate size of the plate. Carefully remove the straw. Students will time how long each bubble lasts, in seconds. Consider letting the students practice blowing the bubbles before the time trials.
7. Have each group of students design and test at least three different bubble solution formulas. Since students will be preparing and testing solutions with total volumes of 100 mL,

it will be easy for them to convert the volumes of each ingredient to percentages (e.g., 20 mL of glycerin in 100 mL of solution is a 20% solution by volume of glycerin). However, if students inadvertently use other total volumes, they easily can convert their measurements to percentages of the total volume by using the following equation.

$$\text{Volume \%} = \frac{\text{volume of solute (mL)}}{\text{total volume of solution (mL)}} \times 100$$

The volume of the solute is defined as the volume of the detergent plus the volume of the glycerin.

8. Discuss why the teams start with the water to create their solutions (soap and glycerin are stickier than water and their residue will cling to the graduated cylinder). Beginning with water minimizes residue in the cylinder and makes it easier to clean. Encourage students to try and prevent the solutes from touching the sides of the cylinder as each is added.
9. Make sure students understand how to create the solutions. For example, if the formula is 75 mL of water, 15 mL of liquid detergent and 10 mL of glycerin, first add water up to the 75-mL mark on the cylinder. They then add 15 mL of liquid soap to raise the total amount of liquid in the cylinder to 90 mL. If they then add 10 mL of glycerin, the solution will top off at 100 mL.
10. Once each group has identified its best solution for producing long-lasting bubbles, have the Reporters share it, in turn, with the class. Have students post the formulas on the board, and follow with a class discussion of the similarities and differences among the recipes.
11. Have each group demonstrate its best bubble solution in front of the class by a member of another group.

Words to Discuss

Colloid

Component

Concentration

Graduated cylinder

Homogeneous

Meniscus

Milliliter

Mixture

Solute

Solution

Solvent

Substance

Suspension

Volume

ACTIVITY 3

Properties Of Solutions

Create and evaluate at least four different bubble solution recipes using glycerin, liquid detergent and water. Conduct Bubble Time Tests for each solution to see which recipe produces the longest-lasting bubbles. Your group will need the following materials.

- 100 mL of glycerin
- 100 mL of liquid detergent
- 500 mL of water
- 100- or 250-mL graduated cylinder
- 4 pairs of safety goggles
- 2 plastic drinking straws (cut in half)
- 4 8-in. plastic plates (on which to blow bubbles)
- 4 clear plastic cups (to hold solutions)
- 4 plastic coffee stirrers
- plastic teaspoon
- paper towels
- stopwatch or clock with a second hand

Formula	Water (mL)	Glycerin (mL)	Detergent (mL)	Total Volume (mL)	BUBBLE TIME TEST				
					Time 1	Time 2	Time 3	Time 4	Average Time
A				= 100					
B				= 100					
C				= 100					
D				= 100					

1. Create your first formula, keep in mind the amount of each liquid you have available and the properties of each. You cannot obtain more raw materials. Each solution should contain a total volume of 100 mL. Use the table above to record each formula.
2. Mark the plates A, B, C, and D. Also mark the cups used to mix each of your bubble solutions A, B, C, and D.
3. For each solution, start by measuring the proper amount of water into the graduated cylinder. Add the proper amounts of liquid soap and glycerin to the water in the cylinder. Try not to let the soap or glycerin touch the sides of the cylinder as you add them to the water. Transfer your first solution to cup A.
4. Gently stir the solution so that the soap and glycerin are completely dissolved into the water. Make sure to use a different coffee stirrer for each solution.
5. Place one teaspoon of solution A on the plastic plate marked "A". Place the tip of a straw into the solution and blow a bubble no larger than the plate. Carefully remove the straw and observe the bubble. Use a watch or clock with a second hand to time how long the bubble lasts (in seconds) before it breaks. Record the result on your table.
6. Repeat the Bubble Time Test 3 more times for Solution A (you will conduct a total of 4 tests). Record each result on your table. Calculate and record the average time for Solution A.
7. Create your second formula and repeat the Bubble Time Test for Solution B (Steps 3–6). Then repeat the procedure again for your other 2 formulas, Solutions C and D. Remember to use a clean, dry plate to test each solution.
8. Which solution produced the longest-lasting bubble? Write the formula for the "winning" solution. Use percents to describe the relative amounts of each ingredient in your winning solution. (Hint: 20 mL of glycerin in 100 mL solution = 20% glycerin in the total solution).

$$\frac{\square \text{ mL Detergent}}{\text{100 mL Total solution}} = \square\,\%$$

$$\frac{\square \text{ mL Glycerin}}{\text{100 mL Total solution}} = \square\,\%$$

$$\frac{\square \text{ mL Glycerin}}{\text{100 mL Total solution}} = \square\,\%$$

Overview

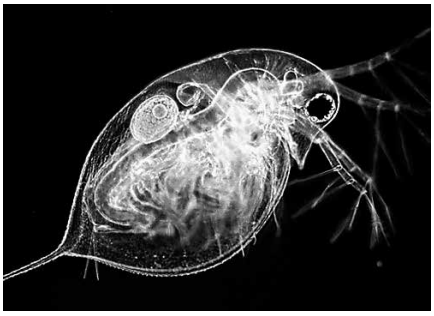
Students will observe the heartbeat and behavior of *Daphnia magna* under normal conditions and in the presence of alcohol. Students will learn that alcohol is a depressant; alcohol can impair functioning of the body even at low doses; and prolonged exposure to alcohol can cause permanent damage or death.

Class time: 60–90 minutes.

ACTIVITY 4

Measurable Effects

Ethyl alcohol acts a depressant on the nervous system and affects areas of the brain that govern speech, thought, muscle movement and coordination, breathing, and heart rate, among others. In this activity, students will observe how exposure to low concentrations of alcohol over time gradually decreases the heart rate of *Daphnia.*



This impact on cardiac function results from the action of alcohol on regions of the nervous system that govern heart rate. The effect is similar in humans, where alcohol acts on connections between nerve cells and can affect regulation of basic functions, such as heart rate and breathing. In extreme cases of alcohol consumption or alcohol poisoning, the heart actually stops and death can occur.

Daphnia are freshwater crustaceans, commonly found in pond water. Crustaceans are an invertebrate class within the arthropod group, the largest and most diverse phyla of animals on earth. *Daphnia* are sometimes referred to as "water fleas" because of their jerky movement through water. They are almost transparent, with a single compound eye and easily identifiable heart, which is part of an open circulatory system. The double-branched antennae of *Daphnia* aid locomotion, and the movement of appendages near the gills is clearly visible through a microscope.

Daphnia live approximately 50 days and can reproduce sexually and asexually. Under ideal

Science Standards

INQUIRY

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

LIFE SCIENCE

- Living systems at all levels of organization demonstrate the complementary nature of structure and function.
- Special cells perform unique functions in multicellular organisms. Groups of these cells cooperate to form tissue, such as muscle. Different tissues are grouped together to form larger functional units, called organs. Each type of cell, tissue and organ has a distinct structure and set of functions that serve the entire organism.
- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination and protection from disease. These systems interact with one another.
- Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.

Safety Issues

Advise students to exercise care as food coloring will permanently stain clothing.

Student use of ethyl alcohol must be closely monitored. Store alcohol in a secure place. Denatured 95% ethyl alcohol, which has been altered to prevent human consumption, can be purchased from any science supply company.

Students must thoroughly wash hands after handling *daphnia* and water in which *daphnia* are contained.

conditions, most individuals in a *Daphnia* culture are females, which produce eggs without mating. The eggs, which are visible under a microscope, are held in the female's body for several days until hatching and are visible under a microscope. When environmental conditions become stressful (shortage of food, poor water quality, unfavorable temperatures), more males are produced and the offspring mate. After mating, the females produce a different kind of egg (cyst) that can survive for a long period of time, even when dry.

There are 150 known species of *Daphnia,* which form an important link in natural aquatic food chains. *Daphnia* and related small invertebrates feed on algae, bacteria, fungi and decaying organic matter. In turn, they are major food sources for many kinds of fish, insect larvae and larval amphibians. *Daphnia magna* is the most commonly cultivated species.

Setup

Read Safety Issues (sidebar, left)

For Part B, you will need to prepare 200 mL of a 10% alcohol solution by mixing 20 mL of 95% ethyl alcohol with 180 mL of distilled water. To be precise, this solution requires 21 mL of alcohol mixed with 179 mL of distilled water. However, this exercise does not call for such accurate measurements. If using 70% ethyl alcohol, use 28 mL of ethyl alcohol and 172 mL of distilled water to make the alcohol solution. If purchasing grain alcohol, ask for 140 (=70%) or 190 (=95%) proof alcohol.

Daphnia can be ordered from science or aquarium suppliers, and can be maintained in cultures at room temperature, 24–31°C (75–88°F). *Daphnia* especially like to live in water with high concentrations of single-celled algae (for example, green pond water), but also will eat dried yeast that has been mixed with tepid water. Water pH cultures can range from 6.5–9.5.

Have students work in teams of two. Place materials in a central location.

Materials

Each team of two students will need:

- 40 mL of distilled water (for Part A, practice)
- 10 mL of prepared alcohol solution (for Part B, see Setup)
- 3 small cups (bathroom-size)
- 3 plastic pipettes with a small opening
- Plastic pipette with large opening
- 2 clean coverslips
- 2 clean microscope slides (plastic or glass)
- Bottle of green food coloring
- Container of pond water with live *Daphnia*
- Clock or watch with a second hand
- Graduated cylinder (to measure 20 mL)
- Marker
- Microscope
- Paper towels, several sheets
- Toothpick (for stirring)
- Copies of student pages (distributed in sequence, see Procedure)

Procedure

Part A. Water Replacement Challenge

1. Have Material Manager for each team of students pick up a clean microscope slide and coverslip, 2 pipettes, 2 small beakers or containers, several sheets of paper towels, and a copy of the Water Replacement Challenge student sheet. Instruct students to label one container "Plain Water" and the other container "Colored Water."

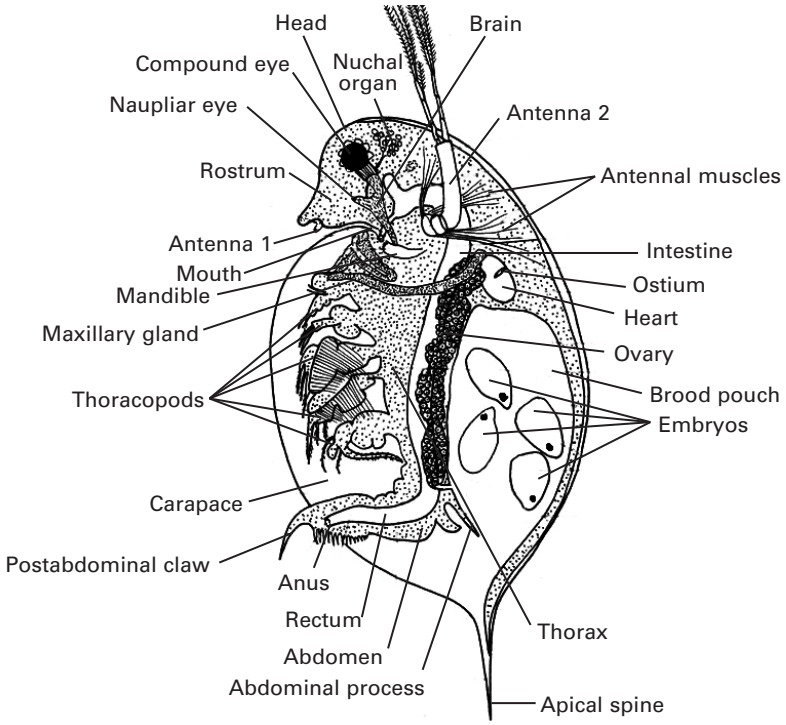


Illustration and identification of *Daphnia* parts by R.S. Fox. After W.H. Freeman and B. Bracegirdle. 1979. An Atlas of Invertebrate Structure.

2. Give each team a graduated cylinder and have students measure 20 mL of water into each of the two containers. Students should add five drops of green food coloring to the container labeled "Colored Water," and stir the mixture with the toothpick.
3. Call students' attention to the microscope slide and coverslip. Challenge them to think about why it might be useful to add a stain or fluid to a microscope slide after it has been prepared. For example, if the coverslip were removed each time a stain were added, it would disturb or destroy the contents on the slide.
4. Demonstrate for students how to use a pipette to "pick up" the clear water and place one drop of it on the center of a slide. Show students how to cover the drop with a coverslip by aligning one edge of the coverslip on edge of the slide, and allowing the coverslip to gently cover the drop of water.
5. Challenge students to come up with a way to add the colored water to the slide without removing the coverslip. After students have shared their ideas, ask, *What happens to water or other liquids if you touch them with a paper towel?* See if they can figure out how to use a paper towel to add the colored water to the slide. (See student sheet for detailed instructions.)
6. Have each team fill its first pipette with clear water, gently place one drop on the slide and cover it with the coverslip.
7. Next, have students fill the second pipette at least half-full with the colored water. Instruct them to place one drop at the edge of one side of the coverslip. It is important to remind students to place only one drop at a time, and that the drop must touch the edge of the coverslip.
8. Have students tear one sheet of

Alternate Activity

Two approaches to this activity are presented. The main activity takes place in the lab. Students will gauge the effect of increasing ethyl alcohol exposure on the heart rate of a living *Daphnia*. It requires a variety of laboratory apparatus and materials, and a *Daphnia* culture. Through the activity, students will develop skills in lab procedures, data gathering and interpretation of results.

In the Alternate Activity (see p. 17), or second approach, students view a BioEd video to observe the effects of increasing exposure to ethyl alcohol on *Daphnia* by counting the heartbeats in an experiment in a microscopic video recorded on a DVD (included with this guide).

Words to Discuss

Appendages

Arthropod

Cardiac

Crustacean

Consumption

Daphnia

Depressant

Invertebrate

Locomotion

Phyla

Vertebrate

THE *DAPHNIA'S* HEART

The heart rate of *Daphnia* is extremely variable, and can be affected by temperature, age of the individual, trauma, and exposure to chemicals. The heart rate obtained in plain water on the Experimental Setup Video Presentation is considerably lower than the rate students will get from the Heartbeat Count Video Experiment. The heartbeat ranges in both videos are normal for *Daphnia*.

paper towel into 1-inch pieces. Beginning with one piece, students will gently touch it to the opposite edge of the coverslip. The paper towel will act as a wick and absorb some of the fluid from beneath the slide, and at the same time draw fluid from the drop of colored water they placed on the other side underneath the coverslip.

