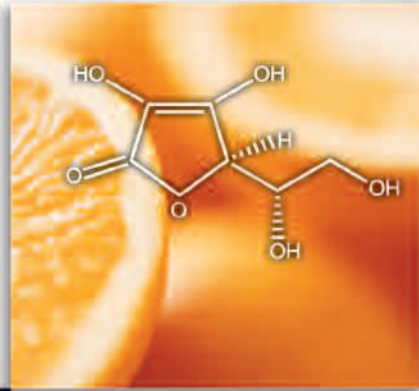
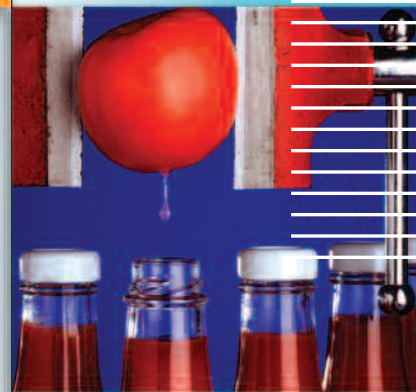
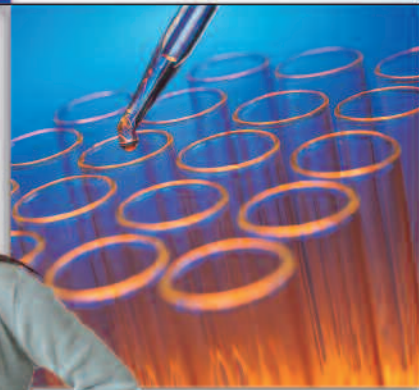


Teacher's Resource Guide



The Science and Scientists Behind the Food...

Connect your students to this dynamic real world application of chemistry, biology and physics.



Discovery
EDUCATION



IFT Foundation
The Institute of Food Technologists' Foundation



INTRODUCTION TO FOOD SCIENCE & TECHNOLOGY

Discovery Education, The Institute of Food Technologists (IFT), and the IFT Foundation are proud to present “The Science and Scientists Behind the Food,” a multimedia resource kit that introduces your students to the field of Food Science and Food Technology. This area of study is not about nutrition or cooking, but rather about core sciences. Biologists, microbiologists, chemists, physicists, and engineers all work in this field, and their important contributions affect world health, the environment, and the economy.

*This teacher’s guide offers your students an opportunity to see real-world applications of their laboratory skills. There are six engaging, laboratory-ready lesson plans related to food science and technology. You can efficiently implement them as part of your existing biology, chemistry, or physics curriculum. Each **standards-based** lesson includes lab preparation instructions, a list of materials, a student direction page, a vocabulary list, debriefing questions and extension activities.*

Also, throughout the guide you’ll find brief biographical sketches of professional food scientists and links to the Discovery and IFT websites for additional information.

Finally, to complement the lessons there is a three-part DVD presenting 1) what we mean by “food science and technology,” an overview and history of the field, 2) how food microbiologists ensure safe food, and 3) how food chemists develop and improve processed foods. Look inside the back cover for specific suggestions on how to most effectively integrate the lessons and DVD.

Cover images (top to bottom; counterclockwise): ascorbic acid (Vitamin C) and oranges; cereal; *E. coli*; test tubes; ketchup

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LESSON #1: BIOLOGY—Osmosis

Length of Lesson: *One-to-two 45-minute periods*

Subject Area: *Biology*

Overview:

Student teams study osmotic pressure and a semi-permeable membrane by replicating osmotic conditions within a cell when it is placed in a highly salted or sugared solution. Then, they apply discoveries to explain effectiveness of traditional food preservation.

Objectives:

Students will understand the following:

- 1) Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world.*
- 2) Water and other materials pass through cell membranes to sustain life.*
- 3) Increasing the solute concentration outside a bacterium kills or prevents reproduction by causing water to flow out of the cell.*
- 4) Salt and sugar solutions (part of traditional food preservation procedures) can be used to raise osmotic pressure.*

STANDARDS

LIFE SCIENCE

The cell

- Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world.*

SCIENCE AND TECHNOLOGY

Understandings About Science and Technology

- Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.*

TEACHER PREPARATION

Film Canisters—

- Visit your local photo finisher and ask for empty plastic film canisters. Any canister that has a snug-closing lid will do. Most shops will be glad to give you a bagful.*
- Press the tip of a sharp knife into the bottom of the canister. Make a curving cut toward the bottom. Cut off the bottom by cutting the side close to the bottom. To avoid any sharp edges on the cut, make the cut by pulling the knife toward the outside from the inside. Cutting off the bottom with a sharp knife is not a student activity.*

Dialysis tubing—

- Many vendors sell this tubing. One option is from Science Kit, www.sciencekit.com, stock number WW6141705, ten feet of three-inch (flat width) tubing \$11.90.*
- Three-inch tubing is the smallest standard tubing that will fit the 33 mm rim of a film canister.*

Making cytoplasm—

Prepare or have students prepare a 1% (w/v) sodium chloride solution. You may choose to add a very small amount of food coloring to the solution.

SUGGESTED MATERIALS

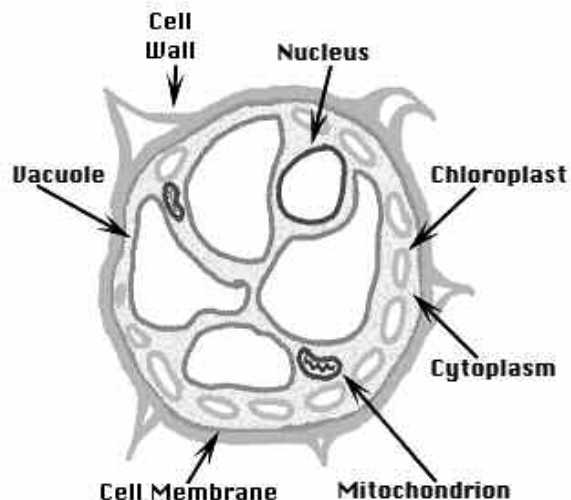
(Prepare one set of materials for every student team.)

- One film canister with lid prepared using instructions above*
- Three six-inch lengths of dialysis tubing*
- One 250ml-beaker containing “cytoplasm”*
- One 250ml-beaker containing a saturated sugar solution*
- One 250ml-beaker containing a saturated salt solution*
- One balance accurate ± 0.2 gm*
- Two–three absorbent paper towels*
- Scissors*
- Hole punch*
- Timer or clock*
- Notepaper for illustrations and recording results*

> PART 1: INVESTIGATION

- 1) Conduct a brief class discussion by posing questions such as: What makes food go bad? (Answer: Microorganisms as well as other factors.) How do we preserve foods? How did people preserve foods before refrigeration? Have any of your parents or grandparents made homemade jam or beef jerky? Ever wonder why it doesn't go bad?*
- 2) Tell students that in lab teams they will build a virtual bacterial “cell” and explore semi-permeable membranes and osmotic pressure. From this exploration they will be able to see why placing foods in salt or sugar solutions helps preserve food. Have students record their hypothesis describing what will happen to the virtual cell in various solutions.*
- 3) Draw a simple plant cell on the chalkboard and review these three parts: cell wall, cell membrane, and cytoplasm (see figure on page four). Explain that bacteria and plant cells have these three components; human cells do not have a cell wall. Ask students to draw the virtual “cell” and label comparable parts. (Answer: Prepared canister is cell wall, the tubing is the semi permeable cell membrane, and the 1% saltwater mixture replicates cellular cytoplasm.)*
- 4) Distribute to each team: one prepared film canister, a length of dialysis tubing, and a mixture of 1% salt/water.*
- 5) Direct students to create their virtual “cell” using the following directions: (see illustration on page five)*
 - a. Making a cell wall: Punch holes in the sides of the canister using a hole punch. Check for sharp edges that might puncture the cell membrane.*

DIAGRAM OF A CELL



Labeled cross-section of a plant cell

CAREER CONNECTION



Katherine M. J. Swanson, Ph.D.