Note. Caution students to absorb only a tiny amount of fluid at a time, so that the slide doesn't become dry under the coverslip.

9. Have students repeat the process until they can see that the colored water is underneath most of the coverslip.
10. *Optional.* After students have replaced the clear water with colored water, have them replace the colored water with clear water.
11. Once students have mastered the technique, have them wash and clean the microscope slide and coverslip. If glass, both will break easily, so tell students to be careful to avoid cuts and accidents.

Part B. Observing the Effects of Alcohol

1. Provide 1 clean slide, 1 coverslip, the pipette with a large opening (for "picking up" the *Daphnia*), 1 pipette with a small opening for the alcohol solution, a container with several *Daphnia*, and a container with 10 mL of 10% alcohol solution. Make sure students have access to a clock with a second hand (room clock or stop watches). Distribute the What are *Daphnia*? and Working With *Daphnia* student sheets.
2. Ask students, *What are the rules when handling chemicals?* Discuss the alcohol solution they will be using.
3. Demonstrate for students how to use the large diameter pipette to "pick up" one *Daphnia* and gently "squirt" it onto a slide. Show students how to gently cover the *Daphnia* with the coverslip (align one edge of the coverslip on an edge of the slide and allow it to gently cover the *Daphnia* in solution).
4. Distribute the remaining student sheets. Have teams follow the instructions, in sequence, on their student sheets. Remind students to check off each box as they complete a step.
5. Depending on your students' familiarity with microscopes, it may be necessary to refresh their memories about how to use the equipment. In this activity, students will only use the low power (shortest) objective. Due to the thickness of some of the *Daphnia*, students may break the coverslip when focusing if using high power. It always is important for students to use coverslips to protect the microscope lenses.
6. Provide instructions for students to gently suction the *Daphnia* from the slide at the completion of the experiment and return it to a fresh container of pond water, located in a designated place in the classroom. Have students clean up.
7. Discuss students' observations and conclusions as a group. Ask each pair of students to share its results with the class or prepare a class chart and compute the overall averages corresponding to each addition of alcohol.

Alternate Activity: BioEd Video

Please review the prior activity before performing the Alternate Activity.

Students work in teams of two. Begin by telling students that the *Daphnia* shown on the microscope slide in the video they are about to see was exposed to increasing concentrations of ethyl alcohol. First, the *Daphnia* in placed in plain water. Next, in each of three sequential steps, four drops of a 10% ethyl alcohol solution were added to the slide.

Explain that each team will count the *Daphnia* heartbeat rates at each step of the activity shown as follows. 1) Heart rate of the *Daphnia* in plain water, 2) Heart rate after adding 4 drops of ethyl alcohol, 3) Heart rate after adding 4 more drops of ethyl alcohol (total of 8 drops), and 4) Heart rate after adding 4 more drops of ethyl alcohol (total of 12 drops).

1. Distribute the student data sheets.
2. Start the video. The heartbeat rate for the *Daphnia* in plain water will be too fast for student teams to count accurately. Use the DVD player controls to slow the playback rate to 1/4 speed. Run the first experiment and call out to the teams, "Start." Teams should count heartbeats until you call out, "Stop" after 10 seconds. Temporarily stop the video to give teams time to process their data.
3. Have the two members of each team add their counts together and divide by 2 to get a team average. Next, have teams multiply their average counts by 4 to determine the actual number of heartbeats in 10 seconds at full speed. (As an alternative, you could slow the experiment to one-quarter speed and count for 40 seconds to get a 10-second real-time count.) Have teams enter their counts in the "plain water" row of the data table.
4. Start the video again and show the first addition of 4 drops of 10% ethyl alcohol. The heartbeat slows sufficiently from the plain water count to be able to count beats in real time. Students may note an occasional odd or skipped heartbeat. This is due to a slight misalignment of the *Daphnia's* heartbeat and the shutter rate of the camera. On occasion, parts of two successive heartbeats will appear to combine.
5. Continue and complete the activity by having teams fill in the data tables and answer all questions.

Answer Key

An answer key for this activity is located on page 56.

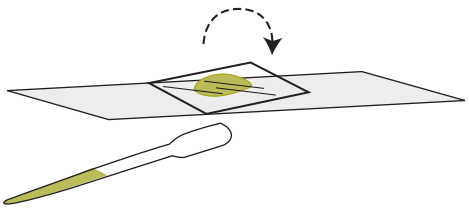
ACTIVITY 4

Water Replacement Challenge

Check off each box as you complete a step.

❑ 1. Obtain 1 microscope slide, 1 coverslip, 2 pipettes, 2 small containers, a bottle of green food coloring, a toothpick, a marker, several sheets of paper towels, a graduated cylinder, and a container of water. Label one container "Plain Water" and the other container "Colored Water." Add 20 mL of water to both containers. To the container labeled "Colored Water," add 5 drops of green food coloring. Be careful when using food coloring. It will stain your clothing permanently.

❑ 2. Place a single drop of clear water in the center of the microscope slide. Holding the coverslip at an angle, gently cover the drop of water. Place the slide on a paper towel on your desk.



❑ 3. Your challenge is to replace the clear water on the slide with the green colored water without removing the coverslip.

   a. Partially fill a one plastic pipette with the colored water.

   b. Place a drop of the colored water at the edge of one side of the coverslip.

   c. Take a small piece of paper towel and gently touch it to the opposite edge of the coverslip. The paper towel will act as a wick and absorb some of the fluid from underneath the slide. Be careful to remove only a tiny amount of fluid at a time.

   d. Repeat the process until you can see that the colored water is underneath most of the coverslip.

❑ 4. Now reverse the process. Replace the colored water from underneath the coverslip with clear water.

   a. Partially fill the second, clean pipette with clear water.

   b. Place a drop of clear water at the edge of one side of the coverslip.

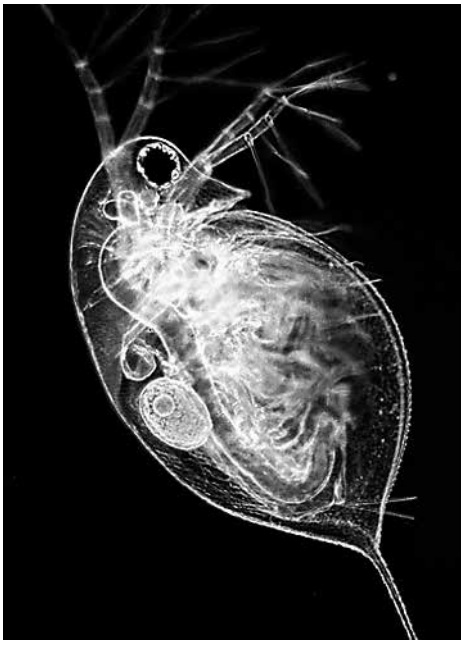
   c. Take a small piece of paper towel and gently touch it to the opposite edge of the coverslip. Repeat the process until you can see that the colored water has been removed from underneath the coverslip.

ACTIVITY 4

What are "daphnia"

Daphnia are tiny crustaceans that live in fresh water ponds and lakes. Crustaceans are an invertebrate class within the arthropods, the largest and most diverse phylum of animals on Earth. *Daphnia* are sometimes referred to as "water fleas," because of their jerky movements through water. As you can see by the image to the right, *Daphnia* are almost transparent, with a single compound eye and an easily identifiable heart. The heart is part of an open circulatory system.

Daphnia form an important link in natural food chains in lakes. They feed on algae, bacteria, fungi and decaying plant material. In turn, they are major food sources for many kinds of fish, insect larvae and amphibians.



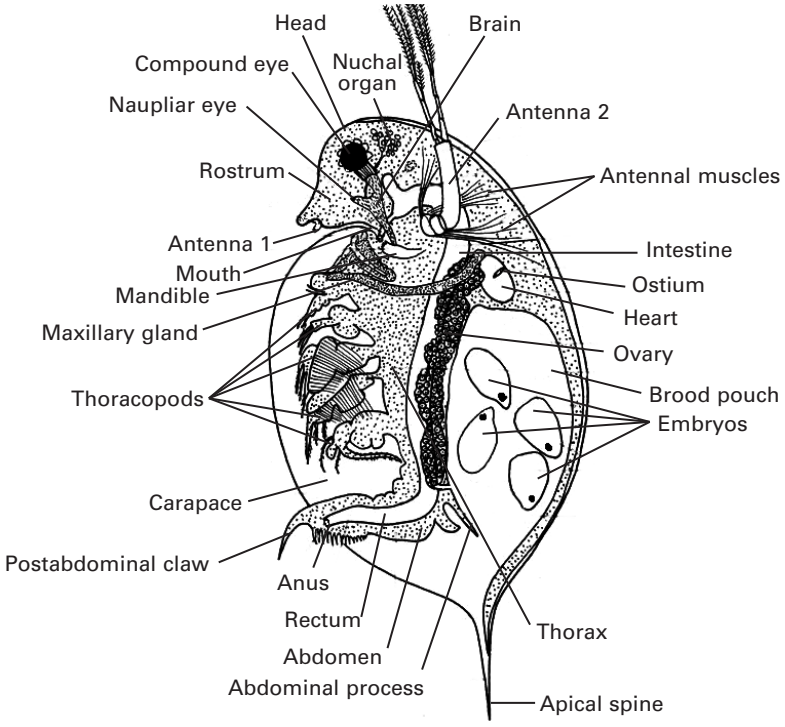


Illustration and identification of *Daphnia* parts by R.S. Fox. After W.H. Freeman and B. Bracegirdle. 1979. An Atlas of Invertebrate Structure.

ACTIVITY 4

Working With "daphnia"

Check off each box as you complete a step.

- ❑ 1. Obtain a container of pond water containing *Daphnia* and a container with 10 mL of a 10% ethyl alcohol solution.

- ❑ 2. You will need 2 plastic pipettes—one with a large opening and one with a small opening—and a clean microscope slide and coverslip.

- ❑ 3. Lay the microscope slide on a paper towel and have the coverslip ready.

- ❑ 4. Use the pipette with the large opening to collect a *Daphnia* carefully to observe. Squeeze the bulb of the pipette, submerge the tip in the pond water, and gently try to suction one *Daphnia* into the pipette. If you miss, bring the pipette to the surface and gently squeeze the bulb to expel the water. Try not to create bubbles. *Daphnia* can be killed easily if air becomes trapped under their carapace (outside covering). Any *Daphnia* that are floating on the top of the water either are dead or have air trapped under the carapace. Do not select one of them.

- ❑ 5. Once you have a *Daphnia* in your pipette, watch it until it sinks almost to the tip of the pipette, and then gently squeeze the water and *Daphnia* onto the microscope slide. Stop squeezing when you see the *Daphnia* on the slide, as it will make it more difficult to set the coverslip if you have a lot of water on the slide. Holding the coverslip at an angle, gently cover the drop of water and *Daphnia*. You must use a coverslip to protect the lenses of the microscope.

- ❑ 6. Place the slide under the microscope. Be sure to dry any water that accidentally spills onto the microscope stage.

- ❑ 7. Using LOW POWER, locate your *Daphnia*. You will find that you can see the details of the organism better if you dim the light source on the microscope (by using the diaphragm).

- ❑ 8. Find the heart (see diagram on "What Are *Daphnia*?" sheet). Remember that the *Daphnia* has thickness, so you may need to focus on different layers to see the heart clearly. It should be pulsating very fast.

- ❑ 9. Using your diagram, see how many other structures you can identify.

- ❑ 10. After observing the *Daphnia*, carefully return it to your container of pond water by using the pipette to gently remove the *Daphnia* from the slide.

ACTIVITY 4

Does Alcohol Affect Heart Rate?

Check off each box as you complete a step.

- ❑ 1. Collect a *Daphnia* in water and place it on a microscope slide. Cover the *Daphnia* with a coverslip.
- ❑ 2. Using LOW POWER, on your microscope, locate the *Daphnia*.
- ❑ 3. One team member will be the timekeeper and the other team member will count the heartbeats of the *Daphnia*. Count its heartbeat for 10 seconds and record the number of beats on your data table.
- ❑ 4. Consider the Water Replacement Challenge you completed earlier. You now will replace the water surrounding the *Daphnia* with a 10% alcohol solution—without removing the coverslip.
    a. Load a clean pipette halfway full of alcohol solution.
    b. Place the drop of the alcohol solution at the edge of one side of the coverslip.
    c. Take a small piece of paper towel and gently touch it to the opposite edge of the coverslip. Repeat. Be careful to take only a tiny amount of liquid at a time. If you pull the liquid across the slide too quickly, it may kill the *Daphnia*.
    d. Repeat the process until you have added 4 drops of alcohol.
- ❑ 5. Count the *Daphnia's* heartbeat for 10 seconds. Record the results on your data table.
- ❑ 6. Add 4 more drops of alcohol to the slide using the same process as you did in step 4.
- ❑ 7. Count the heartbeat again for 10 seconds. Record the results on your data table.
- ❑ 8. Add 4 more drops of alcohol to the slide using the same process as you did in step 4.
- ❑ 9. Count the heartbeat a third time for 10 seconds. Record the results on your data table.
- ❑ 10. Add 4 more drops of alcohol to the slide using the same process as you did in step 4.
- ❑ 11. Count the heartbeat a fourth time for 10 seconds. Record the results on your data table.
- ❑ 12. Carefully use a pipette to return the *Daphnia* to the container of pond water that your teacher has prepared for the class. Do not return the *Daphnia* to your small container of pond water.
- ❑ 13. If time allows, repeat the entire experiment with another *Daphnia*.
- ❑ 14. Follow your teacher's instructions about what to do with the slides and coverslips, and each of your solutions and pipettes.

ACTIVITY 4

Alcohol: Results and Conclusions

Use the data table below to record your experiment results, then follow the instructions and answer any questions listed below. Use the back of this sheet to record your answers.

Solution Content	Heartbeat/10 Seconds	
Plain Water		
Four additional drops of 10% alcohol		
Four additional drops of 10% alcohol		
Four additional drops of 10% alcohol		
Four additional drops of 10% alcohol		

To find out how many times the heart is beating per minute, you must multiply your 10-second count by what number (hint: how many seconds are in a minute?). Complete the last column of your data table above, then use the back of this sheet to answer the questions below.

1. Why do you need to count the heartbeat rate before you add alcohol?
2. Why is it important to wash your hands thoroughly with soap and water when working with pond water?
3. What happened to the heart rate of your *Daphnia* as you added the alcohol? Include other observations you made about your Daphnia. (What structures could you see? Were any of them affected by the alcohol?)
4. Why do you think you had the results you did?
5. What percentage of alcohol did you use? Did you increase the strength of the alcohol during the experiment? Approximately how long were the *Daphnia* exposed to the alcohol?
6. Construct a line graph of your results with the *Daphnia* alcohol experiment. What do you think would happen to the *Daphnia*'s heartbeat rate if four more drops of alcohol (16 drops total) were added to the *Daphnia* slide? Extend the graph line with dashes to see what the heartbeat rate might become. Predict what would happen to the *Daphnia* if you continued adding alcohol.
7. Why do you think you were asked to use ethyl alcohol (same type found in liquor) for this experiment, instead of methyl alcohol (found in rubbing alcohol)?
8. Based on your observations, does alcohol act as a stimulant or depressant on the heart rate of the *Daphnia*?
9. What is another experiment you might conduct using *Daphnia*? What would you want to find out? What do you think the result would be? List the steps you would follow.

Overview

Students research and identify normal functions of body systems, predict effects of alcohol on each system, and compare results. Students will learn that the body is an integrated system and that alcohol has different short- and long-term effects on different body systems. Class time: 60–90 minutes.

ACTIVITY 5

Somebody's body

When a person takes a drink of alcohol, some alcohol is absorbed directly into the bloodstream through the lining of the mouth. The rest goes down the esophagus into the stomach. Most is absorbed directly into the bloodstream through the lining of the stomach and small intestines. Blood circulates quickly, and alcohol can reach every organ in the body through the bloodstream in as little as 90 seconds after swallowing. The amount of alcohol in the blood peaks within 30–45 minutes after consumption of a standard drink (defined as 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of 80 proof alcohol). Since alcohol cannot be stored in the body and is a harmful substance, its components must be altered into something the body can safely tolerate. Ten percent of alcohol is eliminated through sweat, breathing and urine, but your liver must process the remaining 90 percent into a form that is acceptable for the body. At most, the liver can detoxify a limited amount of alcohol per hour without toxic effects on the body, depending on gender, weight, genetic characteristics, food consumption, etc. If the liver reaches a saturation point, which occurs when a person consumes more alcohol than the liver can process, excess alcohol (ethanol) and acetaldehyde (first product of alcohol metabolism) escape into the bloodstream, thus causing further impairment to the organs, including the brain. This is what causes intoxication.

As acetaldehyde levels increase, metabolism slows the conversion to acetic acid and even more acetaldehyde accumulates. This causes a rapid increase in blood flow to the skin (flushing), rapid heartbeat, headache, nausea, and extreme drowsiness. The toxic effects also can include inhibition of mitochondrial (powerhouse of the cell)

Science Standards

INQUIRY

- Develop descriptions, explanations, predictions and models using evidence.

LIFE SCIENCE

- Living systems at all levels of organization demonstrate the complementary nature of structure and function.
- Specialized cells perform specialized functions in multicellular organism. Groups of specialized cells cooperated to form a tissue, such as a muscle. Different tissues are, in turn, grouped together to form larger functional units, called organs. Each type of cell, tissue, and organ has a distinct structure and set of functions that serve the organism as a whole.
- The human organism has systems for digestion; respiration; reproduction; circulation; excretion; movement, control and coordination; and protection from disease. These systems interact with one another.
- Regulation of an organism's environment involves sensing the internal environment and changing physiological activities keep conditions within the range required to survive.

Extension

Ask students to list different diseases and disorders that could affect various organs. Also have students make a list of any medications and drugs—including alcohol, and other poisons and toxins—that can affect organs. Examples of diseases or conditions might include diabetes, heart attacks, arthritis, cancer, flu, colds, bacterial infections and injuries. Medications might include aspirin, antibiotics, cancer drugs, cocaine, etc. Pick several diseases/disorders from the list and ask students, *What organs are involved with this drug? What is the effect on other organs? Can a medication or alcohol be a poison? Why or why not?*

ALCOHOL & METABOLISM

Ethanol does not contain any minerals, vitamins, carbohydrates, fats, or proteins but still must be metabolized. The first step of alcohol metabolism is the oxidation (the addition of oxygen and release of energy) of ethanol to acetaldehyde by alcohol/dehydrogenase (the addition of oxygen and release of release of energy). The acetaldehyde is further oxidized to acetic acid and finally CO_2 and water through the citric acid cycle. A number of metabolic effects from alcohol are directly linked to the production of an excess acetaldehyde. (See www.NIAAA.NIH.gov.)

reactions and functions, thus beginning a vicious cycle of lowering metabolism even further. Consumption of enough alcohol in a short enough period of time can induce a coma, and possibly even death. Long-term effects of alcohol abuse include damage to the liver (hepatitis and cirrhosis), the nervous system, and other organs in the body.

The prefrontal lobes of the brain, where judgment and reasoning are processed, are the last part of the brain to develop, and are not complete until a person reaches his or her early 20s. Therefore, alcohol presents an especially difficult dilemma for adolescents: their brains are not yet equipped to make the best decisions regarding alcohol consumption, which can damage their brains before they even are fully developed. Alcohol-related damage includes shrinking of a part of the brain called the hippocampus, which is involved in creation of memory. Alcohol also can alter perception of spatial relationships, cause substance dependence, reduce the ability to learn, and cause depression, among other cognitive impairments. Recent studies have suggested that acetaldehyde may inhibit enzymes intended to convert specific neurotransmitters from aldehydes to acids. The neurotransmitters that accumulate instead may react with the acetaldehyde to form compounds similar to morphine, which may help to explain, in part, the development of alcohol addiction.

Setup

Make transparencies of the Body Organ Sets and The Human Body student sheets. Photocopy The Human Brain student sheet and cut out the brain images so that each student will receive one image of the brain. Make six copies of the Body Organ Sets page.

Materials

- Overhead projector
- Transparencies of two student sheets (see Setup)

Each group of four students will need:

- Access to the Internet, textbooks, library books and magazines (Part B)
- Glue sticks or tape
- Pair of scissors
- Pen or pencil
- Writing paper
- Prepared copy of brain image (see Setup)
- Copy of the Human Body and the Body Organ Sets student sheets

Each student will need:

- It's Your Body, Effects of Alcohol on the Body, and Somebody's Body student pages

Procedure

Part A. The Human Body

1. Have students read the Somebody's Body student sheet and record what they think might be important about conducting this exercise. For a class discussion, also have students describe what they would like to learn.
2. Divide students into groups of four. Have the members of each group count off from one to four, so that each student has a number.
3. Ask students if they can identify the three structures on The Human Body student sheet. Brainstorm with students to help them identify a major function for each of the three structures shown. Have groups label the three structures and list the most important function of each one.
4. Next, give each group one copy

of the Body Organ Sets student sheet. Have students cut out each group of organs. Remind students not to separate organs that are drawn together. Each student should receive the organ set corresponding with his or her number.

5. Have students use preselected web sites, age appropriate academic articles, class textbooks, and/or books checked out from the library to identify the names of the organs in their respective groupings and one or two major roles performed by each organ.
6. Use the transparencies of the student sheets to discuss the placement and function of the organs. Have students from different groups assigned with the same organs demonstrate where they think each part should be placed. Within each group, students should glue organs in place as the class reaches a consensus about the organs' identity, function and placement. Have group members label each organ on their student sheet and include the functions on their diagrams as they are glued down.
7. Ask students, *What major organ is missing?* Give one brain image to each group. The teacher will designate which sections of the brain each numbered student will research the major function of. Students with a "1" will do the frontal and parietal lobes, "2" temporal and occipital lobes, "3" the cerebellum, and "4" the brainstem.
8. Have groups add the brain image to their diagrams of the body. Ask students, *How are materials transported throughout the body? What are examples of these materials? Do activities of the body need to be coordinated? If so, how do you think this is accomplished?*

Part B. What Effect Does Alcohol Have on the Human Body?

1. Give each student a copy of What Effect Does Alcohol Have On the Body? student sheet. Have students work in their groups to develop predictions about which two structures are most affected—long- and short-term—by alcohol (students should place an "X" by the organs they choose). Instruct students to identify any structures they believe are not affected by alcohol by placing a star by those organs. Remind students to think about the functions of each structure as they make their predictions.
2. Have students use the Internet and the Library to create a list of the most important effects alcohol has on each organ. Student lists should be organized into columns marked "short-term" and "long-term." The web sites listed in the sidebar to the right are good places for students to start.
3. Discuss the outcomes of this activity as a class. Ask students the following questions.
   - What structures did you predict would be most affected by alcohol? On what did you base your predictions?
   - How did your predictions about the effects of alcohol compare with your research? What was most surprising to you? Why?
   - Do you think it is important for people to have information about alcohol? Why? At what age to you think people need to have this information? Why?

Research Web Sites

National Institute on Alcohol Abuse and Alcoholism
www.niaaa.nih.gov/

U.S. Department of Health and Human Services, and Samhsas: National Alcohol and Drug Information
www.samhsa.gov/

The National Council on Alcoholism and Drug Dependence, Inc.
www.ncadd.org/

National Institute on Drug Abuse
www.drugabuse.gov/

ACTIVITY 5

Somebody's Body

Read through the instructions below. Discuss, as a class, what you think you might learn. On the back of this sheet, list one or two questions you would like to answer while doing this activity. Use another sheet of paper to answer the questions below.

PART A

1. Count off so that each of you has a number (1–4). Remember your number.

2. Look at The Human Body page. Decide what you think is the most important function of each structure. Label each and include the function of all structures below the label on the diagram.

3. Find the Body Organs Sets page and locate the body organ set with your number on it. Cut around the outline. Do not separate organs that are drawn together.

4. Using reference sources provided by your teacher, identify each organ. Determine the major job or function of each organ and list these on the diagram.

5. Discuss placement of the images with your group members, then place the organ groups on the diagram. Do not glue anything on the diagram.

6. As a class, discuss where the organs should be placed and what the major role each plays in the body. Make any changes to your diagram, if necessary, then glue each organ group in place. Draw lines and label each part, and include the most important functions of the organs.

7. Are any major organs are missing? If so, obtain an image of the missing organ. Have one person in the group cut it out and attach it to the diagram.

8. Each person in the group should identify the name of the section that corresponds to their number. What is the function of your assigned area of the organ?

9. How do you think materials such as food nutrients are transported throughout the body? What are some other examples of materials that must be transported to different areas of the body?

10. Do activities of the body need to be coordinated? If so, how do you think this is accomplished?

PART B

1 Look at the Effects of Alcohol on the Body sheet. Place an "X" by the two structures you think will be most affected by drinking alcohol in the "Short-term Effects" column. Do the same in the "Long-term Effects" column.

2. Draw a star on the diagram by any line pointing to an organ that you think alcohol will not affect. When making your choices, refer to what you have already discussed and written about the functions of the body organs .

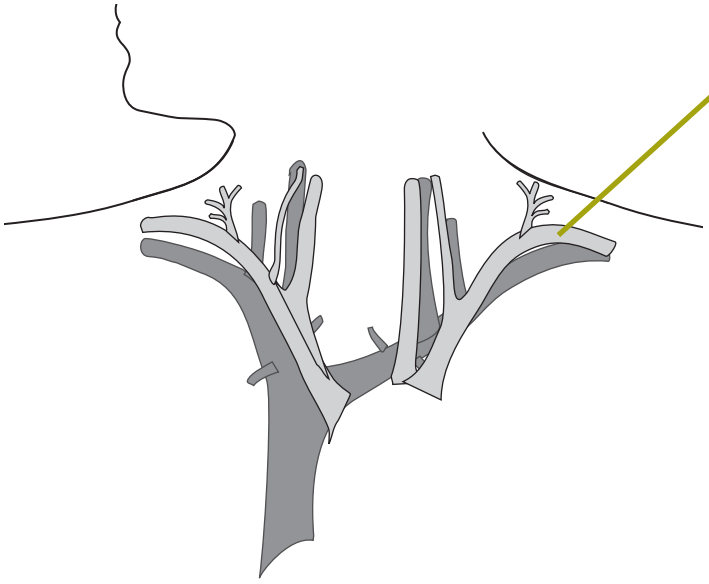
3. Discuss your predictions. How do your predictions compare with others in the class?

4. Look at the reference materials supplied by your teacher. List important short-term and long-term effects of alcohol for each organ on the diagram. Did you find any organs that were not affected by alcohol? If so, which ones?

5 Discuss your findings as a class. Add information and make corrections to your diagram as needed.

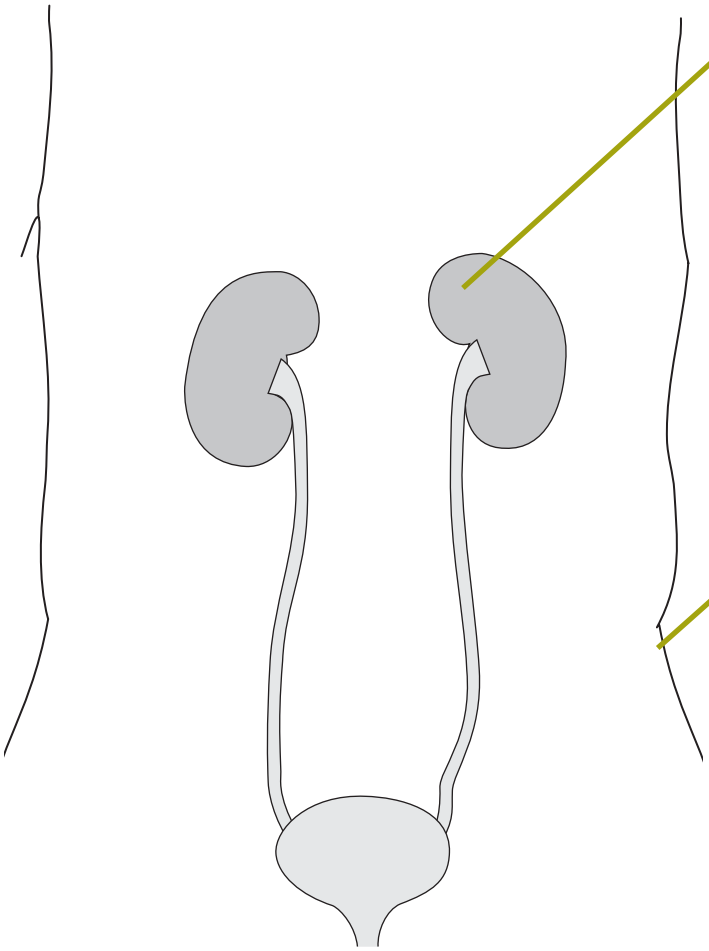
ACTIVITY 5

the human body



STRUCTURE

List functions below.