Vice President Food Safety

Ecolab Inc.
Egan, MN

"I became interested in food microbiology when I was in college, although in high school

I was interested in working with food. I changed my major from Education to Dietetics on my first day at college after discussions with the faculty of Foods and Nutrition because the broad range of opportunities excited me. I became aware of careers in food science and technology during my dietetics studies. Food microbiology was a required course, and after the first day of class I was hooked. The field of food science lets me apply my interest in science in a practical manner that I can relate to and has excellent job opportunities. Food Science and Technology is a field that can provide a challenging and rewarding career for anyone interested in science or technology. Since everyone needs to eat, there is a constant demand for well trained food scientists. Organizations such as IFT provide excellent scholarships, as well as opportunities to network with professional microbiologists, which is very helpful in finding the right job. Careers can also diverge into areas of business and marketing, policy development, management of people, methods development, and a whole host of other careers to meet a variety of individual interests."

For more information about this scientist and many others, visit www.discoveryschool.com/foodscience.

- b. Making a cell membrane: Begin by cutting a six-inch length of tubing from the roll. Immerse the tubing under tap water for two minutes and gently open. Close the tubing and tie an overhand knot toward one end. Gently tighten the knot and smooth it toward the end. Pull on the short end of the tubing to finally tighten the knot. Do not pull on the long end.
- c. Assembling the cell: Slide the knotted tubing into a prepared cell wall and evenly spread about 3/8 of an inch of tubing over the film canister rim. Blow gently into the tubing to open it inside the canister. Fill the tubing to overflowing with prepared cytoplasm. Snap the cap on the rim of the canister and blot dry.
- 6) Distribute the beakers of sugared water and salted water. Students will follow the same procedure for each beaker. Between testing each solution, students must carefully rinse the canister and replace the six-inch piece of dialysis tubing.
- 7) Testing procedure:
 - a. Weigh the virtual "cell."
 - b. Predict whether it will weigh more or less after being submerged in the solution.
 - c. Place "cell" in the salt water beaker for five minutes.
 - d. Remove it and blot dry with paper towel.
 - e. Weigh the "cell" on the balance and record results.
 - f. Repeat steps **c**, **d**, and **e** at three five-minute intervals for a total of 15 minutes in solution.
 - g. Prepare "cell" for next test with sugar water.
- 8) Ask students to record their results on a class chart with eight columns (original virtual plant "cell" weights, weight after sugared solution at five minutes, 10 minutes, and 15 minutes, and weight after salted solution at five minutes, 10 minutes, and 15 minutes). Total each column of results and conduct a class discussion regarding the data.
- 9) Results: Class data will show that the virtual "cells" that were placed in the sugared and salted solutions weighed less than the original "cell." (Total weight of water loss is about 2% in salted and 4% in sugared solutions. Weights at five, 10, and 15 minutes provide graphable data that will describe trends.) In salt and sugared solutions, the difference in osmotic pressure causes the water in the cell to flow out of the cell, and so under these conditions, these cells will be lighter than in the control solution. This demonstrates that bacteria will lose water in hypertonic environments and cannot grow. Therefore, bacterial cells cannot sustain life on salted fish, salted ham, jams, or fruit in syrup.

> PART 2: QUESTIONS/APPLICATIONS

- 1) Conduct a class discussion and debriefing using questions like the following:
 - How many of you predicted that the "cell" would weigh more, rather than less, after being submerged in the solutions? Explain your initial thinking.

- What do the class data show? (By comparing the sums of columns totaled previously, you should achieve more reliable results. Containers in the sugared and salted solutions should weigh less than the original “cell.”)
- How can you explain the weight loss? Use the word **HYPOTONIC** when describing the solutions.

(Answer: In the salted and sugared solutions which are hypertonic, the relative osmotic pressure inside the cell causes the cell water to flow *out* of the cell, and so under these conditions, these cells will be lighter than the original “cell.”)

- 2) Explain how traditional food preservation procedures work to prevent the growth of bacteria. (Answer: In the salt and sugared solutions [hypertonic environments], bacteria will lose water and cannot survive. This applies to harmful bacteria that could make people sick as well as bacteria normally found in foods that causes it to spoil.)
- 3) Now consider drying food. How does this traditional food preservation procedure prevent bacterial cell growth? (Answer: You can make a material hypertonic relative to its surroundings either by adding more solute or by taking away water. If a food was once 95% water and it is physically dried to 40% water, the food becomes a hypertonic environment for bacterial cells.)
- 4) At one time procedures such as drying foods, salting foods, and storing them in syrups were the “new” technology. In some cases, we continue to use them successfully. What modern foods do you know of that are preserved by drying or in hypertonic environments created by salt or sugar? (Answer: Dried fruits or pasta, salted fish, salted ham, jams, or fruit in syrup.)

> EXTENSIONS:

- 1) Run the experiment by immersing the “cell” into a beaker of distilled water. Predict the weight. (Answer: The “cell” will be heavier because it contains 1% solute and is hypertonic relative to distilled water. Note: the rate of change depends on the solute concentration—the greater the difference, the faster the change.)
- 2) Ask students to use a microscope to investigate what happens to plant cells (lettuce, potato, etc.) after they have been immersed in a sugared or salted solution.

> EVALUATION:

Oral or written: Students will explain why traditional technologies of food preservation work by demonstrating clear understanding of the four objectives and relevant vocabulary.

.....



Prepared Film Canisters



Dialysis Tubing



Prepared Model Cell



Model Cell in Hypertonic Solution

VOCABULARY

Hypotonic—Having lower osmotic pressure, often as a result of lower solute.

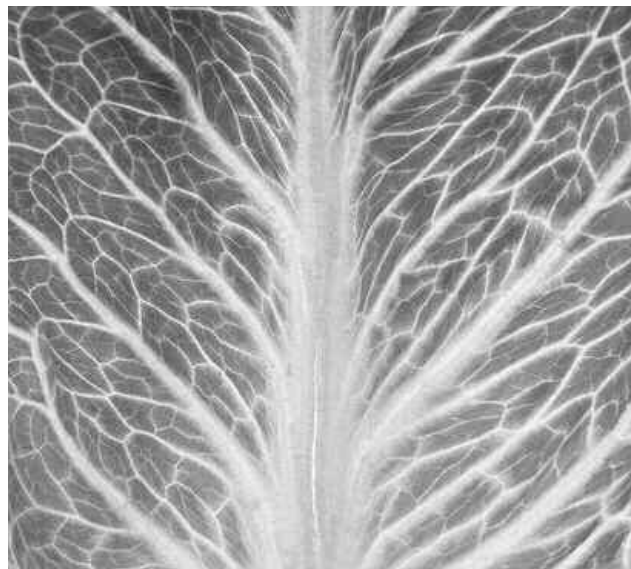
Hypertonic—Having higher osmotic pressure, often as a result of higher solute.

Isotonic—Having equal osmotic pressure. (Water will flow out of a hypotonic solution into a hypertonic solution until it achieves equal osmotic pressure.)