STRUCTURE

List functions below.

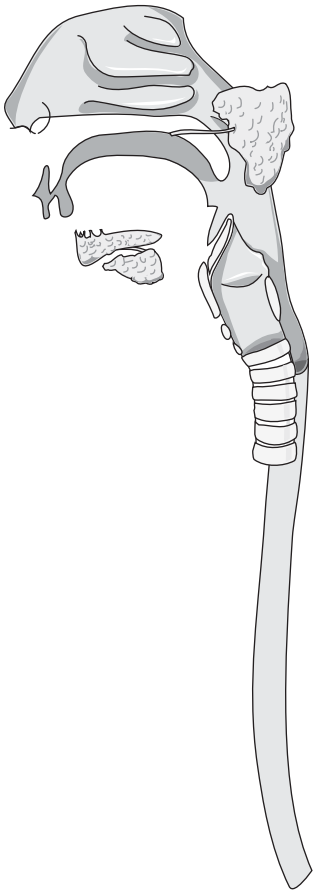
STRUCTURE

List functions below.

ACTIVITY 5

body Organ Sets

1.



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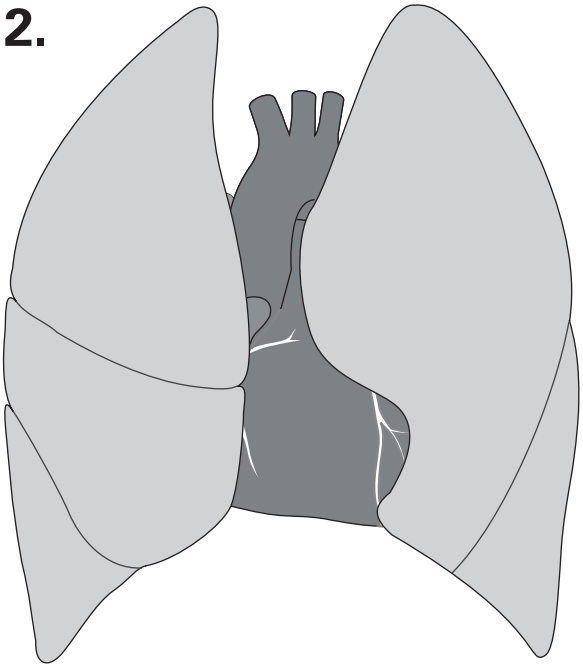
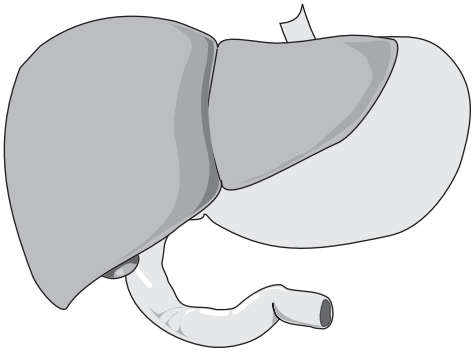


3.



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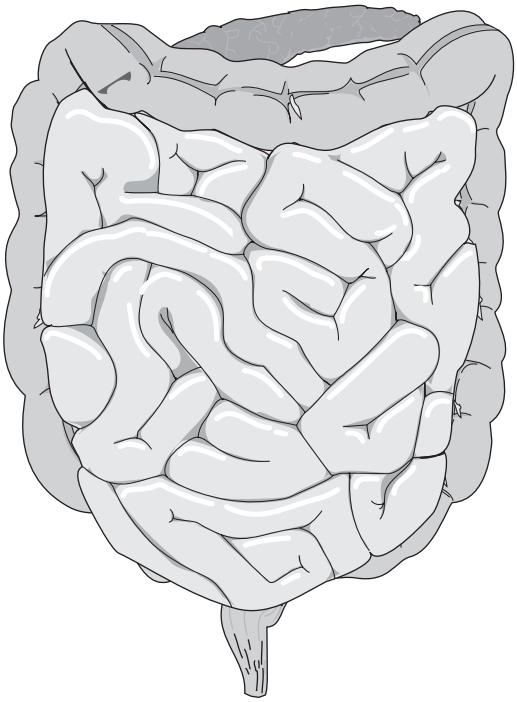
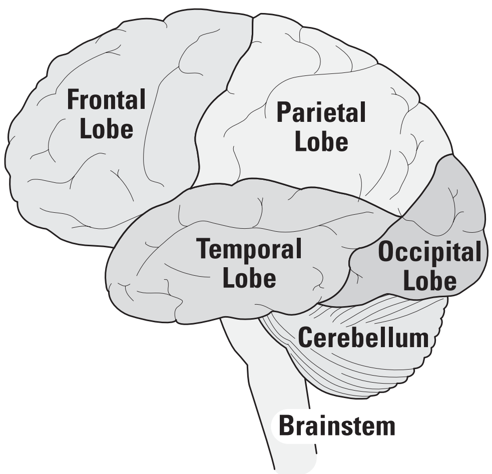
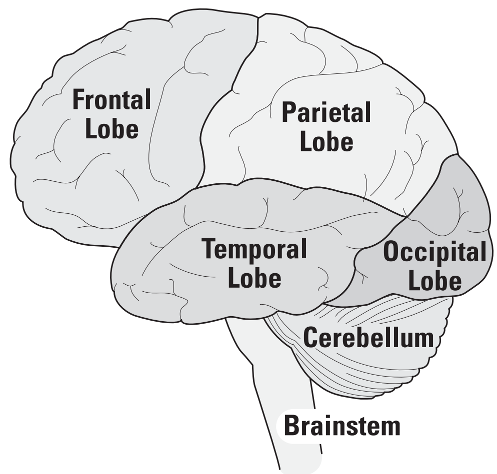
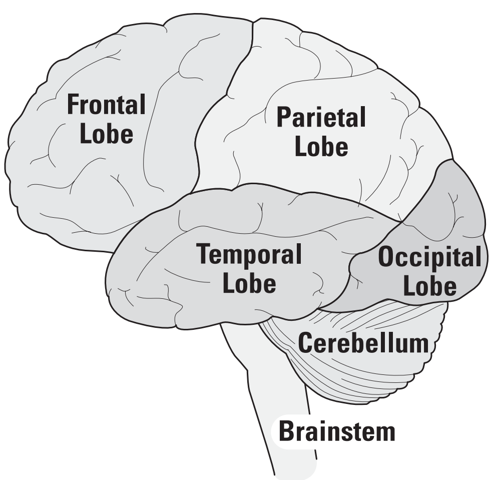


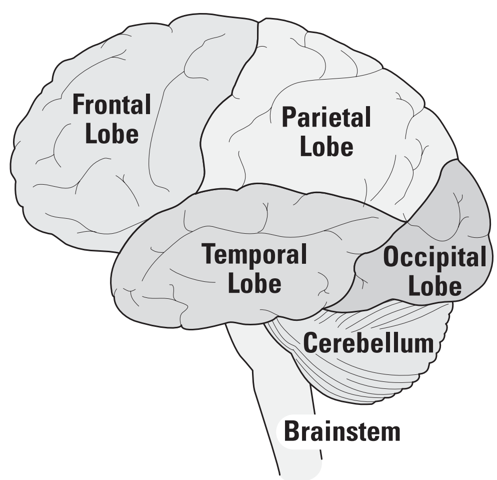
ACTIVITY 5

the human brain







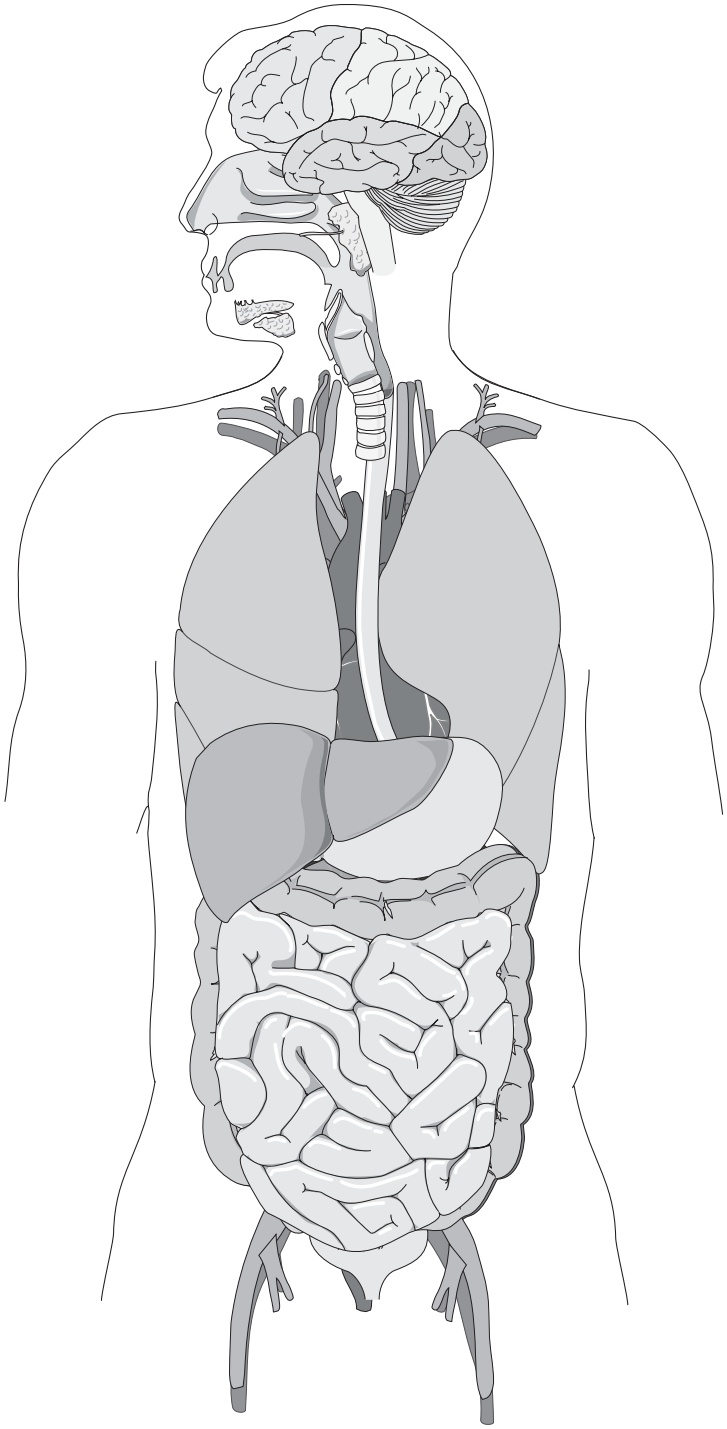


ACTIVITY 5

Effects of Alcohol on the Body

Using a separate sheet of paper, list the short-term and long-term effects of alcohol on each of the organs shown below. Circle any organ or structure you predict could be affected by alcohol. Draw a star by any organ you predict is not affected by alcohol.

SHORT-TERM EFFECTS	LONG-TERM EFFECTS
1. Brain	Brain
2. Mouth	Mouth
3. Esophogus	Esophogus
4. Heart	Heart
5. Lungs	Lungs
6. Stomach	Stomach
7. Liver	Liver
8. Pancreas	Pancreas
9. Small Intestine	Small Intestine
10. Large Intestine	Large Intestine



Overview

Students work through a problem-based case involving an unidentified alcohol shipment made to a flavoring manufacturer. In the process, they apply concepts related to different kinds of alcohol (methyl, ethyl and isopropyl), physical properties of substances, and solutions. Class time: 45–90 minutes.

ACTIVITY 6

Alcohol is a Chemical

In common usage, "alcohol" often refers to beverages that contain ethyl alcohol (ethanol). However, alcohols actually make up a chemical family, which also includes methyl alcohol (methanol), isopropyl alcohol (rubbing alcohol) and even glycerol (glycerin). All alcohols are carbon-containing molecules with an -OH group attached to one of the carbons. Chemists distinguish among different kinds of alcohols based on their chemical structures. (See chemical structures in the sidebars, p. 32).

Alcohols have many important uses as solvents, industrial raw materials and disinfectants. Methyl alcohol (Methanol), known as wood alcohol, is used as a solvent, fuel and in antifreeze. Ethyl alcohol (Ethanol), the active ingredient in alcoholic beverages, also is a component in the fuel known as "gasohol," and is used in medicines, food products and perfumes. Isopropyl alcohol (Isopropanol), or rubbing alcohol, serves as a disinfectant and an industrial cleaner. Most alcohols and alcohol mixtures are highly poisonous. For example, according to the U.W. Environmental Protection Agency, even a few teaspoons of methanol can cause blindness—a few tablespoons can be fatal.

For most purposes, alcohol is mixed with water or other substances. These mixtures are solutions and the amounts of each component usually are expressed as percentages of the total volume of the solution.

Setup

Photocopy student pages (see Materials). For the Thoughts and Conclusions page, students will work groups of four.

Materials

Each student will need:

- Several sheets of writing paper

Science Standards

INQUIRY

- Different kinds of questions suggest different kinds of scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models and theories.

PHYSICAL SCIENCE

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

EARTH & SPACE SCIENCE

- Water is a solvent.