Osmotic pressure—The pressure difference across a semi-permeable membrane caused by the difference in concentration of solutes on either side.

Semi-permeable membrane—A membrane that allows the flow of some materials (especially small molecules or ions) but blocks others.

Solute—A substance dissolved in a liquid.



LESSON #2: BIOLOGY—Food Forensics

Length of Lesson: *Two-to-three 45-minute periods*
Subject Area: *Biology*

Overview:

Students research and peer-teach information about pathogens that cause foodborne illnesses. They diagnose probable causes of illness from descriptions on the patient case study cards, and recommend how to avoid future illness.

Objectives:

Students will understand the following:

- 1) Regardless of the environment, the possibility of illness may be present. The presence of E. coli 0157:H7, Salmonella, Listeria monocytogenes, and Clostridium botulinum in foods are serious threats to health.*
- 2) The physical symptoms of an E. coli 0157:H7 infection, Salmonellosis, Listeriosis, or botulism from Clostridium botulinum toxin, help physicians to identify the pathogen and treat the patient.*
- 3) There are specific steps individuals can take to minimize exposure to these pathogens and to destroy them when they are present.*

SUGGESTED MATERIALS

- Large chart paper
- Computers with access to the Internet or library reference texts
- File folders—one per team
- Expert information charts—one per student
- Patient case study cards—two per team (*Run multiple copies of the case study card on page eight to accommodate more teams, or assign only one card per team.*)

> PART 1: INVESTIGATION

Jigsaw teamwork causes members of a team to separate and join expert teams that study one particular topic. The original teams then reconvene and share their expertise with their teammates.

- 1) Ask students if they've ever had food poisoning. Have them guess how many cases of foodborne illnesses there are each year (the 1999 estimate was 76 million.) Tell your students they are about to become FBI agents, not Federal Bureau of Investigation, but "Foodborne Illness Investigators". Assign your students into teams of four. Distribute one file folder to each team and ask students to write their names on the top of the folder. At the close of each day, students will return to their original team, place all their research in their folders, and return the folders to you for safekeeping.

STANDARDS

SCIENCE AS INQUIRY

Understandings About Scientific Inquiry

- *Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.*

LIFE SCIENCE

Interdependence of Organisms

- *Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.*

SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

Personal and Community Health

- *Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms—sensory, motor, emotional, social, and technological that can reduce and modify hazards.*



- 2) Ask students to count off one through four in each team. Each number will join other classmates with the same number to form an expert team. Number Ones study *E. coli* O157:H7, Twos study *Salmonella*, Threes study *Listeria monocytogenes*, and Fours study *Clostridium botulinum*. Set up specific classroom areas where the expert teams will meet.
- 3) Send students to join their expert teams and distribute an expert information chart to each student. Ask students as teams to read the information chart that will help them conduct their research. Expert teams should use Internet resources (or library references) to complete their charts. www.foodsafety.gov is a great resource for information on pathogens and www.fightbac.org has information on preventing foodborne illness. Encourage students to share research answers and corroborate what they find.
- 4) When students have completed their research, send them back to their original team where they will teach other team members what they have learned. Together they must create a chart of combined information on large chart paper using the same headings that were on their expert charts.

> PART 2: APPLICATION/SIMULATION

- 1) Ask one member of each team to choose two patient case study cards. Each team will prepare two oral reports to share with the class that describe each patient, his or her symptoms, and the history of what they ate or did. The team will identify the suspected pathogen and what specific information helped them with the diagnosis. They will then make specific recommendations for each patient to help them avoid future foodborne illness.
- 2) Answers: Case studies 1 and 4 - Salmonellosis, Case studies 3 and 6 - Listeriosis, Case studies 5 and 8 - *E. coli* O157:H7 infection, and Case studies 2 and 7 - Botulism from *Clostridium botulinum*.

> EXTENSIONS:

- 1) Students may research newspaper stories reporting significant outbreaks of foodborne illnesses in the United States and steps that the government or industry took to track down and/or limit the contamination.
- 2) Students may also investigate time and temperature recommendations for leftovers on the counter. What is the reason for controlling these?
- 3) To help students better understand how easily contamination can spread from infected people who do not wash their hands, put "Glogerm" (a commercially available UV-fluorescent substance) on a doorknob or desktop at the beginning of a class period. (It is completely harmless.) At the end of the period, use a UV light to reveal who has been contaminated.
- 4) Solve the mystery of foodborne illness at <http://www.accessexcellence.org/AE/mspot/twoforks/>.

> EVALUATION:

Oral or written: Students will explain how individuals can avoid foodborne illnesses caused by *E. coli* O157:H7, *Salmonella*, *Listeria monocytogenes* and *Clostridium botulinum* by demonstrating clear understanding of the three objectives and relevant vocabulary.

VOCABULARY

Bacteria—Microscopic, one-cell living organisms.

Dehydration—Serious loss of body fluids, generally the consequence of diarrhea and vomiting.

Diarrhea—Frequent, watery bowel movements.

Infection—Disease caused when pathogens invade the body and multiply.

Neurotoxin—A poisonous substance produced by living cells (such as *Clostridium botulinum*) that can damage or destroy nerve tissue.

Pasteurization—A process in which food is heated to a specific temperature for a specific amount of time in order to kill microorganisms that could cause illness or death.

Pathogen—A disease-producing agent (e.g. bacterium).

Protocol—A set of procedures

CAREER CONNECTION



Pina M. Fratamico, Ph.D.

*Microbiologist/Lead Scientist
USDA-Agricultural Research Service
Eastern Regional Research Center
Wyndmoor, PA*

"My research is in the area of food safety and focuses on understanding how bacteria adapt to conditions in foods and during food processing and storage. I collaborate on research projects with scientists in other government agencies, in universities, and in the food industry. I am often invited to make presentations of my research at conferences, universities, and also in other countries. A career in the discipline of Food Science and Technology offers many opportunities. High school students should have an understanding of these opportunities and exciting developments in the field."

For more information about this scientist and many others, visit www.discoveryschool.com/foodscience.

PATIENT CASE STUDY CARDS:

CASE STUDY PATIENT 1

Maria has been suffering from abdominal cramps and diarrhea for two days. She also has a slight fever. She had been feeling fine. In fact, before becoming ill, she visited her in-laws who served homemade cookie dough ice cream. (The secret recipe has been in the family for years.)

CASE STUDY PATIENT 5

Hannah is totally into whole foods and avoids all processed foods. Her favorite lunch is tofu in a whole-wheat pita bread with fresh tomatoes and sprouts. With all this attention to keeping her body healthy, she was astounded when she woke up in the middle of the night with bloody diarrhea.

CASE STUDY PATIENT 2

Samantha is a 10-month old baby who was fine yesterday, but has suddenly become ill. First her mother noticed that she was listless, almost like a rag doll, and her abdomen was distended. She wouldn't eat and had been drooling. Her mother thought that was probably because Samantha had been teething a lot lately. Last night she had rubbed Samantha's gums with honey, which seemed to help. But today, the baby was not just crying; she was wailing.

CASE STUDY PATIENT 6

Grandma must be getting old. Today she complained of a headache, stiff neck, and having trouble concentrating. When she got up from her chair, she nearly fell down. She didn't even want to eat any more of the homemade queso fresco cheese that I brought her a few days ago.

CASE STUDY PATIENT 3

Madison is pregnant and concerned. Recently she has been feeling achy. This morning when she woke up, she had a headache and stiff neck. She also complained that her morning sickness seems to have returned. She doesn't think she has been around any sick people, although she has been to family cookouts. She loves hot dogs, even straight out of the package!