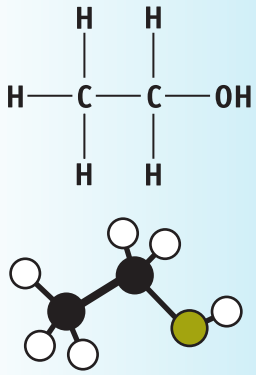
Words to Discuss

Alcohol

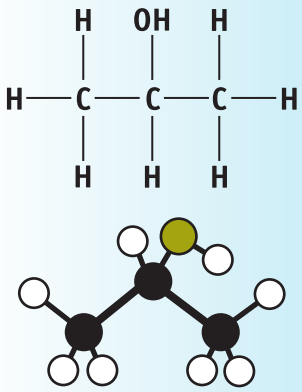
Molecule

Solvent

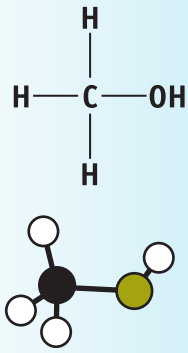
Ethyl Alcohol (ethanol)
C_2H_5OH



Isopropyl Alcohol (isopropanol)
C_3H_7OH



Methyl Alcohol (methanol)
CH_3OH



- Pen or pencil
- Copy of each student page, distributed in sequence (see Procedure, item 3)

PROCEDURE

1. Refer to the previous Solutions activity, in which students made percent volume solutions of liquid detergent, glycerin and water. Ask students, *What are other examples of mixtures (solutions) that we encounter every day?* Possible answers include household cleaning products, beverages, and beauty and grooming products. Create a list students' ideas on the board.
2. Use the list to emphasize that many food products and beverages, including alcoholic beverages, are mixtures that can be classified as solutions. Point out that most alcoholic beverages actually are solutions of ethyl alcohol combined with water and flavorings.
3. Distribute the student pages in sequential order, and steps as follows. Allow students enough time to discuss the content of each page thoroughly before proceeding to the next page.
   1. Case Study
   2. Information on File
   3. Chemical Safety Cards
   4. Thoughts and Conclusion
4. Give each student a copy of Case Study: The Unidentified Shipment student sheet. Have students read the introduction to the case—a simulated phone message, discuss the message and questions on the sheet. Students should generate their own questions and think about additional information they might need to solve the case.
5. Distribute copies of the Information On File student sheet and allow students time to discuss it. Repeat with the Chemical Safety Cards page.

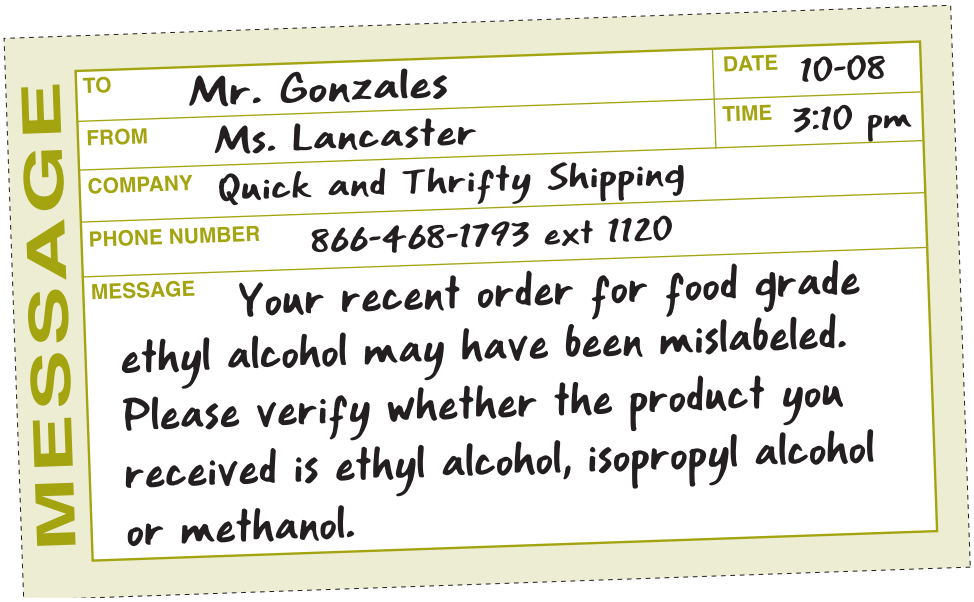
   Note. This exercise is open-ended. Thus, even though students will be able to figure out why Mr. Gonzalez placed the order, why the unlabeled shipment is a cause for concern, and how to identify which kind of alcohol was shipped, they will not find out the actual composition of the shipment.
6. Give each group a copy of the Thoughts and Conclusions student sheet. Have students within each group discuss and develop answers to the five questions at the end of the case.
7. Conduct a class discussion of each of the five questions by allowing the groups to present their ideas. Keep in mind that some questions have definite answers. The remaining questions have multiple possible solutions and are designed to promote discussion and critical thinking.

ACTIVITY 6

Case Study: the Unidentified Shipment

You and your team will play the roles of plant managers employed at Orchid Spices and Flavorings, Inc., a small company that manufactures and packages food flavorings, such as pumpkin pie spice and vanilla extract. Today, you are facing a potentially serious problem. You will need as much information as possible to evaluate the situation and make decisions.

Mr. Gonzalez is a production specialist at Orchid Spices and Flavorings. He received the following message about a shipment of goods received at Orchid Spices and Flavorings earlier in the day. Mr. Gonzalez has brought the message to you. Read the message, then answer the questions below. Use the back of this page if necessary.



1. Should you and Mr. Gonzalez be concerned? Why or why not?

2. Do you have any questions? Record your questions below. If necessary, use the back of this sheet.

3. What other kinds of information might you need? List the information you need.

ACTIVITY 6

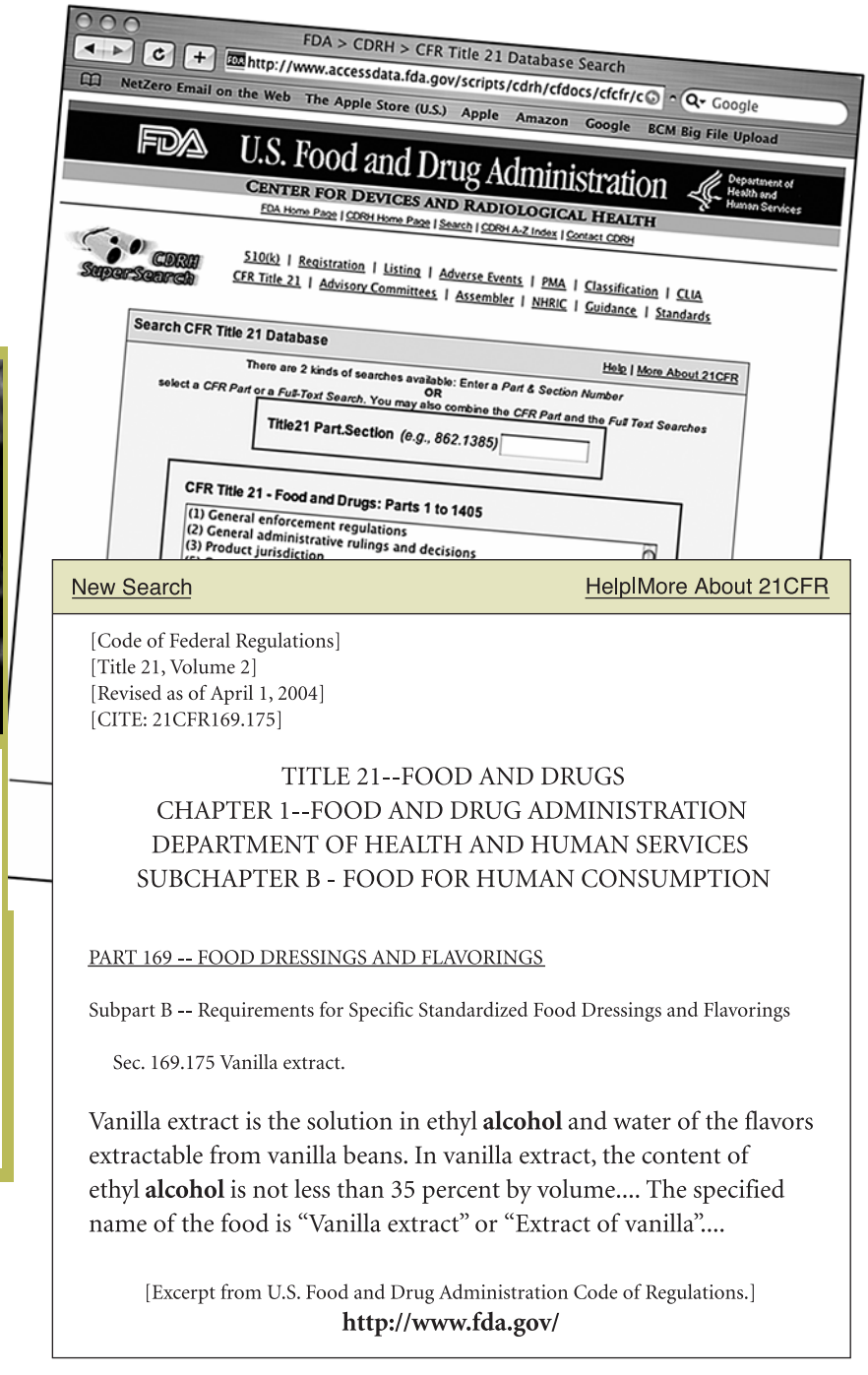
information on File

You asked Mr. Gonzalez to provide you with product facts and the most current U.S. Food and Drug Administration product guidelines posted on the Internet. Read the information he provided and answer the questions below. Record your answers on the back of this page.

Vanilla Production Facts

To make vanilla extract, beans are harvested from the vanilla orchid, a tropical plant. The beans are harvested, dried and aged for up to two years. The dried beans can be used as flavoring. The beans also can be used to produce what is commonly known as "vanilla," or vanilla extract. Flavoring manufacturers chop the beans and soak them in a solution of ethyl alcohol and water. During this process, the chemicals responsible for the taste of vanilla are dissolved into the alcohol solution.

Ethyl alcohol is a component in many foods, medicines, flavorings and perfumes.



1. Does this information provide answers to any of your questions?
2. Do you have any new questions? If so, record them on the back of this sheet.
3. What additional information might you need to evaluate the problem? List the information you need.

The U.S. Food and Drug Administration's website contains detailed information about many products, including food, drugs, medical devices, biologics (vaccines and blood products), animal feed and drugs, cosmetics, radiation-emitting products and combination products (for example, a drug and device sold as one product). Visit the site at www.fda.gov/.

Image supplied by Discover Orchids.

ACTIVITY 6

Chemical Safety Cards

As part of their safety policy, Orchid Spices and Flavorings, Inc., must maintain up-to-date Chemical Safety Cards (CSC) for all chemicals used to manufacture their products. Mr. Gonzalez is production supervisor of vanilla extract and has just brought the following CSCs to you. Read the CSCs and answer the questions below. Record your answers on the back of this page.

Chemical Safety Card

ETHYL ALCOHOL
Common & Trade Names
Alcohol, Ethanol, Grain Alcohol

Chemical Formula: C_2H_5OH
Boiling Point: 78.5°C
Relative Density: 0.8 (water=1)
Physical Appearance: Clear, colorless liquid, weak odor

IMPORTANT DATA

Exposure Routes
Ingestion by mouth, inhalation, skin, eyes

Toxicity
Blood alcohol levels greater than 0.5 grams per mL blood can cause brain damage or death. Non-toxic in small amounts.

Symptoms/Effects
Drowsiness; headache; coma; liver damage; anemia; reproductive effects; irritation eyes, skin, nose; cough

Uses: Alcoholic beverages, pharmaceuticals, toiletries, cosmetics, gasoline additives, antifreeze

Chemical Safety Card

ISOPROPYL ALCOHOL
Common & Trade Names
Isopropanol, Rubbing Alcohol

Chemical Formula: C_3H_7OH
Boiling Point: 82.5°C
Relative Density: 0.79 (water=1)
Physical Appearance: Colorless liquid, rubbing alcohol odor

IMPORTANT DATA

Exposure Routes
Ingestion by mouth, inhalation, skin, eyes

Toxicity
Highly toxic effects in 30-60 minutes exposure at 20 mL dose or above. Dose above 100 mL can cause brain damage or death.

Symptoms/Effects
Drowsiness; headache; dizziness; coma; loss of coordination; nausea, vomiting, abdominal pain; irritated throat, nose, eyes; cracking skin

Uses: Disinfectants, liquid soaps, cleaning solutions, antifreeze, paints, cosmetics, perfumes, toiletries, insecticides

Chemical Safety Card

METHYL ALCOHOL
Common & Trade Names
Methanol, Wood Alcohol/Naphtha

Chemical Formula: CH_3OH
Boiling Point: 65°C
Relative Density: 0.79 (water=1)
Physical Appearance: Clear, colorless liquid, pungent odor

IMPORTANT DATA

Exposure Routes
Ingestion by mouth, inhalation, skin or eye contact

Toxicity
Highly toxic. Blindness can occur at 10 mL dose; dose above 30 mL can cause death.Toxic effects are not immediate,

Symptoms/Effects
Irritation eyes, skin, respiratory system; headache, drowziness, dizziness; nausea, vomiting; optic nerve damage; mental changes

Uses: Jet fuel, paint thinner, windshield washer fluid, embalming fluid, manufacturing of plastics, antifreeze

1. How is this information helpful?
2. Does this information provide answers to any of your questions?
3. Given that no outside laboratory is available to test the shipment, what kind of test could be conducted to figure out what kind of alcohol the company received?

ACTIVITY 6

Thoughts and Conclusions

As a group, think about each question below. Record your ideas about each question. Use a separate sheet of paper for each question, if necessary. Be prepared to present your ideas to the class.

1. Why did Orchid Spices and Flavorings, Inc., place an order for food-grade ethyl alcohol?

2. What is the potential problem implied by the phone message?

3. How could you figure out what kind of alcohol was in the shipment?

4. How much alcohol would have been ordered if Mr. Gonzalez was planning to make 100 liters of vanilla extract?

5. Why do you think the purchase of vanilla extract is not controlled, while the purchase of beer, wine and other beverages containing ethyl alcohol is controlled by law?

Overview

Students will estimate risks associated with different events and compare their estimates to the real probabilities. Class time: 45 minutes.

ACTIVITY 7

Estimating Risk

People perceive risks differently, depending on the nature of the risk and their individual experiences. Risk perceptions are strongly influenced by issues of choice and control; risks often seem "riskier" to people if they have not voluntarily chosen to bear them. Conversely,

A child of an alcoholic has a 75% chance of being vulnerable to alcoholism.

people are more willing to accept or ignore risks that they choose voluntarily, especially if the immediate benefit seems to outweigh the potential for negative outcomes much later in time. In the case of chemical substances that affect the brain, the risks can be very high indeed.

It is important to note that most people begin to use brain-altering chemicals voluntary. Over time, however, if use increases or is sustained, the brain and body adapt to the effects of the chemical. This creates a new "normal" state, adjusted to the presence of the introduced substance. Such adaptation leads to a physical dependence, or "craving," for the substance that is no longer voluntary and may lead to consumption of the substance in increasingly higher and more damaging amounts. For example, more than 80 percent of the current U.S. population chooses to consume the stimulant caffeine in coffee and/or cola drinks because of its taste and/or perceived enhancement of mental and physical performance. Eventually, most caffeine consumers develop a dependence on its stimulating effects and experience mild withdrawal symptoms, such as sleepiness and headaches, when they do not have caffeine.

Other chemicals have more dramatic effects on the brain and body. Many affect the parts of the brain responsible for generating feelings of pleasure or well-being. These drugs are sometimes used inappropriately by people

Science Standards

SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES

- Individuals can use a systematic approach to thinking critically about risks and benefits.
- Important personal and social decisions are made based on perceptions of benefit and risk.
- Perception of risk is affected by issues of personal choice and control.
- Many chemicals influence the function of the brain and nervous system.
- Health risks associated with alcohol, tobacco and other drugs of abuse often are underestimated.

EARLY USES OF DRUGS

Anthropologists have uncovered ancient uses of mind-altering substances for medicinal and ritualistic uses in a number of cultures around the world.

The use of the substances in ritualistic practices was strictly controlled by community leaders and involved plant-based medicines that were less potent and less refined than many of the drugs used today.

CHEMICAL MESSENGERS

Studies on how chemical messengers work within the brain and nervous system hold promise for unraveling many basic questions about the actions of drugs and the causes of some diseases. Almost all drugs that influence the way the brain works do so by altering the transmission of chemical messages. This influence can have important medical applications for the treatment of severe pain or illnesses such as schizophrenia or depression. Some medicines used to treat depression, for example, act on chemical messengers involved in regulating sleep and body temperature. Morphine, a potent pain medication, mimics the effects of a natural chemical messenger that works along brain pathways for minimizing pain and producing a sense of well-being.

to change the way they feel. But, feelings of euphoria, comfort or pleasure usually disappear after the first few uses of these substances. This may result in people taking more and more of the substance to maintain the "high". Unfortunately, continued drug use actually changes the way the brain works. This is the biological basis of addiction.

Many mind-altering chemicals that are abused by children and adults in the US lead to permanent changes in the brain and other parts of the body. These are some examples of commonly abused chemicals. Marijuana use can alter memory regions of the brain and affect coordination and the senses in the short term. Heroin changes the way nerve cells in the brain receive and process messages. Inhalants, which are taken up by fatty tissue in the body, destroy the fat-containing myelin sheath on nerve cell axons and block nervous system communications, sometimes permanently. LSD can contribute to the development of chronic mental disorders. Alcohol, which depresses physical and mental abilities, damages many tissues throughout the body, including the liver and the brain. Alcohol also is a major contributing factor to automobile accidents because it affects coordination and judgment. Nicotine, a stimulant in tobacco, is a very addictive substance that can damage the circulatory system. However, the greatest health risk from smoking comes from other compounds in cigarette and cigar smoke that are linked to development of lung and other cancers.

Eighty percent of all people who have completed drug treatment programs relapse within six months.

MATERIALS

Each group of four students will need:

- Roll of clear tape, 0.5 in.

Each student will need:

- Pair of scissors
- Sheet of paper, 8.5 x 11 in.
- Copy of each student sheet

PROCEDURE

1. Begin with a class discussion. Ask students, What are examples of substances that change the way the brain works or how a person feels? Give students time to think of some of the most common examples, such as alcohol, coffee and soft drinks with caffeine, cigarettes (nicotine), marijuana, inhalants ("sniffing" glue, paint or aerosol sprays), etc.
2. Follow by asking, *Do you think people evaluate possible health risks when they take a substance that affects the brain? Why or why not?*
3. Tell students that one way to quantify risk is to state it as a probability that something will occur. Explain that by studying how frequently events have happened in the past, scientists and statisticians have been able to calculate the risk of many different types of occurrences.
4. Give each group of students a copy of the What Are the Odds? student sheet and have them read all of the statements. Have students cut the statements into strips (so that they can be rearranged easily). Next,

Helpful Resources for Teens

Many students may themselves be in home situations that are dangerous because of physical or sexual abuse. Or they may have friends who do not know where to go for help. There are several web sites where teens can find assistance on their own time and in their own way.

- **Alateen** offers help for students whose lives are being impacted by alcohol use and abuse. Students can call or visit the Alateen web site. Information on the site is available in English, Spanish and French.

  www.Al-Anon.Alateen.org

  To locate a local Alateen meeting, students may call toll free:

  1-888-4AL-ANON
  1-888-425-2666

- **TheCoolSpot.gov** web site, geared for young teens, is an interactive site which allows teens to explore the facts and provides information about alcohol/alcoholism and how to resist peer pressure. *National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health.*

  www.TheCoolSpot.gov

- MindZone, a mental health site for teens, offers students ways to cope with stress and mental illness, helps them recognize if someone needs help, provides mental health resources, and gives the facts about depression, schizophrenia and other illnesses that may affect a young teen's life. *The Annenberg Foundation at Sunnylands.*

  www.Cope.areDeal.org

have students discuss within their groups how likely it is that each event will occur.

5. Students should rank the events numerically, from most likely to occur to least likely. The number "1" should be given to the most likely event. Have students place the strips in order of likelihood from most risk (top) to least risk (bottom). You may want to provide tape and a separate sheet on which students can arrange and secure their strips.

   Note. Tell students that some items have the same odds.
6. Discuss students' predictions briefly by asking which events they placed at the tops and bottoms of their lists. Let each group share some of its predictions and the reasoning behind the choices. Allow student groups to rethink or revise their predictions based on the discussion.
7. Distribute a copy of The Risks Are Real student sheet to each group and ask students to compare their predictions to the actual risk calculations.
8. Conclude by discussing the actual risks as compared to students' predictions. Ask guiding questions such as, *Which ranking surprised you the most? Which were you able to predict most accurately? Do you think you or any of your friends might be ignoring long-term risks because you are making choices based on short term benefits?*

ABUSE VS. ADDICTION

There is a difference between drug abuse and drug addiction. Drug abuse is a voluntary activity: the user makes a choice about taking a harmful drug. Drug addiction is a compulsion: the need to use a drug is overwhelming.

People abuse drugs because the drugs produce feelings of pleasure, or because they remove feelings of stress and emotional pain.

Over time, the body can become "used" to an addictive drug, causing severe withdrawal symptoms when the substance is removed. Addicted people continue drug use to avoid the pain of withdrawal, not because they derive any pleasure from the experience.

DRUG USE TODAY

Drug addiction and abuse is one of the most serious problems of our modern society. There are more than 10 million alcoholics in the United States. About 5.5 million people in the United States are addicted to illegal drugs.

ACTIVITY 7

What Are the Odds?

Read the statements below. Cut the statements into strips and place the events in order from most likely (top) to least likely to occur (bottom). Rank the statements numerically, assigning "1" to the most likely event. Keep in mind that some items are equally likely, so they will share the same number.

_____ Being born left-handed

_____ Living to the age of 116 years

_____ Being killed by a shark

_____ Picking all 5 winning numbers in a lottery (total of 49 numbers)

_____ Quitting smoking successfully without any help

_____ Becoming addicted to caffeine if you regularly drink caffeinated coffee, tea or soft drinks (such as cola)

_____ Being electrocuted

_____ Becoming a professional basketball player if you play basketball in high school

_____ Becoming addicted to nicotine if you smoke cigarettes

_____ Being involved in an alcohol-related car accident

_____ Having poor driving skills after smoking one marijuana cigarette

_____ Being killed by falling out of bed

_____ Permanently damaging the myelin sheath on nerve cells in the brain by "sniffing" paint or glue

_____ Dying from influenza (the flu)

_____ Being pressured by a friend to smoke or use alcohol

_____ Having a fatal accident while playing sports

_____ Becoming dependent on crack or cocaine, if injected

_____ Dying of a smoking-related illness if you start smoking as a teenager

ACTIVITY 7

the Risks Are Real

These are the real odds for the events you ranked, from most likely to occur to least likely. Compare the odds to your rankings. Surprised?

1. Having poor driving skills after smoking one marijuana cigarette	1 in 1
2. Becoming addicted to caffeine if you regularly drink caffeinated coffee, tea or soft drinks (such as cola)	1 in 1.25
3. Becoming addicted to nicotine if you smoke cigarettes	1 in 2
3. Permanently damaging the myelin sheath on nerve cells in the brain by "sniffing" paint or glue	1 in 2
4. Being pressured by a friend to smoke or use alcohol	1 in 3
4. Being involved in an alcohol-related car accident	1 in 3
4. Dying of a smoking-related illness if you start smoking as a teenager	1 in 3
5. Becoming dependent on crack or cocaine, if injected	1 in 4
6. Being born left-handed	1 in 5
7. Quitting smoking successfully without any help	1 in 10
8. Dying from influenza (the flu)	1 in 5,000
9. Becoming a professional basketball player if you play basketball in high school	1 in 10,000
10. Having a fatal accident while playing sports	1 in 25,000
11. Being electrocuted	1 in 350,000
12. Picking all 5 winning numbers in a lottery (total of 49 numbers)	1 in 1,953,393
13. Being killed by falling out of bed	1 in 2 million
14. Being killed by a shark	1 in 300 million
15. Living to the age of 116 years	1 in 2 billion

Compiled from public domain statistics made available by the National Institutes of Health, Center for Substance Abuse Prevention, National Clearing House for Alcohol and Drug Information, American Cancer Society, CareerQuest and Dartmouth University.

Science Standards

INQUIRY

- Different kinds of questions suggest different kinds of scientific investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models and theories.
- Develop descriptions, explanations, predictions, and models using evidence.

PHYSICAL SCIENCE

- A substance has characteristic properties—such as density, a boiling point, and solubility—all of which are independent of the amount of the sample.

HISTORY & NATURE OF SCIENCE

- Scientists formulate and test their explanations of nature using observations, experiments, and theoretical and mathematical models.

SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES

- Individuals can use a systematic approach to thinking critically about risks and benefits.
- Many chemicals influence the function of the brain and nervous system.
- Health risks associated with alcohol, tobacco and other drugs of abuse often are under estimated.

Overview

Students will learn about the effects of alcohol on the human body and conduct a simple activity focusing on blood alcohol concentration, or BAC. They will learn how to estimate BAC through the use of BAC calculator tables. Class time: 60–90 minutes

ACTIVITY 8

One in One Thousand

Every year, alcohol abuse exacts a terrible toll in the United States. Operators of motor vehicles, driving under the influence of alcohol, are involved in about two million accidents annually, leading to approximately 25,000 deaths and more than 700,000 injuries—about 70,000 of those serious. In other words, someone dies in an alcohol-related accident in this country every 20 minutes. Alcohol related accidents are the leading cause of death for Americans between the ages of 16 and 24, and it costs the nation more than $25 billion per year, in the form of higher automobile insurance rates for all drivers, higher medical costs, and increased taxes for everyone.

All states have laws designed to prohibit people from operating motor vehicles while under the influence of alcohol. These laws define alcohol intoxication, based on the concentration of alcohol in the bloodstream. Drivers pulled over for suspected intoxication, or involved in an accident where intoxication is a suspected factor, are tested for alcohol impairment. Simple eye-hand coordination and walking tests may be conducted by a police officer on the scene, but the tests are not always accurate. The most thorough tests—which analyze blood or urine samples—are impractical in field conditions. Currently, breath analyzers offers the best "on the spot" technology for determining a driver's level of alcohol intoxication. Police departments use different types of breath analyzers (also referred to as "breathalyzers"). A suspected driver blows air into a device that uses a chemical test, infrared spectroscopy, or a chemical reaction in a fuel cell to measure the driver's blood alcohol concentration.

One's level of intoxication is measured in terms of "blood alcohol content" (BAC), or the amount of alcohol present in his or her blood. Specifically, BAC is defined as the number of milligrams of

BAC: Behavior & Physical Effects

The symptoms of intoxication vary with the individual and the amount of alcohol consumed. The following table describes the behavior and physical effects that are experienced by an "average" person with different BAC levels. Individuals may, however, experience one or more symptoms from other BAC levels simultaneously.

0.05	Loss of emotional restraint, mild impairment of judgment, feeling of warmth, flushing of skin, vivaciousness
0.10	Slight slurring of speech, loss of fine motor movements (such as writing), slower reaction time, confusion with tasks requiring thinking, inappropriate laughter, embarrassing behavior
0.20	Very slurred speech, staggering gait, double vision, lethargic but able to respond to voices, difficult sitting upright in a chair, memory loss
0.30	Stuporous, able to be aroused only briefly by strong physical stimulus (such as a face slap or pinch), deep snoring
0.40	Comatose, not able to be aroused, incontinent, low blood pressure, irregular breathing, bluish skin, unresponsive to painful stimuli
0.50	Coma, death possible from cessation of breathing, excessively low blood pressure, or vomit blocking air passages

alcohol dissolved in 100 milliliters of blood. A BAC of 0.1 is equivalent to 1 part alcohol in 1,000 parts of blood. With a BAC of 0.08 or above (1 part alcohol in 1,250 parts blood), a person is considered legally intoxicated in all 50 states and the District of Columbia. In most states, a person driving with a BAC of 0.08 or above will have his or her license automatically suspended for 90 days to a year—for a first offense. He or she also may forfeit his or her vehicle.