CASE STUDY PATIENT 7

Jacob first realized he was sick when he felt totally exhausted, and it was only 10 in the morning. He grew even wearier as the day went on, and developed double vision. By the time his neighbor drove him to the hospital, he could hardly speak. Jacob had been fine the week before while his wife was visiting her mother. He ate out a couple of times, but most of the time he ate in. There was meat in the freezer and all the veggies he and his wife had canned from their garden last year.

CASE STUDY PATIENT 4

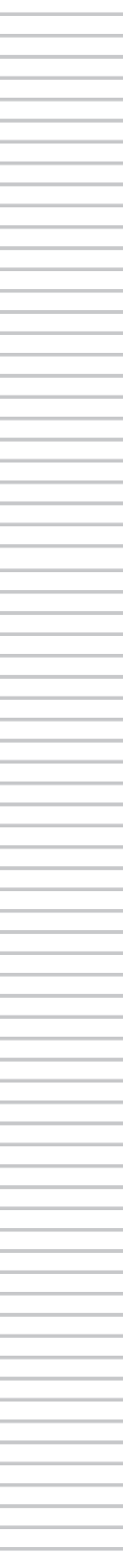
Salvador's joints are stiff and he complains of pain when he urinates. He is only 35 years old and generally boasts of good health. In fact, he has only taken one sick day last winter when he had a "stomach bug" with diarrhea.

CASE STUDY PATIENT 8

Ethan's mother took him to the emergency room because he had severe abdominal cramps and bloody diarrhea. She could not understand why suddenly he was so sick. Just the day before he had been playing with his little friends and swimming in the neighbor's kiddie pool.

EXPERT INFORMATION CHART

Pathogen:	How disease diagnosis can be confirmed:
Sources of contamination:	
Disease caused by pathogen:	Complications for some vulnerable groups:
Symptoms of the disease:	
Duration of disease:	Treatment:
	Prevention protocol:



LESSON #3: CHEMISTRY—Heat of Solution is Cool

Length of Lesson: One 45-minute period

Subject Area: Chemistry

Overview:

Students will measure the temperature change of endo and exothermic reactions by dissolving polyols (sugar alcohols often used as sugar substitutes) and salts.

Objectives:

Students will understand the following:

- 1) Chemical reactions may release or consume energy.
- 2) Food is a form of potential chemical energy.

STANDARDS

PHYSICAL SCIENCE

Chemical reactions

- Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by producing heat and by emitting light.

SUGGESTED MATERIALS

(Prepare one set of materials for every student team.)

- Small styrofoam cups
- Thermometer
- Room temperature water
- Graduated cylinder
- Anhydrous calcium chloride (CaCl_2)
- Table sugar ($\text{C}_6\text{H}_{12}\text{O}_6$)
- One or more containers of sorbitol ($\text{C}_6\text{H}_{14}\text{O}_6$), mannitol ($\text{C}_6\text{H}_{14}\text{O}_6$), erythritol ($\text{C}_4\text{H}_{10}\text{O}_4$) and/or xylitol ($\text{C}_5\text{H}_{10}\text{O}_4$)
- Sodium chloride (NaCl)
- Test tube racks
- Balance

> PART 1: INVESTIGATION

- 1) In classroom discussion, ask students if mint gum really makes mouths cooler. Explain that in sugar-free gum, polyols (sugar alcohols), which are sugar substitutes, do not cause cavities. They are also safe for diabetics who cannot have sugar. Have students hypothesize what will happen when polyols are added to water. Are they really “cool?”
- 2) Instruct each team to do the following:
 - a) Add 30 ml water to up to seven styrofoam cups and record the temperature in degrees Celsius of the water.
 - b) Measure 5 grams of each substance.
 - c) Beginning with calcium chloride, since it is deliquescent, one at a time, add 5 grams of the substance to the water.
 - d) Measure the final temperature of the water (the lowest or highest it becomes after the crystals have dissolved).

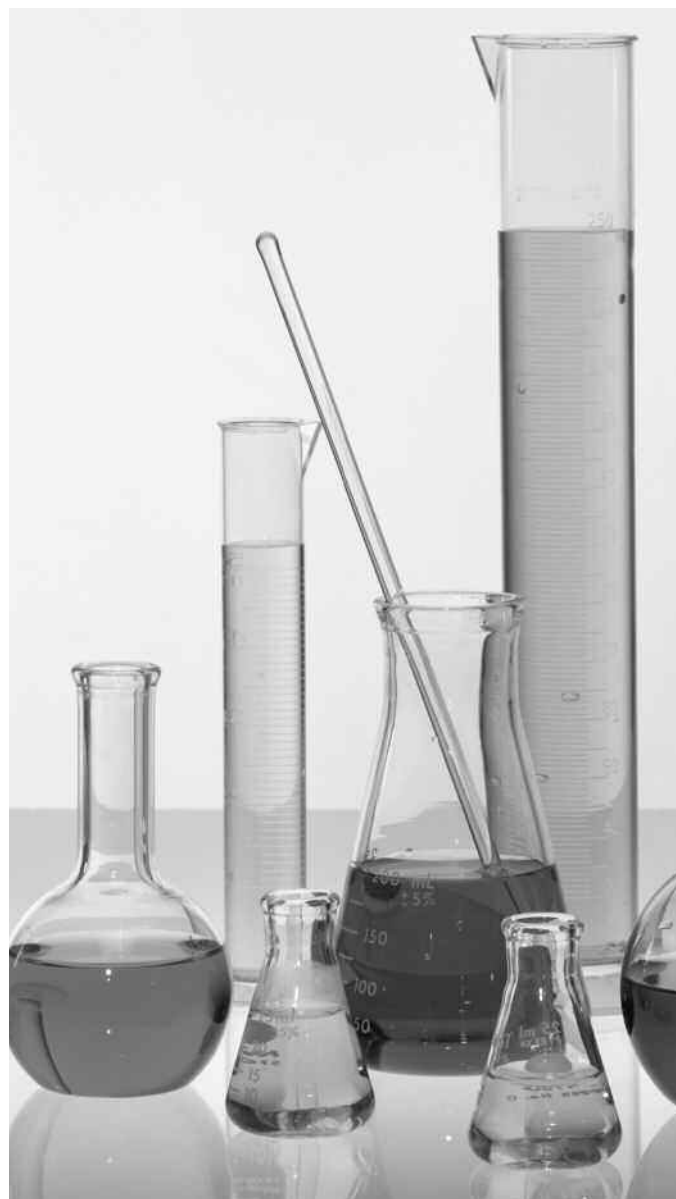
> PART 2: DEBRIEFING

Ask students if it's really possible for chewing gum to make your mouth cooler. What is happening in your mouth? (Endothermic reactions absorb heat, resulting in a “cooling sensation” as certain ingredients such as polyols dissolve.)

Based on the specific heat of water ($C_p = 4.184 \text{ J/g}^\circ\text{C}$), the temperature difference (ΔT), and the grams of solid added, have students calculate the heat of solution (q) at room temperature for each substance using the equations $q_{\text{water}} = C_p \Delta T$ and $q_{\text{water}} = -q_{\text{dissolution}}$.

Answer: Calcium chloride: $\sim -75 \text{ J/g}$; sodium chloride: very small; sucrose: very small; mannitol: 121 J/g ; sorbitol: 111 J/g ; erythritol and xylitol: 167 J/g .

If students' results are not the same as the known heats of solution, have them identify variables and sources of error (possibilities include temperature of water, since the heat of solution calculated is dependent on it, energy loss from the styrofoam cup, inability to fully dissolve solids).



> **EXTENSIONS:**

- 1) Students can dissolve sugar-free candies or add chewing gum to water and measure the temperature change.
- 2) Several brands of ice-melting salts can be similarly tested (for example, calcium chloride is commonly used). Is it desirable for endo- or exothermic reactions to occur? (Answer: Exothermic, so that the heat melts the ice.)

> **EVALUATION:**

Oral or written: Students will explain how food is a form of potential chemical energy by demonstrating a clear understanding of the activity objectives and relevant vocabulary.

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VOCABULARY

calorie—The International System of Measures (SI) unit of heat energy required to raise the temperature of one gram of water by one degree Celsius under standard conditions.

Calorie—This term is commonly found on food packaging. The standard SI prefix kilo is used to indicate 1000 times more, but in this country, we use the capitol C. Therefore a Calorie = one kilocalorie.

Deliquescent—To dissolve and become liquid by absorbing moisture from the air.

Endothermic—Absorbs heat.

Exothermic—Releases heat.

Heat of solution—The net enthalpy that results from solute/solvent interactions as the solute dissolves.

Teachers: if your students look for more information about polyols on the Internet, they will find that food industry literature uses the term *negative* heat of solution, even though chemistry equations dictate that they have a *positive* heat of solution. The difference in terminology stems from the definition of “positive” and “negative” (since the assignment of signs is always arbitrary).

CAREER CONNECTION



Peter Jamieson

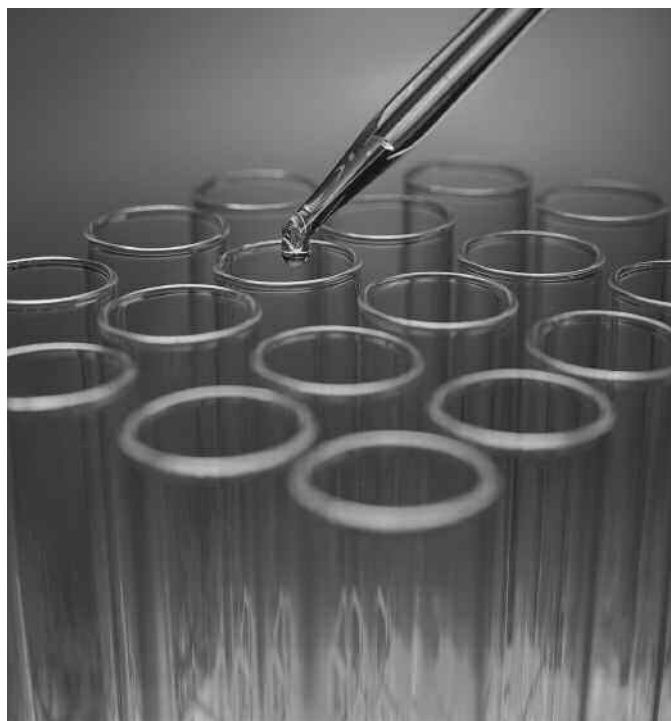
Manager of Applications
Research and Technical
Services

SPI Polyols, Inc.
New Castle, DE

“Our company is a manufacturer of ingredients that find their way into many everyday items – such as toothpastes, adhesives, ice cream, baked goods, and candies. I work specifically in the applications research and development group creating new ingredients as well as evaluating established ones in various applications.

Examining applications – no matter how mundane they may seem – or creating new products depends specifically on understanding how each ingredient works with the other. Therefore we need science to determine what the ingredients are made of, how they will react, how can they be created, and how can they be measured.”

For more information about this scientist and many others, visit www.discoveryschool.com/foodscience.



LESSON #4: CHEMISTRY—Acids for Pickling

Length of Lesson: One-to-two 45-minute periods
Subject Area: Chemistry

Overview:

Students will titrate three unknown solutions and prepare graphs for each titration. By comparing the titration curves of unknowns A and B, they will discover the buffering capacity (reserve acidity) of weak acids.

Using the following criteria, they will choose the acid type (organic or inorganic) that is best suited for pickling:

- An acid with high buffering capacity so that the low pH remains stable, even though changes may occur in the pickled food.
- A pH that is too low to allow growth of most forms of bacteria.

Students will compare the titration curve of the unknown (apple juice) to the titration curves of solutions A and B to determine whether apple juice contains a strong or weak acid.

Objectives:

Students will understand the following:

- 1) All of the hydrogen ion of strong acids, such as inorganic acids, is released into solution when added to water. These acids are completely dissociated.
- 2) Titrating strong acids with a strong base produces a smooth curve. The pH rises continuously as base is added.
- 3) Some bacteria produce organic acids as byproducts. This is often useful in food production: fermentation of milk by lactic acid bacteria makes yogurt.
- 4) Only some of the hydrogen ion of weak acids, such as organic acids, is released into solution when added to water. Because these acids are only partially dissociated, pH measurements detect only the dissociated hydrogen ion.
- 5) The reserve hydrogen ion (buffering capacity) of weak acids can be measured by titrating them with a strong base. As hydrogen ion is removed from solution by the strong base, more reserve hydrogen ion dissociates until all hydrogen ion has been dissociated. This produces a characteristic graph with a plateau at the pH where reserve hydrogen ion is dissociated.
- 6) Foods must have a pH below 4.5 to prevent bacteria from growing.
- 7) Partially dissociated organic acids, like vinegar (acetic acid), are excellent choices for food preservation. Because these acids are only partially dissociated, they present a pH that is safe to ingest. Dissociation of additional hydrogen ion compensates for changes in food product that neutralize some of the original hydrogen ion.

STANDARDS

PHYSICAL SCIENCE

Chemical Reactions

- A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions between reacting ions, molecules, or atoms).

TEACHER PREPARATION

Prepare 0.1 M solutions of hydrochloric acid and acetic acid. You will need apple juice on hand. Identify these solutions as follows:

A = Hydrochloric acid
B = Acetic acid
Unknown = apple juice

Prepare 1.0 M NaOH (sodium hydroxide) solution. Do a test titration of the acetic acid solution with the NaOH. Adjust the concentration of NaOH so that 100 ml of acetic acid will be completely neutralized by 20 – 30 drops.

Decide whether you want to have students dispense their own solutions or whether you will do that. Arrange your lab accordingly.

Remind students to follow expected laboratory safety procedures when handling unknown solutions.

SUGGESTED MATERIALS

- pH meter or computer pH electrode. (Good quality wide-range pH paper can be substituted.)
- HCl
- Acetic acid
- Apple juice
- NaOH (sodium hydroxide)
- Distilled water
- Eyedroppers
- 250 ml glass beakers
- Glass stirring rods
- Graph paper

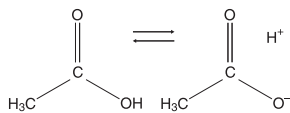
> PART 1: INVESTIGATION

- 1) Ask students what acids are used for. Ask them to describe the chemistry of an acid (Answer: Hydrogen-containing molecules or ions able to give up a proton to a base, or substances able to accept an unshared pair of electrons from a base).
- 2) Have students hypothesize what happens to the pH of an acid when a base is added.
- 3) Demonstrate the following:
 - How to do a drop-by-drop titration.
 - How to monitor the pH of the test solution with your pH equipment.

- How to record and notate data.
 - How to plot pH (dependent variable) against drops added (independent variable).
- Put students into lab teams and distribute any materials.
 - Have students run their three titrations.
 - When completed, tape up each team's graphs in groups of like solutions.