As shown in the BAC: Behavior & Physical Effects chart above, the effects of alcohol in humans increase as BAC levels rise. Many factors affect how an individual reacts to alcohol. These factors can include variations in body weight, gender, body fat and water content, nutrition, drug use and long-term drinking habits. Alcohol experts, though, have developed calculators that predict what a person's BAC might be after taking one or more drinks. Different calculators are available for women and men. Both calculators assume the subject has consumed standard volumes of alcoholic drinks (one 12-oz beer = 1.5 oz of liquor = one 5-oz glass of wine), which deliver the same amounts of alcohol to the blood stream. The charts on the BAC transparencies estimate the effects of 1–10 drinks on men and women of different body weights. Time between drinks also is important. If a person consumes several alcoholic drinks in succession over several hours, the charts will overestimate the BAC. To correct the BAC estimate for time, subtract 0.015 from the table number for each hour since the drinking began. For example, if drinks are consumed over a period of one hour, 0.015 should be subtracted from the derived number on the chart and 0.03 should be subtracted if

DRIVING SIMULATORS

Researchers at the National Advanced Driving Simulator (NADS) often study the effects of various BAC levels on drivers. Obviously, this cannot be done safely on the open road. Volunteers of different ages and drinking practices pretend to drive under different roadway conditions, such as dense traffic. Sometimes, drivers are given realistic tasks to perform while driving. For example, eating, changing a CD or talking on a cell phone while being safely subjected to a variety of road conditions. In fact, the NADS is equipped with 3-D sound to simulate real, and sometimes unexpected, loud noises.

The NADS is the "mother" of all simulators. It cost about $60 million to build and is big enough to hold not only different vehicles, but also monitoring equipment, a huge projector, and data collection stations. NADS has a 360° field of view and sits on six immense hydraulic legs that simulate pitch, roll, and spin. Different vehicles, or modules, can be put inside the giant simulator (one at a time). There's a Chevy Malibu, Ford Taurus, Jeep Cherokee—and even an 18-wheeler truck cab!

To learn more about the driving simulator and current studies, visit The University of Iowa NADS web site at www.NADS-sc.uiowa.edu.

ONE INVENTOR'S STORY

Several inventors were working on breath analyzers at the same time. One inventor, Robert Borkenstein, developed a breath analyzer without ever having gone to college. He did it while he worked as a police captain in charge of laboratory services, before retiring from the force after 22 years of service.

After that, at age 46, he went on to earn his Bachelor's degree from Indiana University. He later became the first chairman of the University's Department of Forensic Studies. Borkenstein wanted to make life better for people by finding a way to control alcohol consumption. The invention of a breath analyzer was part of his life's work.

WHAT IS THE SAFEST BAC?

Although a low BAC may have minimal effects on the body, the only BAC level considered safe for operating a motor vehicle is 0.00.

the drinks were consumed over two hours.

SETUP

Photocopy student pages and prepare transparencies. Place materials in a central location.

MATERIALS

- Overhead projector
- Transparencies of Blood Alcohol Calculators and BAC: Behavior and Physical Effects pages

Each group of four students will need:

- 75 mL each of water, isopropyl alcohol, glycerin, and detergent in 100-mL beakers or containers
- Small graduated cylinder
- Eyedropper or plastic pipette
- Small beaker or jar with plain water
- Four small clear plastic cups or test tubes and a test tube rack
- 1,000-liter beaker or water bottle (1-liter size) with water
- Green or blue food coloring
- Paper towel for spills
- Calculator (optional)

PROCEDURE

Part A. Every Drop Counts

Safety note. Before proceeding, caution students to be careful with the food coloring. It will stain fingers and clothing.

1. Begin a discussion on blood alcohol content and what it means. Ask students, *How many automobile accidents do you think take place in the United States every year where one or more of the driver had been drinking alcohol?* Give students three choices. (Two million). *How many people do you think are killed in accidents involving drunk drivers?* (25,000, that is about the number of students attending 50 elementary schools with 500 students each). Explain that law enforcement must monitor people for drunk driving for the safety of all people, and that tests have changed over the years from a simple coordination test to the BAC system. Ask, *What is blood alcohol content or BAC?* (Measure of the quantity of alcohol in the blood). *What determines if a driver is legally drunk?* (Blood alcohol content or BAC of 0.08 or higher).
2. Tell students they will be exploring the meaning of the term BAC and then investigating the effects of different BAC levels on human behavior and physical condition.
3. Have the Materials Managers collect the materials for their teams.
4. Explain that a BAC of 0.01 is equal to 0.1 mL of alcohol dissolved in 1,000 mL (1 liter) of blood. Student groups will simulate BAC by adding food coloring (representing pure alcohol) to 1 liter of clear water (representing blood) and observe the result. To do this, they first have to determine how many drops of food coloring equals a BAC of 0.01. Review the steps for accomplishing this. Using the eyedropper and a graduated cylinder, student groups will count how many drops it takes to reach the 10 mL level in the cylinder. They then divide that number by 100. This gives them how many drops of food coloring it will take to simulate a BAC of 0.01 in 1,000 mL of water. Typical answers will range from 140–160 drops for 10 mL. Dividing by 100 will give teams an average answer of 1.5 drops (number of drops that equal 0.1 mL).

5. Students then add 1.5 drops of food coloring to the large water container, labeled as blood, to simulate a BAC of 0.01. Ask for ideas on how to make a half-drop. You may want to skip 0.01 BAC level and start with a BAC level of 0.02. This will require 3 whole drops. A BAC of 0.04 will require 6 drops. After each addition of food coloring, students will take samples of the "blood" for later comparison and replace the samples with equal amounts of clear water.
6. Discuss student observations as a whole class. Students should find that even a small amount of food coloring ("alcohol") will have a dramatic effect on the appearance of the water ("blood"). The effect becomes stronger with increasing BAC levels.

Part B. Estimating BAC

1. Begin a discussion on drunk driving and the effects of different blood alcohol levels on males and females with these questions. Ask students, *How does our state compare to others when it comes to alcohol-related accidents?* (The MADD web site provides statistics by state, www.MADD.org/stats). *How many standard drinks does it take to be legally drunk?*
   What are the body and behavior symptoms of increasing levels of BAC?
2. Project the "BAC Behavior and Physical Effects" transparency and discuss how a person's behavior and physical condition change with increasing levels of blood alcohol. Explain that, due to a variety of factors, different people may exhibit different behavior and physical effects as their BAC increases. Be sure that students understand the various symptom terms in the table. Ask, *What variables might affect a person's reaction to increasing BAC?* (age, gender, weight, fat content, food, time, etc.). Make a list of their answers on the board. Add any variables not apparent to the students and discuss the reasons.
3. Tell your students that scientists have established a general set of guidelines to predict how a person's BAC will change, based on the number of alcoholic drinks consumed over various periods of time. Project the BAC Calculator Table and compare the numbers for males and females. Shaded areas are the BAC levels at which one is considered legally drunk. The body eliminates alcohol over time (the liver processes about 0.3–0.5 oz per hour). Thus, for every hour after a person has the first drink, subtract 0.015 from the BAC in the chart to determine the probable BAC level for that person. For example, a 100-pound male who had four drinks in two hours will have a BAC of 0.12 (0.15 - 0.03 = 0.12), or legally drunk.
4. Give student groups copies of the BAC charts and the BAC Behavior and Physical Effects sheet. Discuss any words from the Effects chart that may be new to your students. Have them answer the questions on the What's Your BAC student sheet. Check and discuss their answers.

Words to Discuss

BAC

Breath analyzer

Intoxication

Simulator

ACTIVITY 8

BAC: Behavior and Physical Effects

The symptoms of intoxication vary with the individual and the amount of alcohol consumed. The following table describes the behavior and physical effects that are experienced by an "average" person with different BAC levels. Individuals may, however, experience one or more symptoms from other BAC levels simultaneously.

BAC	SYMPTOMS	NO. OF DRINKS
0.05	Loss of emotional restraint, mild impairment of judgment, feeling of warmth, flushing of skin, vivaciousness	about 1
0.08	Impairment of motor functions, reduced vision and judgment legally impaired	about 2
0.10	Slight slurring of speech, loss of fine motor movements (such as writing), slower reaction time, confusion with tasks requiring thinking, inappropriate laughter, embarrassing behavior	about 3
0.20	Very slurred speech, staggering gait, double vision, lethargic but able to respond to voices, difficult sitting upright in a chair, memory loss	about 5
0.30	Stuporous, able to be aroused only briefly by strong physical stimulus (such as a face slap or pinch), deep snoring	about 8
0.40	Comatose, not able to be aroused, incontinent, low blood pressure, irregular breathing, bluish skin, unresponsive to painful stimuli	about 10
0.50	Coma, death possible from cessation of breathing, excessively low blood pressure, or vomit blocking air passages	over 10

TIME FACTOR

BAC calculator charts provide estimates of BAC. There is one other factor that needs to be considered. Over time, the body eliminates alcohol from the blood at a rate of 0.015 BAC per hour. If a person has just one drink, virtually all traces of alcohol are eliminated from the blood in 6–7 hours. To accurately estimate BAC, we must also know how many hours have elapsed since drinking started. To calculate the estimated BAC taking the amount of time into consideration, multiply the number of hours since drinking started by 0.015. Subtract the product of that from the BAC from the chart to arrive at the actual BAC.

Actual BAC = estimated BAC – (Number of hours x 0.015)

SAMPLE PROBLEM

A person has an estimated BAC of 0.8. The person has been drinking for 3 hours. What is this person's actual BAC?

SOLUTION

Multiply 3 by 0.015 3 x 0.015 = 0.45
Subtract 0.45 from 0.8 0.8 – 0.45 = 0.35

This person's actually BAC is 0.35.

ACTIVITY 8

BAC Calculator: Female

BODY WEIGHT (LBS)	1 DRINK	2 DRINKS	3 DRINKS	4 DRINKS	5 DRINKS	6 DRINKS	7 DRINKS	8 DRINKS	9 DRINKS	10 DRINKS
90	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.51
100	0.05	0.09	0.14	0.18	0.23	0.27	0.32	0.36	0.41	0.45
120	0.04	0.08	0.11	0.15	0.19	0.23	0.27	0.3	0.34	0.38
140	0.03	0.07	0.1	0.13	0.16	0.19	0.23	0.26	0.29	0.32
160	0.03	0.06	0.09	0.11	0.14	0.17	0.2	0.23	0.26	0.28
180	0.03	0.05	0.08	0.1	0.13	0.15	0.18	0.2	0.23	0.25
200	0.02	0.05	0.07	0.09	0.11	0.14	0.16	0.18	0.2	0.23
220	0.02	0.04	0.06	0.08	0.1	0.12	0.14	0.17	0.19	0.21
240	0.02	0.04	0.06	0.08	0.09	0.11	0.13	0.15	0.17	0.19

TIME FACTOR

HOURS SINCE FIRST DRINK	SUBTRACT THIS FROM BAC
1	0.015
2	0.03
3	0.045
4	0.06
5	0.075
6	0.09

Source: Evans, Glen and Robert O'Brien (1991) The Encyclopedia of Alcoholism

ACTIVITY 8

BAC Calculator: Male

BODY WEIGHT (LBS)	1 DRINK	2 DRINKS	3 DRINKS	4 DRINKS	5 DRINKS	6 DRINKS	7 DRINKS	8 DRINKS	9 DRINKS	10 DRINKS
100	0.04	0.08	0.11	0.15	0.19	0.23	0.26	0.3	0.34	0.38
120	0.03	0.05	0.09	0.12	0.16	0.19	0.22	0.25	0.28	0.31
140	0.03	0.05	0.08	0.11	0.13	0.16	0.19	0.21	0.24	0.27
160	0.02	0.05	0.07	0.09	0.12	0.14	0.16	0.19	0.21	0.23
180	0.02	0.04	0.06	0.08	0.11	0.13	0.15	0.17	0.19	0.21
200	0.02	0.04	0.06	0.08	0.09	0.11	0.13	0.15	0.17	0.19
220	0.02	0.03	0.05	0.07	0.09	0.1	0.12	0.14	0.15	0.17
240	0.02	0.03	0.05	0.06	0.08	0.09	0.11	0.13	0.14	0.16

TIME FACTOR

HOURS SINCE FIRST DRINK	SUBTRACT THIS FROM BAC
1	0.015
2	0.03
3	0.045
4	0.06
5	0.075

Source: Evans, Glen and Robert O'Brien (1991) The Encyclopedia of Alcoholism

ACTIVITY 8

Every drop Counts

You will need a small graduated cylinder, eyedropper or plastic pipette, a small container of plain water, four small clear plastic cups and paper towels. Answer any questions on the back of this sheet.

1. Fill the eyedropper or pipette with water.

2. Add single drops of water to the cylinder. Carefully count the drops until the fluid level reaches 10 milliliters. Record the number of drops below.

3. Divide the number of drops by 100. The result equals the number of drops of alcohol that needs to be added to one liter of blood to produce a BAC of 0.01. Write your answer below.

4. Fill in the spaces in the table below. Your answer from step 3 goes in the space for BAC = 0.01. How many drops would it take to make a BAC of 0.02, 0.04, and 0.08?

	BAC = 0.01	BAC = 0.02	BAC = 0.04	BAC = 0.08
Number of Drops				

5. Fill the large beaker or water bottle with 1,000 mL (1 liter) of water. You will be adding drops of food coloring to the water to simulate different blood alcohol levels. In this simulation, what does the 1,000 mL of water represent? What does the food coloring represent?

6. Use the table above as a reference. Add the correct number of drops of food coloring to the beaker to simulate a BAC of 0.01.

7. Use one of your plastic cups to collect a sample of water from the beaker (representing a BAC of 0.01). Fill the cup half way. Set the sample aside for later reference. Using another cup, fill it half way with clear water and pour it into the beaker to replace the colored water you removed for a sample. Why should you do that?

8. Add more food coloring drops to the beaker of water to simulate a BAC of 0.02, 0.04, and 0.08. Between each addition of food coloring, take half a cup of the colored water as a sample and set it aside. Replace the sampled water with clear water.

9. Line up your samples side by side. Observe each of the samples, and answer the following questions.

   - What changes to the clear water (simulated blood) did you observe when you added food coloring (simulated alcohol)?
   - How did the samples change with the addition of more food coloring?
   - What does this experiment tell you about alcohol's effects on the blood?

ACTIVITY 8

What's Your BAC?

Use the BAC Charts for Males and Female to answer the questions below.

1. Examine the BAC charts. What do the red areas represent?

2. Compare the chart for males with the chart for females. How do they differ? Why do you think this might be so?

3. Using the calculator charts for a reference, answer the following questions on the back of this sheet.

   A. A male weighing 160 pounds has 3 drinks in less than 1 hour.
      - What is his BAC?
      - Is he considered legally drunk?
      - Is it safe for this person to drive a car?

   B. A female weighing 160 pounds has 3 drinks in less than 1 hour.
      - What is her BAC?
      - Is she considered legally drunk?
      - Is it safe for this person to drive a car?

   C. What is the BAC for the male and female if they consumed their 3 drinks over 2 hours time?

      Male = _____ Female = _____

   D. Describe what behavior and physical effects might occur to a 120-pound female if she consumed
      8 drinks over a 2-hour period. (Hint: First determine her BAC.)

   E. Describe what behavior and physical effects might occur to a 100-pound male if he quickly (less than one hour) consumed 10 drinks.

   F. The female chart starts at 90 pounds and the male chart starts at 100 pounds. Estimate what the BAC numbers would be for a 70-pound male or 70-pound female for 1 drink?

   G. Do you think it is completely safe for any person to operate a car after one drink?

4. Work these next questions out in your head. Do not write them down. This is private information!

   A. What is your weight? If your weight is not on the chart, estimate the answers.

   B. What would your BAC be if you had three drinks in two hours?

   C. What behavior and physical effects might you experience if you had 3 drinks in 2 hours?

   D. If you have a driver's license, would it be safe for you to drive after drinking?

ACTIVITY 8

BAC "CSI" Challenge

Using the BAC Charts for Males and Females and the BAC Behavior and Physical Effects chart below, solve these alcohol-related mysteries. Work with your team and determine what information you will need to solve each mystery. (Hint: Do not forget the effect time has on BAC levels.)

WHAT'S HIS BAC?
A male, who weighs 160 pounds, had four drinks over two hours. His normal behavior has changed. His speech is slurred and he reacts slowly. He is embarrassing himself and easily gets confused. Could he hurt himself and others if he were allowed to drive a car? What is his BAC? Could the police arrest him?

MALE OR FEMALE?
An office worker stops off at a tavern for some after work drinks. The worker, who weighs 160 pounds, has four beers over a period of two hours. The worker is legally drunk and should not drive home. Is the worker a male or a female? What is the person's BAC?

CALL FOR HELP?
A friend has been drinking. He has passed out and you can't wake him. His breathing is irregular. His skin is bluish. Should you call 911? Why or why not?

BAC BEHAVIOR AND PHYSICAL EFFECTS

0.05	Loss of emotional restraint, mild impairment of judgment, feeling of warmth, flushing of skin vivaciousness
0.10	Slight slurring of speech, loss of fine motor movements (such as writing), slower reaction time, confusion with tasks requiring thinking, inappropriate laughter, embarrassing behavior
0.20	Very slurred speech, staggering gait, double vision, lethargic but able to respond to voices, difficult sitting upright in a chair, memory loss
0.30	Stuporous, able to be aroused only briefly by strong physical stimulus (such as a face slap or pinch) deep snoring
0.40	Comatose, not able to be aroused, incontinent, low blood pressure, irregular breathing, bluish skin, unresponsive to painful stimuli
0.50	Coma, death possible from cessation of breathing, excessively low blood pressure, or vomit blocking air passages

Science Standards

EARTH & SPACE SCIENCE

- Water is a solvent.

LIFE SCIENCE

- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, protection from disease, and control and coordination.
- Disease is a breakdown in structures or functions of an organism.

SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES

- Alcohol and other drugs often are abused substances. Such drugs change how the body functions and can lead to addiction.
- The potential for accidents and the existence of hazards imposes the need for injury prevention. Safe living involves the development and use of safety precautions and the recognitions of risk in personal decisions. Injury prevention has personal and social dimensions.
- Students should understand the risks associated with social hazards, such as transportation, and personal hazards, such as drinking.
- Individuals can use a systematic approach to thinking critically about risks and benefits.
- Important personal and social decisions are made based on perceptions of benefit and risk.

PostAssessment

Students will reexamine their responses to the unit pre-assessment and reformat each false statement as a true statement, using knowledge gained from the unit to substantiate their answers. Note that all statements in the pre/post test are false. Class time: 90 minutes.

ACTIVITY 9

And Now, What About Alcohol?

This post-assessment allows students to compare their prior knowledge about alcohol to what they have learned as a result of conducting investigations in The Science of Alcohol. This activity may serve as a summative assessment through which students can gauge their own learning, as well as a unit assessment for grading purposes.

SETUP

Photocopy student pages. Bring completed PreAssessment activity sheets to class.

MATERIALS

Each student will need:

- Writing materials
- Copy of the student sheet

PROCEDURE

1. Review concepts covered throughout this unit and refer back to the original chart of student-generated questions (Activity 1). Ask, *Have all of the questions been answered?* Discuss answers that have been provided. If some questions have not yet been addressed, discuss how students might be able to find the answers using the Internet or other sources. If the questions are relevant, assign student teams to research them.
2. Pass previously completed pre-assessments back to students to use as a post-assessment. Instruct them to review their answers and identify any questions that they now would answer differently. Allow students to make any necessary corrections in the spaces below their original answers with a different colored pen or pencil.
3. Write the first question on the board or project it using an overhead projector. Discuss the question and gain consensus from students about whether

Enrichment Activities

Alcohol abuse is a major health problem in the United States and around the world. Much information on the effects of alcohol and its consequences is available on the Internet. The following alcohol-related topics might be appropriate for individual students or teams of students to consider for a research project. Have students take on the role of television, radio, or newspaper investigative reporters when producing articles or stories about alcohol and its effects on society.

- What are the statistics for alcohol-related automobile accidents in each state? Which states have the greatest problems? How strict are those states' penalties for operating a motor vehicle under the influence of alcohol?
- What are the effects on babies (fetal alcohol syndrome) when mothers abuse alcohol during pregnancy? What is the incidence rate of fetal alcohol syndrome (number of babies affected per 100,000 births) in the US. What is the treatment for babies with fetal alcohol syndrome?
- What is binge drinking? What are its dangers? What demographic group is it most commonly seen?
- Is there a relationship between alcohol and violence?
- What is the annual cost of alcohol abuse in the United States?
- Who is more likely to abuse alcohol and become alcoholics, men or women?
- What are the symptoms of alcoholism?
- Are children of alcoholics likely to become alcoholics too? It there a genetic predisposition to alcoholism?
- What are some of the human costs of alcohol abuse? What does it cost if someone is arrested for driving while intoxicated? What is the emotional cost of alcoholism on the drinker, the family, and associates?

statement is true or false (it is false). Ask, *How can you make this into a true statement using the information that you have learned?*

Place a rewritten statement below the original. For example, the first statement is, "Alcohol acts as a stimulant when consumed in large amounts."

To make the statement true, it could be rewritten several different ways. For example, "Alcohol acts as a depressant when consumed in large amounts."

4. Have students follow this example to rewrite each statement they originally identified as false, as a separate true statement.

Answer Key

An answer key for the pre- and post -assessments are located on page 55.

Additional Web Sites

NATIONAL INSTITUTE FOR HIGHWAY SAFETY
www.iihs.org/iihs

THE ALCOHOL COST CALCULATOR: GEORGE WASHINGTON UNIVERSITY MEDICAL CENTER
www.alcoholcostcalculator.org/

Mothers Against Drunk Driving – Youth in Action
www.YouthInAction.org

BAC CALCULATOR: UNIVERSITY OF OKLAHOMA POLICE DEPARTMENT
www.ou.edu/content/police.html

ACTIVITY 9

What do You Know?

Are the following statements true or false? Circle "T" for True or "F" for False.

TRUE	FALSE	STATEMENT
T	F	1. Excess consumption of alcohol acts as a stimulant.
T	F	2. Alcoholic beverages contain only alcohol.
T	F	3. Alcohol, once consumed, goes directly to your kidneys for filtering.
T	F	4. All alcohol is safe for consumption.
T	F	5. Small amounts of alcohol normally do not affect neurons in the brain.
T	F	6. Alcohol has calories, and does provide some nutrients.
T	F	7. Alcohol makes an individual more outgoing and articulate.
T	F	8. When large amounts of alcohol are consumed, the liver processes less efficiently, but more quickly.
T	F	9. Besides beverages, there are not a lot of uses for alcohol.
T	F	10. The presence of food in the stomach increases the rate of absorption of alcohol into the bloodstream.
T	F	11. Drinking beer is safer than drinking liquor.
T	F	12. Alcohol rarely can affect parts of the brain that deal with learning and memory.
T	F	13. Any effects from drinking alcohol occur in the short-term.
T	F	14. Everyone eliminates alcohol at the same rate.
T	F	15. Alcohol is not a drug.

Name _____ Date _____

ANSWER KEY

Activity 1 and Activity 9

All of the statements are false.

Are the following statements true or false? Circle "T" for True or "F" for False.

1. **Excess consumption of alcohol acts as a stimulant.** While a small amount of alcohol can act as a stimulant in the short-term, alcohol, in general, is a depressant.
2. **Alcoholic beverages contain only alcohol.** Alcoholic beverages, such as beer and wine, which are produced through fermentation, contain carbohydrates and other substances derived from the source materials (grapes for wine, and grains and sugars for beers and ales. Even distilled alcohol products (vodka, brandy, whisky, etc.) contain ethyl alcohol, water and other substances that provide flavoring.
3. **Alcohol, once consumed, goes directly to your kidneys for filtering.** Once someone takes a drink of alcohol, some of it is absorbed directly into the bloodstream through the mucosal lining of the mouth. The rest goes down the esophagus into the stomach. But it is not digested like food. Most alcohol in the digestive system is absorbed directly into the blood stream through the lining of the stomach and small intestines. Once in the bloodstream, alcohol goes to all parts of the body. Since blood circulates quickly through the body, ingested alcohol can reach every organ in the body within 90 seconds.
4. **All alcohol is safe for consumption.** In reality, all alcohols are toxic. Ethyl alcohol, the alcohol in beverages, is not poisonous in smaller amounts. However, blood alcohol concentrations above 0.35 percent can be lethal. In addition, many chemicals are classified as alcohols. Some of these, such as methyl alcohol (methanol), are very toxic.
5. **Small amounts of alcohol normally do not affect neurons in the brain.** Any amount of alcohol affects neurons (nerve cells) in the brain.
6. **Alcohol has calories, and does provide some nutrients.** Pure ethyl alcohol yields 7 calories per gram, as compared to 4 calories per gram for carbohydrates and 9 calories per gram for fats. However, alcohol alone does not provide any nutrients (substances that are important for growth or maintenance of the body).
7. **Alcohol makes an individual more outgoing and articulate.** Ingesting alcohol only makes an individual think that he or she is more sociable, because in low doses, it provides a release from inhibitions. Alcohol also affects other brain functions, including judgment.
8. **When large amounts of alcohol are consumed, the liver processes less efficiently, but more quickly.** Regardless of intake, the liver only can process up to 0.3 ounces of alcohol per hour.
9. **Besides beverages, there are not a lot of uses for alcohol.** Different kinds of alcohol have a variety of uses. Ethyl alcohol is a major ingredient in some medicines, fuels, paints and cleaners.
10. **The presence of food in the stomach increases the rate of absorption of alcohol into the bloodstream.** After eating, the stomach holds food for digestion and closes off its contents from the small intestine. At the same time, most alcohol is absorbed into the body from the small intestine. Eating food with alcohol keeps the alcohol from reaching the small intestine as quickly as would happen on an empty stomach.
11. **Drinking beer is safer than drinking liquor.** A mixed drink with one shot of 40-proof alcohol (1.5 ounces) has the same total alcohol content as a 12-ounce bottle of beer or a 5-ounce glass of wine.
12. **Alcohol rarely can affect parts of the brain that deal with learning and memory.** Long-term, chronic drinking can cause permanent memory loss and brain damage. Almost 70% of people in treatment for alcohol-related problems suffer severe impairment of memory formation, abstract thinking, problem-solving, and abilities to concentrate.
13. **Any effects from drinking alcohol occur in the short-term.**There are many long-term effects on health, including permanent brain and liver damage.
14. **Everyone eliminates alcohol at the same rate.** Everyone eliminates alcohol from the body differently. The rate at which alcohol is eliminated from the body is affected by several factors, including body size, gender, amount of food and sleep, and heredity.
15. **Alcohol is not a drug.** Alcohol is a drug that slows down the nervous system. Alcohol use can lead to abuse or dependency, similar to that resulting from using other drugs of addiction.

ANSWER KEY

Activity 4

1. **Why do you need to count the heartbeat rate before you add alcohol?** The normal heartbeat rate must be known to use as baseline data before one can judge the effect of the alcohol.
2. **Why is it important to wash your hands thoroughly with soap and water when working with pond water?** Pond water can contain harmful microorganisms.
3. **What happened to the heart rate of your *Daphnia* as you added the alcohol? Include other observations you made about your *Daphnia*.** Answers will vary, but students should find that heartbeat decreases with exposure to alcohol. Many will find that the *Daphnia* die because of prolonged contact with alcohol. Other observations might address movement, erratic speed, and appearance of other organs.
4. **Why do you think you had the results you did? Alcohol is a depressant, acting to lower heart rate and slow other organ functions.**
   It is toxic to the body.
5. **What percentage of alcohol did you use? Did you increase the strength of the alcohol during the experiment? Approximately how long was the *Daphnia* exposed to the alcohol?**
   Ten percent alcohol was used in this experiment. The strength (concentration) of the alcohol did not change. However, the cumulative effects of the alcohol exposure led to gradual decreases in the observed heart rates. Answers will vary, but the average time of exposure usually is 5–10 minutes.
6. **Construct a line graph of your results with the *Daphnia* alcohol experiment. What do you think would happen to the *Daphnia's* heartbeat rate if four more drops of alcohol (16 drops total) were added to the *Daphnia* slide? Extend the graph line with dashes to see what the heartbeat rate might become. Predict what would happen to the *Daphnia* if you continued adding alcohol.**
   Answers will vary but, in general, the *Daphnia heartbeat* rate will diminish towards zero. The *Daphnia*'s heart will stop and the *Daphnia* will die if further alcohol is added.
7. **Why do you think you were asked to use methyl alcohol (rubbing alcohol) for this experiment, instead of ethyl alcohol (alcoholic beverages)?**
   Methyl alcohol is very poisonous even in very small amounts, and is never consumed by humans. Ethyl alcohol is less toxic, and is found in small amounts in many things that humans consume. It is important to examine the possible effects that alcohol might have on living organisms.
8. **Based on your observations, would you say alcohol acts as a stimulant or depressant on the heart rate of the *Daphnia*?**
   Alcohol is a depressant.
9. **What is another experiment you might conduct using *Daphnia* What would you want to find out? What do you think the result would be? List the steps you would follow.**
   Answers will vary.