> PART 2: DEBRIEFING AND APPLICATION

- Have teams review each other's graphs.
- Lead a discussion of the differences between the titration curves of solutions A and B. Compare the plateau in the acetic acid titration (solution B) to the smooth plot of the hydrochloric acid (solution A). Explain the concept of partially dissociated, or weak, acids. Draw the molecules of acetic acid (see figure) and hydrochloric acid (HCl).



- Ask students if their hypothesis was correct. Ask them to consider acetic acid: did the pH *always* increase when they added base, or were there any plateaus?
- Write the criteria for a good pickling solution listed in the overview on page 12, on the board. Ask students to identify and defend the best choice from among the solutions that they titrated.
 - Confirm the choice of solution B and restate the idea that the buffering capacity of a weak acid acts like a pH shock absorber. Weak acids resist change in pH within their dissociation range.
 - Discuss how/why pickling works. (Answer: Natural fermentation by bacteria in the environment that produce acetic acid. Most bacteria cannot survive in an environment with a pH lower than 5.0.)
 - Ask students if the unknown (apple juice) behaved more like a strong or weak acid and why. Does it contain acetic acid? (Answer: No, apple juice contains malic acid. There are many organic acids, all characterized by the COOH structure).

> EXTENSIONS:

Students may titrate other samples and plot titration curves that reveal whether the samples are partially dissociated or completely dissociated acids. Consider orange juice (citric acid, ascorbic acid), yogurt (lactic acid), or lemon-lime soda pop (phosphoric acid). Where did these acids come from? (Note, colored samples may interfere with pH paper.)

> EVALUATION:

Oral or written: Students will explain which solutions are best choices for pickling by demonstrating a clear understanding of the objectives and relevant vocabulary.

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VOCABULARY

Completely dissociated acid—When all of the available hydrogen splits from the molecule.

Dissociate—When atoms or groups of atoms split from the remaining molecule.

Ion—An electrically charged atom or group of atoms. When a hydrogen atom splits off its parent molecule, it becomes a hydrogen ion, H^+ .

Partially dissociated acid—When only a portion of the available hydrogen splits from the molecule.

pH—A numerical scale from 0 to 14 that indicates the acidity or alkalinity of a solution. A pH of 1 is highly acidic and a pH of 14 is highly alkaline. Neutral solutions have a pH of 7.

Titration—A lab procedure where known amounts of reagent are added to a reaction vessel and the response recorded.

CAREER CONNECTION



Nirav Pandya, M.S.

Dairy Operations & Research Manager

University of Nebraska
Lincoln, NE

"I was always interested in science. However, I didn't know much about dairy/food science until I chose it as my undergrad major. It took only one class of dairy processing to know that this is what I really wanted to do in the future. My keen interest in the subject led me to my Master's in Dairy Science from South Dakota State University. Dairy/food science is basically an application of the sciences, engineering and technology, and business for the study of milk production and processing, to improve the taste, nutrition, and value of milk products. My current job involves the manufacturing of different dairy products as well as product development. Developing new flavors of ice cream is enjoyable and allows me to use my knowledge and skills to satisfy the consumer's need for a certain taste or product. The best part of the job is the show of happiness on the face of the consumers while eating my products. I use my chemistry, biology, and engineering training to improve the quality of dairy products. THIS IS A GREAT JOB!"

For more information about this scientist and many others, visit www.discoveryschool.com/foodscience.

LESSON #5: PHYSICS—Jelly Sandwich Packaging

Length of Lesson: Three-to-four 45-minute periods

Subject Area: Physics

Overview:

Students will design packaging to protect a jelly sandwich during shipping.

Objectives:

Students will understand the following:

- 1) Understand that for the velocity of an object to change, a force must be applied. Falling objects accelerate due to gravity.
- 2) Understand that for a falling object to stop, a counteracting force must exist. Since a falling object decelerates almost instantly when it hits the ground, the counteracting force must be much larger than the force of gravity.
- 3) Determine the velocity of an object dropped from two meters.
- 4) Determine the mass of dropped objects and calculate their force using the standard formula $force = ma$, and/or momentum $= mv$.

STANDARDS

SCIENCE AS INQUIRY

Abilities Necessary to do Scientific Inquiry

Design and Conduct Scientific Investigations.

- Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.

PHYSICAL SCIENCE

Motions and Forces

- Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F = ma$, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.

SCIENCE AND TECHNOLOGY

Understandings About Science and Technology

- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

Abilities of Technological Design

- Identify a problem or design an opportunity.
- Propose designs and choose between alternative solutions.
- Implement a proposed solution.
- Evaluate the solution and its consequences.
- Communicate the problem, process, and solution.

SUGGESTED MATERIALS

(Choose the format that best fits your classroom. Regardless of the format you choose, assign a point value (dispensing materials by the item or square inch) to each material so that student teams may calculate the "cost" of their design.)

- **Format A**—Student teams design their packaging in class and collect materials for their packaging outside of class using whatever materials they can gather. Students create their packaging in class. (Advantage: More creativity, more diversity of design, less teacher preparation. Disadvantage: Possibility of less student participation.)
- **Format B**—Provide students with packaging materials such as cardboard from cereal boxes, foam peanuts, shredded paper, bubble wrap, tape, glue, etc. (Advantage: Level playing field, more consistent student participation. Disadvantage: Less diversity in design, more teacher preparation.)

> PART 1: INVESTIGATION

- 1) Conduct a brief discussion about packaging by asking questions such as:
 - Don't you just hate it when packaging doesn't work? Have you ever experienced opening a package where the food had been smashed?
 - Have you ever seen a stock person restocking shelves in the supermarket? What foods have the most durable packaging?
 - Why don't we package everything in cans?
 - What materials are used for packaging?
 - What do you think are the attributes of the best packaging designs? (Try to elicit answers such as strong, yet lightweight. Inexpensive, yet attractive, etc.)
- 2) On day one and two teams design and make packaging that will carry and protect a jelly sandwich during shipping. Depending on the format you have chosen, they can design on one day and complete construction at home or work exclusively in the classroom for both days.
- 3) On day three, presentation day, student teams will subject their packaging and sandwich to three stresses that might replicate incidents that would occur if the sandwich were shipped.

- a. Being dropped from a height of two meters.
 - b. Being thrown sideways into a wall from a distance of two meters.
 - c. Being placed at the bottom of a pile of weights (for example, books) until the top crushes down. (Instead, you may choose to drop a plumb bomb onto the top of the packaging until it breaks through or pushes into the top of the sandwich.)
- 4) During the stress tests, the judge(s) must be able to open the package to observe the sandwich after each test. Teams may not change their packaging design after a test, but may reseal the package. Their design will be judged for each stress endured, the practicality of the weight and size of packaging, and the cost.

> PART 2: TESTING THE PACKAGING

- 1) On the day of the presentation, make one jelly sandwich for each team. Prepare the testing areas so that student teams can test their packaging quickly, yet accurately.
- 2) Call student teams one at a time to test their packages. After each test, ask the team to open their package and observe the sandwich. You may establish your own scale for determining success, or use the following rubric: Award 4 points for no damage, 3 for minimal damage, 2 for some damage, and 1 for significant damage.
- 3) After completing the stress tests, give a score for practicality of weight and size using a range of 4 points for “very practical” to 1 point for “impractical.”
- 4) Finally, look at each team’s cost of materials. Rank the teams in order from most expensive (1) to least expensive. Award points equal to each team’s rank on the list, but only for designs that earned at least 2 points in every stress test. Designs earning less than 2 points on the stress tests are not eligible to earn cost-effective points.

> EXTENSIONS:

- 1) Teams can design packaging for more delicate food choices (such as a raw egg, a ripe fruit, or cupcake with frosting) and/or subject the food to more rigorous testing.
- 2) Allow students the opportunity to refine their designs and run a second presentation day.

> EVALUATION:

Oral or written: Require students to demonstrate a clear understanding of the physics of motions and forces by:

- Describing the forces involved when tossing the package sideways into the wall.
- Determining the mass of the package and the mass of the sandwich.
- Determining the velocity, momentum, and force at impact of the package when it is released from a height of two meters.



VOCABULARY

Acceleration—The rate at which velocity changes.

Cost-Effectiveness—Best product for the least cost.

Gravity—The attractive acceleration associated with all matter. The acceleration of Earth’s gravity is 9.8 m/s^2 .

Mass—The amount of matter within an object, measured in grams.

Velocity—The speed of an object in a particular direction.

CAREER CONNECTION



Maria Rubino, Ph.D.

Assistant Professor
School of Packaging
Michigan State University
East Lansing, MI

“I have a BS in chemistry an MS in packaging, and a Ph.D. in Food Science. The main focus of my job is to teach and develop new ideas about packaging science through research. It is important for me to keep up to date with new information and trends which is not an easy task because there is a lot going on in the field of science. Another important activity is to work with my students to create, prove or evaluate new ideas in the food packaging field.”

For more information about this scientist and many others, visit www.discoveryschool.com/foodscience.

LESSON #6: PHYSICS—Splat Test for Viscosity

Length of Lesson: Two-to-three 45-minute periods

Subject Area: Physics

Overview:

Students will measure viscosity of various liquids and determine the proportional inverse relationship between the viscosity of a liquid and the size of the splat it makes when dropped on a paper.

Objectives:

Students will understand the following:

- 1) Define the term viscosity and identify it as a physical property of matter.
- 2) Construct and interpret a standard curve using reference and experimental data.
- 3) Describe, in written and/or graphic form, an inverse relationship between two variables.
- 4) Describe sources of error and potential improvements in an experimental design.

developing explanations, and charts and graphs are used for communicating results.

UNDERSTANDINGS ABOUT SCIENTIFIC INQUIRY

- Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.

PHYSICAL SCIENCE

Structure and Properties of Matter

- The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

TEACHER PREPARATION

Prepare viscosity droppers by cutting the tip off each syringe at the 0 ml mark or (if no 0 mark) where the calibration marks begin. Attach the dropper to a clamp and attach to the ring stand at the maximum height possible. Ensure that all setups are congruent in height.

SUGGESTED MATERIALS

(Prepare one set of materials for every student team.)

- 10 ml plastic disposable syringes (see teacher preparation)
- Utility knife (see teacher preparation)
- Semi-log graph paper (cut into paper targets)
- Ring stands and clamps
- Metric rulers
- Test liquids: olive oil, corn syrup, molasses, honey, chocolate syrup, sour cream, peanut butter, glycerin (enough to provide 20 ml samples of each to each lab team)

> PART 1: INVESTIGATION

- 1) Conduct a brief class discussion of viscosity by posing questions such as:

Why do some liquids pour more easily than others? For example, milk pours more easily than honey. If I asked why, you might say, 'Honey is thicker.' That's close, but the real answer is viscosity.

- 2) Describe viscosity as a quantity that describes a fluid's resistance to flow. This resistance is caused by the intermolecular attraction of the molecules making up the liquid. You can think of viscosity as the 'thickness' of a fluid (a liquid in this case). The higher a liquid's viscosity, the harder it is to pour. Viscosity is an important property of many

STANDARDS

SCIENCE AS INQUIRY

Abilities Necessary to do Scientific Inquiry

Design and Conduct Scientific Investigations.

- Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.

Use Technology and Mathematics to Improve Investigations and Communications

- A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this standard. Mathematics plays an essential role in all aspects of an inquiry. For example, measurement is used for posing questions, formulas are used for

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fluids that we encounter daily. Viscosity influences the texture and desirability of the foods we eat, the effectiveness of cooking oils, and the processing and packaging of our foods.

"Today in teams you will be determining the viscosity of different fluids. There are many ways to determine viscosity, but you will be using a fun, messy way of testing viscosity —the Viscosity Splat Test."

- 3) Ask students to pose a hypothesis. Write this prompt on the board and direct them to complete the statement: The _____ the viscosity, the _____ the splat.
- 4) Distribute to each lab team: one prepared viscosity dropper, one paper target per test material, 20 ml samples of each test liquid except glycerin.
- 5) Direct student teams to complete the lab, following the directions below for each fluid they test.
 - a. Place one paper target beneath the viscosity dropper.
 - b. Load 5 ml of test liquid into the viscosity dropper.
 - c. Use the syringe plunger of the dropper to eject the test liquid, allowing it to drop onto the paper target.
 - d. After each drop, use the metric ruler to measure the splat diameter for the liquid. This is the diameter of the splat that the liquid makes on the paper target. Measure the main body of the splat. Do not measure all the small drops that might separate from the main splat. If the splat is not circular, compute an average of the longest and shortest diameters of the splat.
- 6.) On the board, make a chart with three headings: *Sample*, *cP Viscosity* and *Diameter of Splat*. Provide the following viscosity (cP) values: Olive oil 84 cP, Corn syrup 2,500 cP, Molasses 6,600 cP, Honey 10,000 cP, Chocolate syrup 18,000 cP, Sour cream 100,000 cP, and Peanut butter 200,000 cP.
 - a. Repeat steps 5a through 5d for each test liquid.
- 7) Results: Class data will show that the splat diameters are inversely proportional to the known viscosity (cP) of the sample.
- 8) Direct students to graph the data and construct a standard curve based on the viscosity splat test. The y-axis will show the cP value (count by 10,000's) and the x-axis will show the diameter of splat (count by centimeters).
- 9) Distribute a sample of glycerin. Ask students to repeat the experiment to determine the size of the splat. Use that value to estimate the viscosity (cP value) of glycerin. Compile a class mean and compare it to the correct answer: 100% glycerin has a cP value of 1,410 cP.

> PART 2: QUESTIONS AND DEBRIEFING

- 1) Conduct a class discussion and debriefing about the experiment:
 - What is meant if we state "Y is inversely proportional to X." (Answer: As X increases, Y decreases, and vice versa.)
 - Was the hypothesis that the splat diameter is inversely proportional to viscosity true? (Yes)
 - If you test a new substance with a low viscosity, would you expect the splat diameter to be small or large?
 - What are the sources of error that explain the variability of results in the glycerin investigation? List potential improvements in an experimental design.
 - How can you use standard curves to estimate unknown values?
- 2) Conduct a class discussion and debriefing about the content:
 - What is viscosity?
 - Why is viscosity important to food scientists? How might it affect the ability to pump fluids through pipes? (Answer: Viscosity influences the texture and desirability of the foods we eat, the effectiveness of cooking oils, and the processing and packaging of our food.)



CAREER CONNECTION



Amy Rowley

Graduate Student and
National Science Foundation
Graduate Teaching Fellow

Department of Food Science
and Technology
University of Georgia
Athens, GA

"Science was always something that I enjoyed, however, it was in high school that I first discovered my love for chemistry and decided to pursue a career in the chemical industry. Throughout college I considered careers in pharmaceuticals, fragrances, and education, but after an internship in the beverage flavor industry, my sights were set on food science. My research in food science education focuses on using food science to improve high school students' attitudes toward science, as well as creating interest in food science among high school and college students."

For more information about this scientist and many others, visit www.discoveryschool.com/foodscience.

> EXTENSIONS:

- 1) Ask students to investigate other ways to measure viscosity. The viscosity of clear liquids may be measured by timing the descent of a ball or bearing placed in a cylinder of the liquid. It can also be determined by measuring the flow of a liquid through a small tube or orifice or down an inclined plane. There are also industrial viscometers that measure the resistance of a rotor as it rotates within a liquid.
- 2) Ask students to investigate the viscosity of ketchup, a non-Newtonian fluid. A fluid can be classified as either Newtonian or non-Newtonian based on its behavior when a force is applied to the fluid. The viscosity of water, a Newtonian fluid, is independent of the force applied. In contrast, the viscosity of ketchup and other non-Newtonian fluids is dependent upon the force applied to the fluid. The viscosity of ketchup decreases with increased force—an inverse relationship. So whack the back of the bottle, and the ketchup will flow!
- 3) Ask students to investigate the viscosity of a bowl of oobleck. The recipe for oobleck is 1 box of cornstarch, 1 2/3 cups of water, and 4 drops of green food coloring. What happens to the viscosity of oobleck with increased stirring? (The more stirring, the higher the viscosity; this is also a non-Newtonian fluid.)

> EVALUATION:

Oral or written: Students will show a clear understanding of the nature of viscosity and the definition of an inverse relationship. They will construct and interpret a standard curve using reference and experimental data and recognize sources of error in an experiment.

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VOCABULARY

Centipoises (cP)—A common unit for measuring viscosity.

Inverse proportional relationship—A relationship in which one variable decreases as the other variable increases.

Viscosity—A quantity that describes a fluid's resistance to flow.



Science of Food DVD

Included in this kit is a three-part DVD that you can use to capture your students' interest and enhance their understanding of the field of Food Science and Food Technology.

Below is a brief description of what your students will see on the DVD. We encourage you to preview the DVD to better understand how you can integrate the segments with one or more of the six curriculum lessons in this guide.

Segment #1: TRT 6:28

FOOD SCIENCE OVERVIEW AND HISTORY

This segment begins by recounting the early history of food science and technology. It cites the invention of canning and pasteurization and the outrage generated by Sinclair's *The Jungle*, which exposed the squalid conditions in the meat packing industry. It highlights the establishment of the Food and Drug Administration (FDA) along with other government agencies responsible for protecting public health. The last part shows the products of food science and technology, such as TV dinners, food for astronauts, and vitamin-fortified foods.

Suggested Integration:

- Introduce Lesson #5 Jelly Sandwich Packaging. Your students will recognize that their task is like that of the food technologists who invented the TV dinner.
- Introduce Lesson #6 Splat Test for Viscosity. Like food scientists at National Aeronautics and Space Administration (NASA) or those creating a new food product, your students will have to test viscosity because it greatly influences texture and desirability of foods.

Segment #2: TRT 8:35

FOOD SAFETY

The first part shows the Centers for Disease Control and Prevention trying to find the source of a foodborne illness that struck thousands of people across the U.S. in 1994. The second part discusses the growth rate of microorganisms and the effect of pH, moisture, and temperature. The third part discusses how to keep foods safe to eat, which includes adding preservatives, packaging, irradiating foods, and handling food safely. It also highlights the Partnership for Food Safety Education's FightBAC campaign of "Clean, Cook, Chill, and Separate." This segment ends with how nanotechnology may allow the development of sensors on foods that would detect spoilage or indicate pathogen-friendly environmental conditions.

Suggested Integration:

- Introduce Lesson #2 Food Forensics. Your students will parallel the roles of CDC teams trying to determine what pathogen caused an illness and where the contamination was likely to have occurred.
- Show this DVD segment after Lesson #1 Osmosis and Lesson #4 Acids for Pickling. Your students will make the connection of how food scientists use their knowledge of biology and chemistry to inhibit the growth of pathogens.

Segment #3: TRT 11:04

CHEMISTRY OF FOOD SCIENCE

This segment begins by showing how to make saltwater taffy. Chemistry determines the importance of every ingredient in the recipe. For example, taffy's "secret" ingredient—glycerin—stops the crystallization of the sugar and acts as a solvent for flavorings to make taffy soft, creamy, and flavorful. In the second part, students learn how bomb calorimetry is used in the food industry to determine the energy content of foods.

Suggested Integration:

- Introduce Lesson #3 Negative Heat of Solution is Cool. Your students will see how food chemists investigate the nature of foods through experimentation and careful measurement.





About The Institute of Food Technologists

Founded in 1939, the Institute of Food Technologists (IFT) is the premier scientific and educational society serving the food science and technology field. IFT is a not-for-profit organization whose mission is to advance the science and technology of food through the exchange of knowledge. IFT members represent a broad cross-section of food professionals in industry, academia and government throughout the world.

About the Institute of Food Technologists' Foundation

IFT Foundation was established in 1985 to raise funds for specific innovative programs that enhance the quality of the food science and technology profession worldwide.

About Discovery Education

The leader in digital video-based learning, Discovery Education produces and distributes high-quality digital video content in easy-to-use formats, in all core-curricular subject areas. Discovery Education is committed to creating scientifically proven, standards-based digital resources for teachers, students, and parents that make a positive impact on student achievement and helps educators around the world engage students in the joy of learning by allowing them to explore the world and satisfy their natural curiosity. For more information, visit www.discoveryeducation.com.

Additional Teacher Resources

(Available at www.ift.org. Follow the "Education" link to "Teacher Resources".)

• **From Concept to Consumer: Food Product Development**

This 20-minute video describes a variety of Food Science career options within the large food processing industry, and promotes teamwork as the "road to success" in new food product development and other careers.

• **The Great Food Fight**

This 13-minute video (complete with collateral four-unit lesson guides) presents important food safety information for students of all ages on foodborne illnesses, various related microorganisms, and proper food handling.

• **Experiments in Food Science**

This 80-page booklet contains seven basic food science experiments designed for use in middle and high school science classes. Booklet includes teacher and student activity guides (which may be copied for students' usage).

• **Enzymes in Food Systems Experiments**

This 44-page booklet contains three food science experiments related to Enzyme Systems for use in middle and high school science classes. This single booklet contains teacher information and activity guides, sample data tables, student activity guides and visual masters for copying.

• **Microbiology in Food Systems Experiments**

This 67-page booklet contains four food science experiments related to microbiology and fermentation for use in middle and high school science classes. This single booklet contains teacher information and activity guides, sample data tables, student activity guides and visual masters for copying.

GIVE SCIENCE A TRY: PROMOTE SCIENCE FAIRS

Many of the experiments developed by IFT make great science fair projects.

- *The Internet Science and Technology Fair (ISTF), <http://istf.ucf.edu> is a national science and technology competition where teams of pre-college students research solutions to real world problems using information technology tools. They adhere to content guidelines based on national science content standards, they work with online scientists and engineers as team technical advisors and present their research findings in a website format. Their projects are judged nationally with top team awards from the National Medal of Technology Program at US Commerce. The ISTF is ideally suited for high school teams to research technical issues related to food sciences such as protein engineering, biocompatible materials, sustainable agricultural production and food safety assurance.*
- *The Intel International Science and Engineering Fair, <http://www.sciserv.org/isef/> is another great way to get students involved in science. Whether biochemistry, chemistry, life science or physics, food science experiments fit in. Many local IFT sections give special awards for food science-related projects.*